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Bass Tuning, Part 2: Accuracy and Precision

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Montreal QC Chapter

As mentioned in Part 1 of this series, these articles describe one way to tune the bass. In Part 1, I introduced the related ideas of accuracy (the correctness of a setting) and precision (the ability to reproduce the same setting). Achieving high accuracy and precision is ideal, but it will take longer and requires following specific procedures. Those specific procedures rely on an understanding of the Stretch Interval Set (SIS), which is described in Part 1. This next article in this series builds on that knowledge and covers the various levels of accuracy and precision that can be achieved using different methods, including the SIS.

Lowest Accuracy and Precision

Using E3 as an example, the lowest accuracy method of tuning the bass involves tuning one string of E3 as a single octave with E4 and stopping when it sounds good to our ear. No tests. The good thing about this method is that it is intuitive: There is no theory to learn, and there are no tests to memorize. Unfortunately, that is the only good thing about this method; E3 is correct only as far as E4 is. E4 may have drifted or was not tuned correctly in the first place, and E3 may drift when we add the other unison strings to it due to Weinreich drift. (For more information, see my article "Unison Drift" in the March 2016 *Journal.)* Also, the resulting octave lacks precision; there is a relatively large range of octave sizes that sound acceptable to our ears.

Medium Accuracy and Precision

As mentioned in Part 1, we are discussing tuning a small-scale-inharmonicity piano, which has midrange octaves that are tunable as pure 4:2/pure 6:3 octaves. However, my approach only uses this level of precision on the first two octaves tuned, F3-F4 and A3-A4. As we go into the bass, we are no longer tuning mid-range octaves.

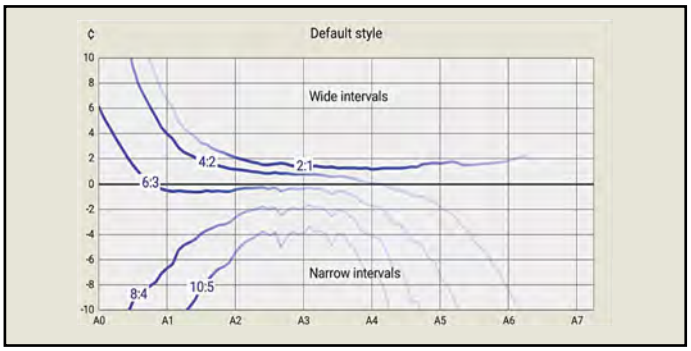

Figure 1: Octave sizes throughout the scale, as suggested by the PianoMeter ETD.

Figure 1 shows the octave sizes suggested by PianoMeter, a well-known and accurate electronic tuning device (ETD). You'll notice that in the midrange, the octave sizes suggested are equally wide 4:2/narrow 6:3. (For our piano, we can tune these sizes, and do, but only for F3-F4 and A3-A4. They both sound pure to our ears with equal beating tests, but are probably not. They are probably wide 4:2/narrow 6:3, as the graph indicates.) Look at the octaves above F4. The curve tends to favor the pure 4:2, and that is indeed how we tune those octaves on a small-scale- (or large-scale-) inharmonicity piano. Now look at the octaves below F3, like those starting at E3-E4. Here, the curve favors the pure 6:3, and so, when tuning our small-scale piano, we only use the 6:3 tests, if any, in the bass.

So, the procedure for medium accuracy and precision involves not just playing E3-E4 and saying it sounds okay, but also checking the 6:3 size by playing the m3/M6 test (E3-G3 and G3-E4). If our ear hears those intervals beating at the same rate, we can assume the octave is a pure 6:3. Often, however, a lower octave tuned by ear then checked with the 6:3 test is found to be a wide or narrow 6:3. When it is tweaked to be a pure 6:3 according to the tests, the technician notices an improvement.

Higher Accuracy and Precision

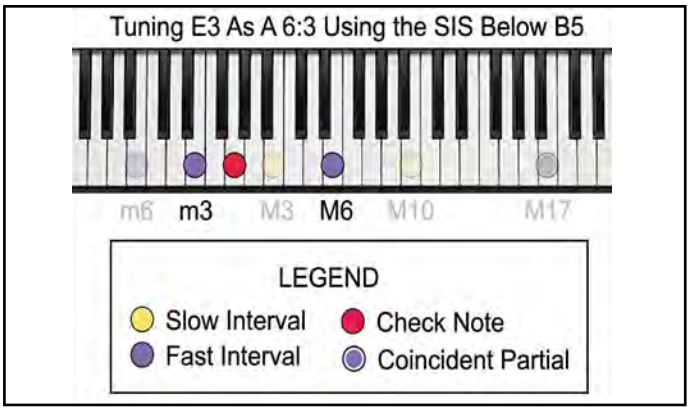

Figure 2: Tuning E3 as a 6:3 octave using the SIS.

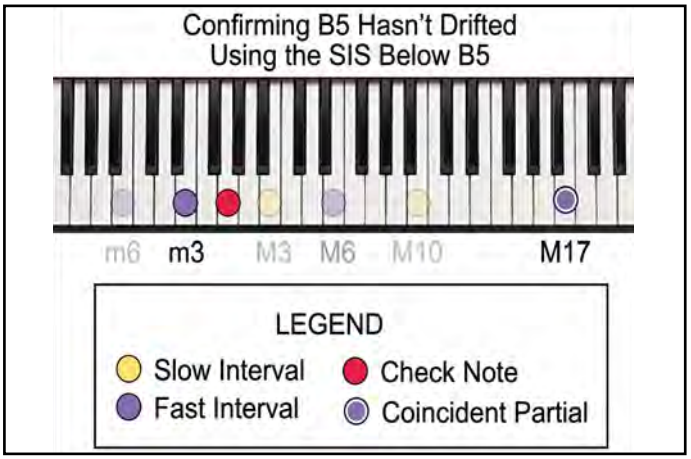

Figure 3: Confirming that B5 hasn't drifted, also using the SIS.

This is where the SIS comes in. (See Part 1 of this article series for a discussion of the theory of the SIS.) We use the SIS to confirm and tune pure intervals. Figure 2 shows the SIS we used to tune E3 as a pure 6:3. The notes used are dark; the notes of the SIS that we don't use are dimmed. You can see the 6:3 test, E3-G3 and G3-E4, but now we can use other notes in the set to confirm that B5 hasn't drifted. We confirm that the P19, E3-B5, is still pure by playing E3-G3 and G3-B5. See Figure 3.

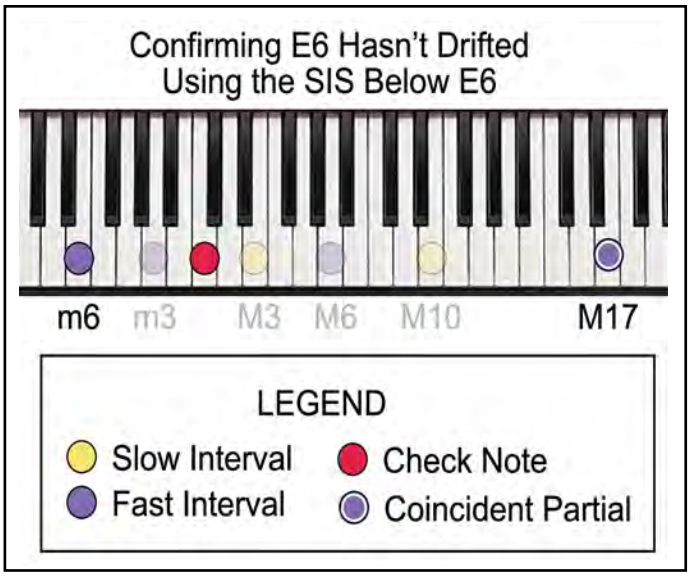

Figure 4: Using the SIS to confirm that E6 hasn't drifted.

Figure 4 shows an SIS that has a check note of C♯4 and includes E3. We can use it to confirm that E6 hasn't drifted by confirming the P22 (triple octave) E3-E6 is still pure by confirming that E3-C4 = C4-E6.

B5 and E6 are in the area of the piano sometimes called the "killer octave." Notes in this area tend to drift during the tuning and often need to be corrected if we want to have a fine tuning. By using the SIS to confirm the P19 and P22 are still pure, we can find and correct pitches that drift in the killer octave area.

How to Use the SIS to Tune Notes with Very High Accuracy and Precision

While using the SIS requires us to use all intervals of both sets, it is very quick, especially when working with a piano that was tuned recently. The benefit is that if any of the notes in the set have drifted, we will catch them.

While the SIS is composed of many fast-beating intervals like M3, M10, m3, etc., which are used to test pure intervals, it is more efficient and sometimes more accurate to play the pure intervals first. Listen to these pure intervals as if they are unisons because most of them are. For example, when listening to a P12, P19, or P22, we basically hear the unison partials alone, except for the top note. If that top note is pure with the coincident partial, it will get lost in the unison, and the interval will just sound like a clean unison. For example, consider the P19, F3-C6. When played, we hear only the unison partials of F3 (i.e., F3-F4-C5-F5-A5). We don't hear the partials of C6 until the 6th partial of F3. Therefore, there is a very strong requirement for F3 to be a clean unison if the P19 is to sound pure. If the 6th partial of F3 is beating, a pure F3-C6 P19 is impossible! (This is not as accurate a description with lower octaves. We will discuss this later in the low bass article in this series.)

So, playing the P11/P12/P19/P22 and P4 (listening at 8:6), and listening for purity, can tell us if something is wrong. Running through the SIS (Listening for M3 = M10, and M6 > M3 (wide P4), and then M6 = M17 = m3 = m6) may help us find that error.

Musical Interval Priority and Tuning Over the Break

The break in the piano is the section between the bass and treble where string design changes — going from wound strings to plain wire, from bichord to trichord, and even switching bridges. The issue of tuning over the break is often presented as a problem, something that makes tuning the piano difficult. This next section will try to explain why I never talk about tuning over the break and therefore do not find it a problem at all.

Understanding what musical intervals are and placing priority on them can free us up to worry about what makes a good tuning (musical intervals) and ignore the things we don't need to worry about (tuning over the break). Musical intervals are intervals from the SIS that are pure. We prioritize their purity not just because they sound good, but because they prove pure unisons, the most important quality of a fine tuning.

Often, technicians use progressive chromatic intervals and worry about them, trying to get them to change speed smoothly and evenly, especially over the break. I don't teach that these intervals have to be progressive over the break, or at all, and I only worry about them so far as they can help tune pure intervals from the SIS. Somewhere along the way, we lost sight of the purpose of progressive intervals. They are simply a guide to help us produce musical intervals like the pure intervals of the SIS. By themselves, progressive intervals are not musical. Only a piano technician would comment on the progressiveness of chromatic intervals, saying they were good or bad. The fact is, no musician will ever comment on how progressive these intervals are, if they can hear them at all, but they may notice a P12 or P19 that is not pure. Also, if we have a plethora of pure intervals, but the chromatic intervals that make them up are not progressive, what are we supposed to do? Do we destroy these pure intervals just so we can say we have progressive M3s, M10s, or M17s? Doesn't that sound a little backward? I would just leave them; my focus is always on making intervals sound musical.

That fact is, we don't need M3s, M10s, or M17s to be progressive over the break; we need them to follow each other. If the chromatic speeds of the M3s from F2 to F3 match the speeds of the M3s from F3 to F4, we will have all pure 4:2 octaves; even if they are not progressive but change at the same time as each other. To illustrate this concept, imagine these M3 beat rates from F3 to A3:

F3-A3 = 7
F♯3-A♯3 = 9
G3-B3 = 8
G♯3-C4 = 9
A3-C♯4 = 8

These are NOT progressive! But if we have these M10 beat rates, then we will have all pure 4:2s:

F3-A4 = 7
F♯3-A♯4 = 9
G3-B4= 8
G♯3-C5 = 9
A3-C♯5 = 8

What's more important? I often say that progressive beat rates are the lowest priority in a fine tuning, and yet, for some technicians, it is still the number one test they use to determine the quality of a tuning. P4s/P5s that are not ugly are also a high priority, so it is unlikely the beats listed would produce clean octaves and non-ugly P4s/P5s, but it illustrates the point.

Pure Unison/Pure Interval Procedure

Many high-level concert technicians have their own preferred ways to tune the stretch, but I teach the SIS because it has so many pure intervals. While one can get different qualities from the stretch by making some intervals not pure, I don't teach this because clean unisons are more important than small differences in interval sizes; if your unisons aren't clean, forget about being fancy with the interval sizes.

Pure intervals prove pure unisons. If your interval sounds pure, you can be pretty sure the unisons are pure. Use the following procedure to prove pure unisons.

1. Play an interval from the SIS that should sound pure.
2. If it does not sound pure, check the unisons.
3. If you can't get a unison pure, look for false beats, mismatched inharmonicity (different string diameters), or hammer mating problems. If issues are found, don't expect this interval to sound pure; do your best.
4. If the unisons are pure, or you get the unisons pure and the interval still is not pure, try to understand what is happening:

    - The unisons are not the problem.
    - The interval does not sound pure because it is not pure.
    - This means the check intervals are not equal.

You may have tuned this interval pure by making the beat speeds equal and swear they sounded the same when you tuned it. *But they are not!* They can't be. The interval is not pure, and it is not the unisons' fault.

Here is where I teach students to understand auditory illusion. The beat speeds were probably not equal, but you were trying to perceive them as equal. Your ear told you what you wanted to hear. Now that your brain knows they are not equal, tell your ear it must listen again and pick one of them to be faster. We call this "accurate guessing"; the beat speeds are probably very close, but we know they are not equal, so just guess which is faster and you will probably be right. Once your ear picks one as faster, you will now know the size of the interval — wide or narrow — and then you can use the golden rule that I teach:

> Check each note of the interval the way it was originally tuned (each note is tuned only one way, which is very accurate) trying to hear it wrong in the right direction that will allow you to tweak the note and make the interval pure.*

*Hearing notes wrong is a lot easier than trying to hear them right. These very small changes in pitch are best done using double string unison (DSU), also known as cracking or shimming the unison. If you hear the note wrong in the wrong direction, do not try to fix it. Move on.

Conclusion

In this article, we talked about how to use the SIS to tune and confirm notes already tuned. We looked at varying the levels of accuracy and precision by choosing more or fewer intervals from the SIS to use. We also talked about how powerful it is to tune many pure intervals because they prove pure unisons, which are so critical for a high-quality tuning. And we showed a neat way to correct notes in the killer octave. In Part 3, we will talk about the curious case of single bass strings, or monochords, which are tuned quite differently than the rest of the bass. □

Mark Cerisano, RPT*, is devoted to improving aural piano tuning techniques. He has used his background in mechanical engineering to test the reliability of assumptions routinely made by piano tuners. He has used his training in education to develop explanations of concepts that simplify understanding of aural piano tuning. Cerisano is the author of several books and* Journal *articles. He can be contacted through his website, IPTS.online.*

For a video on how to use the Stretch Interval Set, scan the QR code: