Intonation – Just and Tempered

BY JOANNA WHITE

Young French horn, trombone, or violin students learn from the first day to place notes in melodies, intervals, and chords so the pitches sound in tune, but beginning flutists often learn only fingerings. Even those who understand the basic elements of flute intonation may think that practice with an electronic tuner solves all the problems, but teachers should go beyond the tuner and teach students the aural ability necessary to play beautifully in tune.

There have been various tuning systems throughout history, and equal temperament and just intonation are the most used systems by musicians today. Understanding equal temperament is essential to playing chamber music with a fixed-pitched instrument, such as a piano. Just intonation, on the other hand, eliminates dissonant beats and allows musicians to play in tune within a harmonic context. There are older tuning systems as well such as mean-tone tuning, with its good-sounding thirds, and Pythagorean tuning with its strong fifths and octaves. Many string players learn various kinds of melodic tuning where note placement depends on the melodic context; this method makes melodies more colorful. Equal temperament and just intonation, which all classical musicians should understand, are the focus for flutists.

Two notes vibrating at the same frequency or speed are in unison and sound pure and static. An out-of-tune unison produces waves or beats that, when strong enough, actually produce a jangly sound. The more out of tune the unison is, the faster the beats become, but the beats disappear when the unison is brought in tune.

Intervals also sound pure when in tune and rough when out of tune. Understanding the harmonic series helps musicians play various intervals correctly. When an air column vibrates, overtones
are not just or pure. Theorist Llewellyn S. Lloyd states: “In the modern tuning of keyboard instruments, called equal temperament, every interval except the octave is mistuned to attain a musical objective; complete freedom of modulation.” He states that ensembles do not play in equal temperament, and that the system is practical but not artistic.

Steps to Improved Intonation

1. Play a steady pitch.
2. Play unisons and octaves in tune with a traditional tuner.
3. Play crescendos decrescendos, loud, and soft in tune with the tuner.
4. Know the pitch tendencies of registers and specific notes on your flute.
5. Know what chord note you are on.
6. Eliminate the extra beats.
7. Use the tools listed in the Intonation Resources Chart.
8. Know the pitch tendencies of the other instruments you play with.
9. Play ensemble music as often as possible, particularly with more advanced players who provide a strong pitch foundation.

Because equal temperament, however imperfect, remains the standard in the world of fixed-pitch instruments, a traditional electric tuner, based on the equal tempered scale is an extremely valuable tool for matching pitch and octaves, learning the intonation tendencies of our instruments, and playing in tune with equal tempered instruments. A tuner is limited however, because it cannot teach just intonation.

Intervals such as major thirds, sound pure when notes are played where they fall in the harmonic series, but they do not sound pure when they are derived from an equal tempered scale. The common harmonics of both notes of a just major third resonate at the same frequencies and do not clash with each other. In equal temperament, on the other hand, the top of a major third lies 14 cents (hundredths of a half-step) higher than the top of a just major third. The equal tempered top of the third is at a different frequency from the same note vibrating as a harmonic of a lower note and does not sound true. If the fundamental C♯ in example 2 is placed as an equal tempered third, its fourth partial clashes with the fifth partial of the fundamental A. If the C♯ is made just, the interval sounds in tune.

Knowledge of just intonation intervals helps us learn the adjustments necessary to be in tune with overtones, and results in noticeably more resonant chords. Barbershop quartets that use extremely pure intervals are a good example. Albert Tipton also pointed out that the greater resonance of in-tune chords provides better sound projection. Since chords using just intonation ratios sound more in tune and stronger, flutists should learn to produce them to blend within an ensemble. Difference tones, low notes that sound when two higher fundamental notes are played together teach this principle. Difference tones are often more audible to flutists’ ears than the resonating partials in the harmonic series because the flute’s range is so high. Flutists can learn to hear difference tones and manipulate them in order to play in just intonation.

When we play two notes simultaneously we hear not only the two tones, but also a much lower difference tone; it is the mathematical difference between the original two fundamental frequencies. These difference tones, especially audible when high tones are close together, sometimes clash with the first two tones, producing dissonance. To remove the out of tune sound and tune the difference tone adjust the distance between the original notes. Experienced musicians on non fixed-pitch instruments listen and adjust each interval to sound true, pure, or just. Flutists generally tune to the root or lower note of the chord but it is sometimes necessary for the lower voice to adjust as well.

Trevor Wye, in Practice Book 4, Intonation, gives a detailed explanation of why dissonance occurs when two frequencies are played together. He shows the example of B♭ and D together.

At A440: (frequency = Herz = Hz. = cycles per second); D = 1174.6 cycles per second; B♭ = 932.3 cycles per second. Difference B (approx.) = 242.3 cycles per second. (B♭ is 246.9) The almost B♭ which sounds faintly when an equally tempered D and B♭ are played together is dissonant with B♭ even though it is two octaves lower. The difference tone lowers to B♭ when the D is lowered 14 cents. An alternative is to raise the B♭ 14 cents. Now the chord has no dissonance. Indeed, with the principles of just intonation the third of a major chord...
method, even young students can recognize that intervals should sound in tune. Students learn to use their ears to tune and adjust. Students should also learn the look of written intervals.

Teachers should decide the next interval to study, but it is easier to work on consonant intervals first. Some teachers use a fourth next but I often teach the major third next because major chords are so prevalent in beginner music. I demonstrate how amazingly far the third of a major chord must be altered to ring in tune. This is often a surprise even to advanced students and helps them understand the necessity for pitch flexibility. Advanced students can learn to play dissonant intervals more in tune too. While playing major or minor seconds in tune is not as exact a science as playing a pure perfect fifth, musicians can learn to make a better sounding dissonance. A minor second that is too narrow will not sound as good as one that is wider.

Teachers with computers in their studios and rehearsal rooms may find Coda Music's Intonation Trainer software helpful. It teaches intonation with a focus on just intonation and is targeted for young students to use the program on their own. Trevor Wye, in his Practice Book 4, Intonation gives good explanations, charts, and many examples for intonation practice. He even includes trios for two flutes; the third part is produced by difference tones.

Alternate fingering use to solve pitch problems should be mentioned as a critical element of intonation flexibility. They offer many solutions but do not eliminate the need for listening and adjusting. Because the high register of the flute is particularly difficult to play in tune, extra practice on high unisons and intervals is warranted. The Filas, Top Register Studies, one key a week, is a suggested resource.

Duets and other ensembles are good repertoire for intonation study. Playing from a score allows students to see where they are within a chord. Teachers can circle all major chords on a page of the score; stop and tune each one. Encourage students to schedule mini-sectionals with other musicians to learn the tendencies of the other instruments and practice applying the principals of just intonation.

When playing with piano requires the ability to play in equal temperament, musicians should also learn to ignore this system to make a melody or chord sound better. When a piano joins a woodwind

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Teaching Intonation

1. Teach how to hold a note steady and how to play unisons in and out of tune.
2. Teach basic intonation tendencies of the instrument and how to deal with them. The Basic Intonation Chart is a good resource and includes:
   - cork and headjoint position
   - scale and range tendencies
   - temperature/intonation relationship
   - dynamics/intonation relationship
3. Teach concepts of tempered tuning, just intonation, and difference tones.
4. Teach how to play unison, perfect 5ths, other consonant and dissonant intervals in tune.
5. Teach alternate fingerings.
6. Play duets with students and coach their ensembles.
7. Use the tools listed in the Intonation Resources Chart.

The modern musician should always listen and adjust to be in tune. It is a satisfying, life-long endeavor.

References

Coda Music's Intonation Trainer Software (www.codamusici.com).
Intonation (http://nowiticky.hypermart.net/justinton/)

1 Jorgensen, p. 5-6.
2 Lloyd/Boyle, p. 60, 89.

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