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The Piano's Gilded Cage

When we listen to a piece of music, we do not normally think about the tuning system upon which it is based. We are, naturally, aware that each piece of music is really only a selection or arrangement of individual pitches from among a larger pool of available tones. A particular piano piece, for example, may be confined to the notes of one particular scale--say G major--one of many scales possible on the piano. Even a piano, however, does not contain all possible pitches. All of these scales, in turn, belong to a particular tuning system, which is itself a selection of pitches from the frequency spectrum. Just by singing we can hear that the frequency spectrum has an infinite number of pitches, and thus there are also an infinite number of possible tuning systems. In this essay, I will discuss the musical and cultural problems which occurred as a result of the widespread use of the piano and its tuning system.

While the audible frequency spectrum is continuous, we generally conceive of the pitch universe as a relatively limited number of fixed frequencies, with absolute boundaries differentiating pitches from 'non-pitches', and a significant amount of separation between adjacent pitches. Most people accept this as natural and inevitable, rather than as a result of how we use our bodies to make music. With regard to the piano, pitch control is a decidedly digital activity. One presses a button with a finger to get a pitch. We can choose which button to press, but otherwise, the quality of the physical action has no impact whatsoever on the frequency of the pitch. Contrast this with visual art. Painting (before pointillism) involved continuous motions produced by the wrist and elbow (not button-pushing produced by the fingers). Our conception of colours is likewise in 'broad strokes'. We think of it as natural and appropriate to think of the visual spectrum as continuous, and have no great compulsion to limit the number of colors or the 'distance' between them. We have names for individual colours (e.g., red, blue, etc...) but define them to be inclusive of an array of shades and hues. Likewise there are no absolute boundaries that separate one 'colour-class' from another.

Keyboard tunings are compromises arising from the intersection of different (sometimes opposing) influences. If you were asked to determine how a piano, or any instrument, should be tuned, the most important factor to begin with would be your own musical goals and tastes. What type of music do you want to be able to play? Which musical features or characteristics do you wish to emphasise? With which other instruments do you want to play together? Historically, we could say that the piano was intended to play classical music together with traditional Western classical instruments and voice. Consequently, keyboard tunings were created toward this purpose, but the ideal had to be brought in harmony with the reality that the piano is a machine with mechanical limitations. On a piano, every pitch must have its own key, its own button. Thus, in contrast to, for example, a violin or the human voice, a piano has a limited number of possible pitches. Specifically how limited this needs to be, moreover, is closely related to a very practical matter: the number of fingers on our hands. Since most people have only 5 fingers on each hand, it would be somewhat unwieldy to have, for example, 30 keys per octave. Without getting into details about theory and acoustics, it just so happens that 12 keys per octave turned out to be good compromise. The number twelve allowed keyboards to come close to approximating the pitches and intervals that were most frequently used by other Western instruments, and yet still be feasible upon which to play. These type of twelve-tone tuning systems were called temperaments because they involved a tempering (i.e., modification) of earlier 'pure' tuning systems. The first temperaments were unequal ones, in which some of the intervals were still acoustically pure. Today, the piano's standard tuning system is commonly called equal temperament, or more precisely 12-tone equal temperament (12-ET). This means that the octave is divided into twelve pitches such that the interval between every pair of adjacent pitches is exactly the same and none of the intervals are pure. It is a common misconception that 12-ET represents the best solution for keyboard tunings because it is the most recent. The fact is that 12-ET is not better; it simply maximises certain musical characteristics at the expense of others.

Within classical music, both theoretical and practical problems arise as a result of the piano's tuning system. When someone is first learning to read music, it is quite common them to ask a question like this: "Why do we need both F-sharp and G-flat since they are the same?" This question reveals the strong influence the piano has on our musical understanding. The fact is that, although they are represented by the same button on the piano, they are not the same note and often not the same pitch either. Counting only plain notes, sharps, and flats we already have a notational system which distinguishes 21 different notes (e.g., A, A-sharp, A-flat, B, B-sharp, B-flat, etc.) These notes have different names because at one time they all sounded different, and on many instruments they still do. This, however, does not even cover all of the pitches in use. By including notes with double sharps and double flats (e.g., C-double-sharp and C-double-flat) the total rises to 35. Moving beyond these, there are even further distinctions that are smaller than a sharp or flat. For example, the pitch D which sounds acoustically pure with G, is different from the pitch D which sounds pure with F. Normally, we don't distinguish between these in written notation, but we can hear the difference between them in practice, and a good musician will naturally make this difference. Most of the other classical instruments have the ability to play more than 12 distinct pitches, and usually do. When these musicians play together with a piano, they must give up these myriad of pitches and conform themselves to the piano's limited selection, because the piano is usually the largest and most inflexible instrument. Hear the difference.

In further response to the question above, we also need both F-sharp and G-flat because they have a different meaning within the music. Temperament came into general practice only about 300 years ago. The tonal/modal system of Western classical music (and its scales, chords, keys, and so forth), however, was developed within earlier tuning systems which did have more than 12 pitches, and thus had more than 12 distinct, meaningful notes. Classical music is a language with its own grammar and syntax, just like a spoken language, and it is these linguistic structures which endow notes with different meanings. Although the underlying reason for these differences in meaning is the fact that these notes did and should sound different, it is still possible to distinguish between some of them even when played on an instrument such as the piano (in which they sound the same) if one is well-versed in the musical language. Nevertheless there was an essential loss of meaning when the piano's more limited pitch system became dominant over the earlier, more expansive tuning systems. Imagine a world in which there were only one shade of each colour: fire-truck red, royal blue, kelly green, and so forth.

It is perhaps difficult for non-specialists to understand how notes or tones can have specific meanings, and what effect the piano could of had upon these. As a further illustration I will turn to the more familiar domain of written language. Imagine the following hypothetical situation. The telephone industry has decided to redesign the arrangement of the letters of the alphabet on telephone touch-tone pads in order to use cell phones as mini-keyboards for connecting to the internet. In the new arrangement, one (and only one) letter of the alphabet will be assigned to each of the twelve standard buttons (0-9, *, and #). Your job is to 'downsize' the alphabet to just twelve letters, while trying to maintain maximum intelligibility for words in standard English. The first cuts would be easy to make (e.g., rarely used letters like q and x) and would have little effect on readability. Next, you would most likely select from several pairs of similarly sounding letters like b/p and i/y. Some words would lose their individual distinctiveness and merge together (e.g., 'by' and 'pi') but would nevertheless be easily comprehended in context. In English we already have many examples of words which are spelled and/or sound the same but retain separate meanings. In order to reach down to the goal of 12, however, you would have to make significant sacrifices which would seriously compromise our ability to communicate in the same way that we do now. This hypothetical situation could be considered comparable to events in music history. It is not so far-fetched to say that the piano's domination has played an essential role in transforming the grammar and syntax within classical music as a result of its pitch system.

Today we have the technical capability to overcome the mechanical limitations associated with the keyboard. Electronic synthesisers, for example, can be programmed in several different tuning systems between which one can easily switch with the push of a button. In spite of this, most synthesisers use only 12-ET. Furthermore, synthesisers have not become accepted as a replacement for the piano in classical music because the timbre is not the same (even though the timbre of modern pianos is likewise quite different from earlier keyboard instruments.) Various acoustic solutions have also been proposed and attempted in the past. Most of these involved the construction of new keyboards with more than 12 keys per octave, such as Giovanni Battista Doni's three-manual cembalo from 1635 with 68 keys per octave, or Julian Carrillo's 1/16-tone piano from the 20th-century with 96 keys per octave. These did not gain wide-spread support, however, as they required performers who were willing to learn a new, and sometimes awkward, playing technique. Yet another solution was developed in the 1930's by Norwegian composer Eivind Groven. Groven built an acoustic pipe organ with 36 pitches per octave that still used a standard 12-note keyboard. Groven's organ has an automatic pitch switching device which selects and shifts between the different pitches during performance without encumbering the performer. A similar system is now being developed for acoustic pianos, although it remains to be seen whether this would find acceptance in the classical world.

The problem is not is not that the piano's equal-tempered system is in itself wrong, but that it has become the unchallenged universal standard. As a consequence of the wide-spread use of the piano, 12-ET, which originated as a compromise to allow pianos to play together with other instruments, has become the dominant tuning system, a default standard to which all of these other instruments must now conform. Many people can not even conceive that there could be an alternative. However, 12-ET did not come into common usage until as late as 1917, thus all music before the 20th century was written and heard in other tuning systems. When we play these pieces today, we do not really hear the same work. It is as if someone were to change the colors in, for example, a Monet painting and yet maintain that it is still the same artwork. Previously, each key even had its own affective characteristics; part of the shared cultural experience of those who made, performed and listened to music. A-flat Major, for example, was the key of the grave and death; while E-flat major was devotion and holiness. Although these characteristics were, of course, subjective, it was possible to conceive of each key as unique because each key actually sounded distinct within unequal temperaments. In 12-ET the quality of every major key is the same, as is the quality of every minor key. Therefore these affective characteristics have become lost. Upon first hearing, many people find performances in historical tuning systems rather unpleasant because they used to hearing it in equal-temperament. Likewise, in the world of art, the restoration of a well-known masterwork, like the ceiling of the Sistine Chapel or "The Last Supper", is almost always met with great controversy. People are shocked by the change of colour, because they have come to accept today's faded and dirty facade as true.

There are also broader cultural and aesthetic problems which have arisen from the piano's dominating role. When a fretless instrument such as a violin gets introduced into a new culture, it can adapt itself to the indigenous musical language, as for example in India. When a piano gets introduced, however, the indigenous music must conform to the piano's tuning system. Historically, the piano has been a kind of "coloniser" in this regard. Moreover, the privileged cultural status of the piano has lent an authority to 12-ET which makes it appear superior and more legitimate than other tuning systems. The more acclimated we are to hearing almost exclusively equal-tempered music, the more natural it sounds and the less accepting we are of alternatives. Music and instruments which use alternative systems, including non-Western music, are perceived as irrational, archaic, experimental, exotic, or just plain out-of-tune — not just different, but deviant from so-called normal 12-ET.

It was due to the piano's mechanical limitations that tempering became necessary, but due to the piano's power that tempering has subsequently come to impose limitations upon the rest of the musical world. Technical solutions will be of no use if no one is willing or open enough to listen to them. The most important need is to raise awareness of and appreciation for other tuning systems and the music which uses them. The musical world is much richer because of them.

The Ivory Cage is ravishing
    But still remains a cage
Ebony and ivory bars
    Holding the spectral plumage afar
We can not hear for we can not see
    The bird's song should be freed

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