TUNING AND TEMPERAMENT

Pianos nowadays are tuned to Equal Temperament, which divides the octave into twelve semitones of equal size, but it has not been always that way. Equal Temperament was known in theoretical form since the late sixteenth century, and was initially used in rudimentary ways on fretted instruments like the lute, mostly as an alternative temperament. Its influence grew in the late nineteenth century and eventually became the standard in Western Music in the twentieth.

Before that, early keyboards like organs, clavichords and harpsichords were tuned to Pythagorean Tuning in the middle ages, to Meantone in the Renaissance, and to Well-Temperaments during the Classical and Romantic periods, when they were joined by the modern piano. Each system has its unique features, suited to the music of its time, and they transitioned from one to another with long periods of coexistence, as did the styles that were associated with them.

Pythagorean Tuning

In the middle ages, harmonising was a pretty simple affair with only Octaves, Fourths and Fifths being allowed. Pythagorean Tuning provided suitable resources for that, as it consists of a simple chain of pure Fifths like FCGDAEB, which form our familiar diatonic scale CDEFGABC. The resulting Major Thirds, beautiful for melodies, unfortunately are too wide and dissonant to use in harmony. When keyboards were expanded to incorporate accidentals (Bb first, then all others), another problem arose - enharmonic flats and sharps in Pythagorean Tuning have distinct pitches. They differ roughly by a quarter of a semitone, the Pythagorean Comma, and cannot be used interchangeably. This means that the last note of in a sequence of twelve is always out of tune with the first one, creating a very narrow “wolf” Fifth that cannot be used in musical context.

Meantone

In the Renaissance, with the introduction of triadic harmonies, it became necessary to make those Major Thirds more palatable to the ear. Meantone systems tuned the Thirds pure by tempering (slightly detuning) a sequence of Fifths narrow. That is, in the chain FCGDAEB, all Fifths are narrow but the Thirds FA, CE and GB are pure. Later variations of Meantone had Fifths slightly less narrow, leaving Thirds a little wide, but in all cases a sequence of twelve notes still formed a wolf interval (wide this time) between the first and the last. Enharmonic notes were still mutually exclusive - a black key could only be a sharp or a flat, but never both.

Well-Temperaments

As modulations started drifting to distant keys, new temperaments had to be devised in order to make all tonalities playable. Hundreds of variations of Well-Temperaments exist, but in general they keep purer Thirds around the white keys, spreading purer Fifths around the accidentals. This progression between Meantone and Pythagorean sizes eliminates the wolf interval, turning the octave into a circle of Fifths. Enharmonic notes are interchangeable, with sharps and flats having the same pitch. More importantly, Well-Temperaments feature Fifths and Thirds in various sizes, with each key having an individual character. This gradient of colours would be skillfully exploited by composers like Bach, Mozart, Beethoven and Chopin.

Equal Temperament

Eventually, the simplicity and uniformity of Equal Temperament pushed other temperament systems aside in the twentieth century. The identical semitones of Equal Temperament make all intervals out of tune – crucially the Fifths only slightly narrow, which is quite acceptable to the ear, but Thirds remain too wide by around one-seventh of a semitone. Pianos have tonal characteristics that make those Thirds less offensive to the ear, and because they are all equally wide, we tend to get accustomed to them, to the point that some people think of pure Thirds as being flat. However, it is not an ideal solution by any means, and there are plenty of fine ears who dislike it. Its greatest contribution to Western Music, perhaps, has been to allow instruments of all types to play using the same intervals, which was not always possible with other temperaments.

A note on pitch

Concert Pitch, A 440Hz, is the current international standard for A4, the A above middle C on the piano. There is no intrinsic value or advantage in that particular number, and it does not relate to any specific pitch found in nature. It is merely a convention to encourage a common reference pitch, with some sensible consideration to what has been used in the last few centuries. It was regularly used in some parts of the world in the 1920s, and was internationally recognised as ISO-16 in 1955.

Historically, the pitch of A has fluctuated between 390Hz and 470Hz, roughly the equivalents of modern G and Bb. Period instruments are often tuned to 392 or 415 to suit the tensions they were designed for, and to enhance the corresponding tonal qualities. Combined with the appropriate temperament, the musical effect has little in common with what we hear on a modern piano in Equal Temperament.

Other curious pitches include Philosophical C, or Scientific C, at 256Hz, which is a power of 2. It is about a third of a semitone lower than the C261Hz found in Equal Temperament at concert pitch, and its A tunes at approximately 430Hz - also called Classical Pitch. Another well-known variety is the Verdi pitch, or A432Hz, which forms a Pythagorean chain of Fifths with Philosophical Pitch's C256Hz. Note that in any other temperament they do not coincide.

For those interested in C256Hz or A432Hz for their mathematical properties, it should be observed that they are only viable on instruments without inharmonicity, like the violin. As bowed strings constantly reset their partials (overtones), they match the natural harmonics without deviation, so the whole scale can be accurately adjusted to any reference pitch.

On a piano, however, octaves have to be stretched, that is, tuned slightly wider than pure to accommodate inharmonicity, or else they will sound narrow. This alone will make all other 87 keys necessarily deviate from the one tuned to the reference pitch, defeating the purpose. It would be more beneficial to use the extra tuning on the piano at whatever pitch it holds, and improve its stability instead of upsetting it.