

How to tune for Bach's Well-tempered Clavier?

Johann Sebastian Bach, who was well versed in mathematics, did not follow a book of rules in these matters - he followed nature. Mathematics was not capable of producing an acceptable temperament. Bach's biographer Forkel, 1771

.....The Tempered Clavier in 2 parts...Each part contains 24 pieces, a prelude and a fugue in each key. The title implies that a keyboard instrument must be tempered, or usable in all keys, if one wants to play these pieces on it. Bach's pupil Adlung, 1758

Even by those keyboard players who know this great work intimately, this matter is often given scant attention. For example, in the notes for a recent recording, a leading Bach expert investigates in depth, tempo relationships between the pieces, but apart from mentioning the pitch used, ignores tuning altogether. Yet it was advances in tuning that enabled J.S. Bach to conceive this work in the first place.

Like most discussions of tuning, this one will begin with mention of Equal Temperament: the tuning system used today for most mainstream music, applied to orchestral performance, pianos, and modern organs. It was once widely assumed that Bach had Equal Temperament in mind. Bach (the argument went) was a unique genius, more advanced than his peers in many respects, who wrote the Well-tempered Clavier explicitly for twenty-four keys (twelve major and twelve minor). Surely one could equate the word 'Well' with 'Equal'? In which case Bach must have endorsed, perhaps even promoted the advanced tuning system which is in general use today.

If we play the Well-tempered Clavier on an instrument tuned in equal temperament, then all the keys sound equally acceptable, because apart from a difference in pitch they all sound exactly the same. This is because all the intervals themselves are equal: all semitones, all whole tones, all thirds, and so on. For some musicians (particularly pianists, whose instruments are always tuned in this way), this implies that Bach would have had this system in mind. Others, knowing that this modern tuning was not the norm in Bach's day, but considering Bach to be ahead of his time, have asserted that even if he did not himself tune in equal temperament, he would have approved of anyone who did. Some present-day scholars accept this suggestion, pointing to the growing use of equal temperament in Germany during Bach's latter years. There are, however, practical and musical reasons for doubting this convenient approach.

We know that 'well-tempered' tunings were not the same as 'equal-tempered', and the difference was held to be important in Bach's time. A considerable list of leading musicians, then and even considerably later, regarded equal temperament as a theoretical tuning which produced unsatisfactory music. This was not a universal prejudice: Rameau, for example, unlike most French musicians, seems to have liked it, in the latter part of his creative life. But the list includes Handel (who left his own slightly vague instructions for tuning the harpsichord – unequally), in France, Francois Couperin, and, tellingly, Bach's own sons and students.

Postponing, for the moment, the practical considerations, the musical ones in turn can be subdivided: firstly, the richness which was heard when the most common keys were tuned in something based on the old system of Meantone (or something close to it) would be lost. No intervals were tuned pure in equal temperament (all thirds, for example, were equally wide). Secondly, the particular characteristics of different keys, audible in an unequal tuning, were recognised as attractive and useful. Admittedly, different musicians responded to keys in slightly different ways: D major was "shrill and stubborn" for Bach's contemporary Mattheson, but had been "bold and martial" for Charpentier in 1682, and later in the 18th century Rousseau was to consider it suited to "gaiety or brilliance". However, there are few if any fundamental differences of opinion, and none would deny that any audible characteristics of different keys are completely

removed by equal temperament, as are the stimulating varieties of dissonance and consonance caused by an unequal tuning, as one moves from key to key in the course of a piece of music.

What does 'well-tempered' mean?

'Well-tempered' systems were the 18th century's manifold and varied response to the problems posed by meantone in a changing musical environment. The term first appears in the writings of Andreas Werckmeister in 1691, in which the author defined it as the process of modifying meantone, to make it more flexible. Meantone, devised early in the 16th century, produced rich sonorities derived from pure thirds, in some half-dozen keys, but unacceptable dissonances in more remote ones. Modulation between keys remained pretty irrelevant until around 1700, after which it became increasingly integral to composition. Well-tempered tunings often tended to produce better harmonies in either 'flat' or 'sharp' keys. In meantone, one had to tune either G sharp or A flat - likewise either D sharp or E flat; one could not have both. G sharp had to form a pure interval against the E a third below, and was thus considerably lower in pitch than A flat, which was pure against the C a third above it. In meantone, A flat and D sharp were in fact very rarely tuned as such, and occasional excursions into keys within which these notes were bound to occur, can produce sour sounds, which one must suspect were found acceptable - if heard only in passing. It is even possible that occasionally, when used at particular points within the music, such 'blue' notes may have been enjoyed for their strange effect.

With pure thirds seen as the basis of good tuning of keyboard instruments, and almost all keyboard players accustomed to its use, many 17th century harpsichords and organs were built with a number of sharp keys split front to back, providing two notes within the length of the key, and extra strings (or pipes) to provide those notes - thus extending the number of keys in which meantone could be tuned. Even after 1700 many well-tempered systems remained close to meantone, retaining several pure thirds. Remote keys involving flats seldom appear in French music of the period, whereas some really extreme 'sharp' keys can be found: the notable Pavane in F sharp minor by Louis Couperin, for example, was composed before 1661, and French tunings made this piece sound rich indeed. By 1700 some German theoreticians began to produce more neutral tunings, but most of the German courts were dominated by French aesthetics, and would probably have used what we might call French-style tunings. In Bach's day, beyond the courts of the aristocracy, the bourgeois cities of Hamburg, Dresden, and Leipzig were more cosmopolitan and more consciously German in their tastes, and it was here that German innovations in tuning found fertile ground. Telemann never worked in a court, but was in charge of the music in Hamburg for decades. When not writing in an imitation of French style, his music contained a notable quantity of 'flat' key signatures. We can note, however, that J.S. Bach at times used 'French' key signatures even when writing for large forces: there were circumstances when good taste and musical sensitivity demanded this. The Funeral Ode for the Queen of Poland and the second Orchestral Suite are notable examples, both in B minor.

As the 18th century proceeded, music underwent radical changes, and ever more flexible tuning systems were devised. Despite this, even in the century's final quarter some authorities continued to promote tunings quite close to meantone. And alongside the work of theoreticians, throughout Europe a modified form of meantone known as 'ordinary temperament' was very widely used, being as flexible as most music continued to demand. It was a subtly varied system, and any version of it produced today (for example on an electronic tuner) will not represent any 'standard'. *Tempérament ordinaire*, as generally understood, is not flexible enough to work for Bach's Well Tempered Clavier, unless one selects, for the most part, only pieces in the more common keys.

Bach and temperament

Most of Bach's keyboard music only explores remote keys in passing. Some particularly bold compositions, however, show that from quite early in life he sometimes did not have meantone in

mind. The modifications to meantone devised by Andreas Werckmeister impressed the elderly Dietrich Buxtehude, who accordingly revised the tuning of Lübeck's organs; when the young Bach spent time there in 1705-6, these advances were surely passed on to him. Some of his early works for keyboard are in surprising keys, like the Toccata in F sharp minor. Even this piece, though, demonstrates that minor keys can be accommodated to a conservative tuning system more easily than major keys. Bach concludes the work conventionally, with a chord in the major, but makes a very rare stipulation, abbreviating this final chord to a quaver's length – in effect a short stab at the keyboard. The tradition of having a conclusion in the major (which was to persist as he wrote the Well-tempered Clavier) was the dominant factor, but Bach compromised, ensuring that the final dissonant chord should be heard very briefly.

The Well-tempered Clavier, of course, also bases many of its pieces in remote keys. Can we imagine Bach tuning his instrument differently when playing such pieces? This remains possible, but his title (as we saw his pupil Adlūng recognised in 1758) suggests a single tuning of a specific type, able to deal with all the keys.

The practical considerations

Bach's obituary, and references from his student Kirnberger, his first biographer Marpurg, and his most famous biographer, Forkel, supply anecdotal evidence for Bach the practical musician. He is described as tuning with great ease and speed. One account mentions that he employed a system where all the thirds were wider than pure; another, that as he played, it was hard to immediately differentiate by ear, one key from another. We must bear in mind the possible prejudices of a later age, as an influence upon such descriptions. We can easily identify a process of movement towards ever-greater use of smoother tuning systems, including something like equal temperament, during Bach's maturity. After his death, music came to modulate extravagantly, and audible differentiation between keys became less important than smooth transition between them. Posthumous praise of J.S.Bach would easily imply, not necessarily with complete honesty, his enthusiastic involvement in the very latest trends and techniques.

Reverting to those biographical anecdotes, one thing is clear: if Bach was using a tuning which was quick and reasonably easy to apply, then it was not perfect equal temperament. A practical musician like Bach had to tune often and fast; today's piano tuners (trained in their art for several years) will confirm that to tune perfectly equally is a skilled and more lengthy procedure than the methods used to tune unequal systems, and it is far easier to 'get it wrong'. On the other hand, some remarks suggest that Bach's was a reasonably advanced system, where no big differences between keys were present. If no thirds at all were pure (although this report might be a slight exaggeration), it was several stages removed from meantone. Bach's tuning of his harpsichord - if indeed he restricted himself to one system most of the time - may have been one in common use, or might have been subtly adapted to his own taste: a perfectly normal occurrence in an age of non-standardisation.

Apart from this, we have no documentary evidence for Bach's personal tastes in this area. Towards the end of the 20th century, internal analysis of his music was undertaken by several scholar-musicians. John Barnes, for example, examined the occurrence of prominent thirds in the preludes of the 48, and concluded, in an article for OUP Early Music in 1979, that the manner in which Bach varied their frequency, prominence, and duration revealed a response to the degree of pleasant or unpleasant harmony which the player would hear, when an unequal tuning system was employed. Barnes used his data to construct a tuning, which has since been shown to be similar to more than one system devised by Bach's contemporaries.

Tempered tunings had been produced even before 1700: Werckmeister devised modified meantone systems for use with organs. Such systems were a natural first step, since organs (tuned in meantone for nearly a century) were extremely expensive to completely re-work. At this date,

clavichords were fretted, so that the temperament (normally meantone) was 'built into' the instrument. Harpsichords had separate strings for each note, and presented no such problems. More advanced temperaments followed: Johann Georg Neidhardt, a major figure in the development of tuning, had, by 1732, published directions for no fewer than 21 tunings varying from one of a conservative nature (called by the author the 'village' temperament, aimed at unsophisticated musical environments), through ever more flexible tunings, culminating in ones designed for 'big city' and finally 'court' use, the latter ultimately being a slightly differentiated form of equal temperament – presumably a theorist's 'perfect' tuning, due to its internal consistency and total flexibility.

Bach compiled the first book of the 48 at a time when well-tempered systems were still quite a New Thing, and leading authorities were themselves undergoing a far from smooth process of conversion. We can assume that he engaged fully with current changes of thought and practice, but as tunings became more flexible, they demanded ever greater skill in the business of tuning. Had Bach chosen a really 'advanced' system for his own use, then, apart from the extra difficulty of applying it (and teaching it), this would have had other disadvantages. If he wrote music which depended on such a system for effective performance, he would be composing, as it were, for idealised rather than real musicians. We may reject the idea of Bach being deeply concerned for the limitations of some who would play his music, but can easily imagine him enjoying the challenge of composing so skilfully as to make all the keys work within a tuning system which was either already in common use, or which he himself was actively promoting among his students – one which remained quite easy to tune.

This suggestion is supported by Bach's demands of the instrument itself. Book I of the Well-tempered Clavier was completed in 1722. Within it he restricted the music to only four octaves, C to c3. This made the work playable on almost all keyboard instruments of the time (including organs). Students were more likely to find themselves using rather old instruments, with restricted keyboards. Clavichords at this time were generally fretted and rarely had even a full four-octave compass: these would have been a student's most reluctant choice for practice. We can compare this to Bach's approach when publishing the six Partitas from 1726, which require a more extended keyboard of four and a half octaves, GG - d3. This very different kind of music was aimed at those advanced and affluent enough to have access to an up-to-date harpsichord, and the music's modernistic technical demands matched this requirement.

Musical considerations

We can explore further, the musical arguments against equal temperament as Bach's choice for the Well-tempered Clavier. Owen Jorgensen, in the course of several articles from 2003-4 for the Piano Tuner's Journal, asked: "what purpose would there have been for Bach to compose in keys like C sharp major if he was using equal temperament, where the Prelude and Fugue in C sharp major sounds identical to its transpositions into C and D major? In C sharp major, music is significantly more difficult to read and play, and there is nothing to be gained by using C sharp major in equal temperament". Of course, one can point to the aim of completing the cycle of 24 keys. But this would reduce the Well-tempered Clavier to the level of an academic exercise, rather than a work of creative genius – one designed, as the title page claims, to entertain as well as to instruct.

Bach's title specifically demands the use of a 'well-tempered' tuning (ie. an unequal one). Jorgensen also pointed out that in 1722 equal temperament, which was still recognised more as a theoretical system than a practical one, had an accepted name in Germany: *Die Gleichschwebende Temperatur*, which had been used by Neidhardt in 1706. Bach could have used this, had he desired it. This, however, was tuning as science, whereas 'Well Temperament' was tuning for practical convenience – and, as we can now examine, as art.

Key characters

Different key characters certainly remained in the minds of many. The French composer Charpentier had in 1682 given a selective list of the emotions attached to keys. In 1806 Christian Schubart, building on the writings of his German predecessor Mattheson (who proposed 17), gave a list of such qualities for all 24 keys. He described, for example, D major as a key displaying triumph and rejoicing (hence its use for marches etc.) and D sharp minor as containing brooding despair. A much-reduced number of such associations persists even today.

Of course, one can overstate this. The conscious exploitation of temperament by a composer involved the idea of writing in different keys to utilise the character of those keys. As Bach's contemporary Johann Mattheson made clear, the application of this idea to instrumental music was an extension of the concept of musical rhetoric – a central concern in the creation of vocal music, and opera in particular. However, while common keys like D major and C minor carried accepted implications as to the nature of the music presented, little music was normally composed in remote keys in Bach's day, and any accepted character implications tended to be restricted to more commonly-used keys. To complete his collection, Bach could and did conveniently transpose previously composed pieces into remote keys, in some cases perhaps fundamentally undermining, in the cause of this new requirement, any enhancement of character which their original keys would have given.

Perhaps for this novel project Bach was ready to set aside anything to do with key-character – at least where it proved convenient. On the other hand, some associations between key and mood are striking, although there is no space here for a proper study of these. To give just two examples: the D major prelude of Book II is martial and triumphant, and the G minor of Book II soulful and sombre. A secondary conclusion, easily reached by a subjective exploration of the music, can be that Bach was conscious of established key characters for many keys where players could expect and enjoy them – in other words, in pieces written in ‘normal’ keys. This would encourage performances which were in the ‘mood’ which the composer may have had in mind – at least in a significant number of instances.

Johann Mattheson (an important and influential figure about whom I have written elsewhere) was a musical trendsetter. But in his published writings he stressed the disadvantages of equal temperament, while in 1719 issuing 48 test pieces for thorough-bass – in all the keys. As a musician at the heart of Hamburg's progressive musical life, he shifted his position, and by 1731 was writing, as an accomplished organist, that although it was a matter of regret that key-characters would have to be, in a real sense, discarded, equal temperament was the ideal system, at least for organs. Mattheson and Bach were aware of each other's creative activities. One could view Mattheson's offering of 1719 and Bach's, of 1722, as illustrating how individuals separated by space but nevertheless part of a creative continuum, can share ideas – even unconsciously – and produce creative output, as it were, in a common cause. And we shall see that Bach, too, was fully aware of changes in tuning techniques – including equal temperament.

The demands of different musical forms

Most music which Bach wrote for the keyboard was based in the ‘conventional’ keys, and did not require remote keys to be sonorous. Variations, for example, would rarely explore remote keys if the subject itself was harmonically straightforward. The Goldberg Variations, like Buxtehude's La Capricciosa variations which inspired them, are firmly rooted in G, the second most basic of all the keyboard tonalities, and a conservative unequal tuning arguably enhances their directness and inherent sonority.

We do not find Bach writing keyboard suites in obscure keys. The most striking use of key signature occurs in one of his few published works: *Clavierübung* II, of 1735. This consisted of highly-wrought music to illustrate Italian style (the Italian Concerto) and French style (Overture in

the French Style). Bach placed the Italianate work in F major, and for publication transposed the French Overture from C minor into B minor – a quintessentially French key signature. Presumably by this date he expected performers to use a tuning suited to both. This published work supports Bach's engagement in the creative mainstream, where tunings might still be unequal, but could reflect and enhance musical characteristics, in this case quasi-nationalistic ones.

In the Well-tempered Clavier, whole pieces were to have as their tonics, C sharp, F sharp, and A flat. If he really favoured an unusually advanced, highly flexible tuning system, we could look for points within these complex works (which often modulate to an extreme degree), where a more conservative tuning simply won't work. In fact, I have found no such instances. Even the most exploratory fugues, like the D sharp minor and A flat major from Book I, and those in C sharp, not only work well throughout in a relatively extreme tuning – some might find that the tensions built deliberately by Bach through the use of successive dissonances in pieces like these, actually gain from the use of extreme intervals within a less modern tuning system. The dense five-part fugue in C sharp minor, Book I, offers a dramatic example. Final chords of the fugues are located carefully – often rather low on the keyboard – so that thirds which might offend the ear are not prominent.

John Barnes doubtless recognised the extraordinary facility in modulation which Bach employed in his fugues. Perhaps with this in mind he concentrated his attention upon the preludes, where chords and more static harmonies occur more frequently. In the preludes we often meet chords in the relevant key, as it were, head-on at the start of the piece, where any unintentional shock value would be greatest. Even here, however, unequal tunings work. It has to remain a subjective matter, to decide how extreme an opening chord like that of the prelude in A flat, Book I, can be. If played immediately after the closing resonant G major chord of the preceding fugue, the extremely wide third A flat - C, which is present if the tuning is conservatively unequal, coming as it does quite high on the keyboard, makes this an arresting moment, which can enhance an attractive change of mood.

Can we guess Bach's tuning system?

Although proposed earlier that well-tempered systems were relatively novel when Bach compiled Book I, there is a gap of nearly three decades between Werckmeister's early work and the first book of the Well-tempered Clavier. Werckmeister changed in the last few years before his death in 1707, to a conviction that equal temperament was the best theoretical system, although he continued to recommend something more practical, and differentiated. Neidhardt had described and named equal temperament in 1706, but went on to explore tunings on a practical rather than theoretical level for several more decades. Mattheson's change of heart has already been mentioned. My personal feeling is that Bach, while still working in a relatively isolated environment at the court of Cöthen in 1722, remained very conscious of meantone, and will have gone already through the stage of modifying his tuning system on the basis of Werckmeister's work, in his younger days, rather than branching out into entirely new realms of thought. This will be explored shortly.

The question which remains, then, is what sort of unequal tuning Bach might have favoured. Here are a few possible sources of clues:

1) As already mentioned, Bach's use of the key of B minor for important pieces suggests a tuning either neutral or at least compatible with 'sharp' keys.

2) In several cases within the 48, Bach preferred to write in sharp keys instead of flat ones, and never the other way round. Hence:

- WTC I: Prelude 8 in E flat minor, but fugue in D sharp minor;
 Prelude and fugue 18 - both in G sharp minor (not A flat minor);
- WTC II: Prelude and fugue 8 - both in D sharp minor;

Prelude and fugue 18 - both in G sharp minor.

Was this entirely due to a personal habit of convenience while transposing pieces? If not, it might suggest that his tuning system favoured extreme 'sharp' keys over the more remote 'flat' keys. C sharp and F sharp, in other words, would sound 'better' than E flat and A flat.

This is a characteristic of the system suggested at the conclusion of this section.

It is generally agreed that the D sharp minor fugue of Book I is a transposition of an original in D minor. Scholars have noted that its prelude was probably created in the key of E flat minor, to conventionally highlight the meeting point of flat and sharp keys – the point at which the two types of key converged. But this does not explain the more consistent presentation of these keys in Book II. Did Bach's consciousness of tuning considerations lie behind the more consistent use of key in the second Book? Of course, one might argue that Bach really equated the keys of E flat minor and D sharp minor as far as tuning was concerned. If so, then perhaps some of the time he had equal temperament in his head, even if not in his instrument.

3) There is the potential evidence of the diagrammatic loops to be found at the very top of Bach's 1722 manuscript for Book I:



It is generally agreed that if these squiggles mean something, it must be a code for a tuning system. There is no space here for an adequate survey of all the scholarly analysis of them which has taken place, but here is a brief summary.

For fifteen years scholars have offered their own interpretations of these graphics. The first to gain widespread notice was Bradley Lehman, in an article for OUP Early Music in 2005, and two other journals. Lehman's interpretation gave a tuning system more flexible than most, but one which suggested a completely different mindset for its creator, from that of Bach's contemporaries: it seemed to have no tangible relationship to meantone, or the tempered systems derived from meantone. Lehman's article prompted a vigorous response, with alternative interpretations offered by others, including Mark Lindley, John O'Donnell, Daniel Jencka, Graziano Interbartolo, and Luigi Swich (whose views formed an article in Early Music six years later, in 2011).

The differences between them ultimately made it clear that forming a definitive view was likely to be impossible – at least for the present. A general point of agreement, though, was that the system thus codified must be an unequal one. The degrees of inequality were varied.

More recently Dominic Eckersley came to a rather different conclusion. While pointing out that it was perfectly possible that the loops were added by someone other than Bach himself, he established a relationship between the graphics and a less advanced, less flexible system, very close to that described by the French theoretician Rousseau in 1775 (but referring to earlier musicians, including Francois Couperin).

The coincidence between the message of the graphics (asserted Eckersley), and the 'ordinary' system of Rousseau, is striking. Eckersley related this system to some by Werckmeister, and was thus able to claim that this tuning, or something close to it, was widely used throughout Europe, concluding that such a system was what Bach had in mind. If, as was suggested earlier, Bach might have used a tuning with a bias towards 'sharp' keys, this is certainly a characteristic of this system. In Eckersley's opinion, it is more natural to place Bach within the mainstream of cultured European practice than to imagine him creating something personal and esoteric, as Lehman's suggested

tuning implies. My own work on Bach's use of notation supports this view. He exploited existing conventions of notation to their limit, but did not choose to invent anything new.

The fact that Bach (or someone close to him) applied this code to his manuscript, suggests that he was instructing his sons and students in the use of a temperament different from that which they might have used in different circumstances - presumably one or more in common use. We know that for many, even meantone remained popular. In any case the aim was to ensure that all the pieces within this significant and unusual creation should be playable with enjoyment. The suggestion, therefore, was a specific system, which the codified loops may reflect. Why no mention of the code was ever made by any of these individuals before or after Bach's death, remains a mystery, and perhaps supports the idea that it was added later, by someone other than Bach. The loops do appear to have been squeezed into an unsuitably small space – after the work's title had been written. Had the work reached publication, one wonders how the title page would have appeared.

When using a Rousseau tuning in the music of the 48, only two keys present chords of something like an extreme nature: E flat and A flat major. Even these are perfectly playable, and all other keys work well. Despite this, it is hard for us today to accept a tuning system close to that of Rousseau as that intended by Bach, when he will have been aware of alternatives. Rousseau's system was still closely related to meantone, and contained the rather extreme practice of making some fifths actually wider than pure; he surely did not envisage much use of accidental keys as tonics. It may be, of course, that modern ears (including my own), brought up in a world of equal temperament, remain unconsciously biased against extreme tunings. Perhaps Bach really did specify this system – because it brought to the ears of those listening in 1722, the maximum variety of timbre which the music could tolerate. or exploit. An important, but unanswerable question remains: Would Bach and his students have been inclined to use more generally, the system which the loops might suggest was intended rather specifically for use in this particular work?

Choosing a tuning system

Scholars disagree as to the meaning of the title page 'loops'. Some suggest their being in the hand of someone other than Bach, and a few as being no more than a casual added doodle. Since it is possible (even convenient) to set the 'loops' aside, what of other possibilities?

The point of all this is to try to guess how Bach himself may have expected the 48 to sound – as far as tuning is concerned. The arguments presented so far, suggest that a suitable tuning should be unequal and reasonably flexible, yet one retaining a degree of key contrast, and quite easy to apply. Unfortunately, a choice of tuning is ultimately bound to be a leap in the dark, so we might begin by eliminating some less likely candidates. Surely we must reject much later systems, like those of Young or Valotti, from the third or final quarter of the 18th century: apart from the late date, Valotti has F major as its richest-sounding key. Such tunings are convenient for orchestral use, rather than for producing colourful keyboard music, springing outwards from the 'home' key of C.

One could tune an easy-going system: unequal, but flexible – perhaps one of Neidhardt's more 'advanced' offerings, but only if we can imagine J.S.Bach regularly taking the trouble to do so. I have little doubt that Bach will have tried tuning in something close to equal temperament at times, but with the time factor involved, we cannot say either how often this may have been, nor how close to true equal temperament he will have got. And of course, the other considerations explored here might suggest that he did not expect it to be normally practised by his students. Alternatively one may accept the challenge of taking to the limit the differentiation of keys, by using a conservative system. The more unequal the system, the greater this differentiation will be.

Before moving on, we must return to organs. As mentioned above, many or most of these instruments, which work so effectively for a large number of pieces within the Well-tempered Clavier, were still, in Bach's day, designed for a more conservative tuning than the more flexible

ones which any harpsichordist could readily employ. Bach would almost certainly have welcomed performance of the work on organ, but players would be expected to select pieces which sounded acceptable on the instrument which they were using at the time. Bach, after all, chose his words with great care, and did not use the word 'organ' on the work's title-page. On the other hand, he was himself deeply involved in organ design and manufacture. Numerous pieces of written evidence point to him being increasingly involved in establishing ever more flexible tunings for organs, and equal temperament was becoming more popular for these instruments at the time Book II of the Well-tempered Clavier was being finalised. It is no easy task to establish a new tuning on a new organ, as one account of a failed attempt where Bach's cousin Johann Nikolaus was involved, makes clear. On a practical level, though, once a tuning has been applied to an organ, it is then quite easy to maintain it – an advantage over a stringed instrument. On the other hand, the organ as a solo instrument remained hugely important in Lutheran practice, and in a solo context transposing was not required. Much of Bach's organ music (dating in many cases from much earlier in his life, while employed at Mulhausen and Weimar) subjectively sounds more impressive in a conservative tuning. Would that we could ask Bach how he felt when one of his monumental organ works in C or G presented a final sustained major chord tuned in equal temperament! To my ears, at least, such climaxes lose half their force.

Even if the transposing facility demanded of organists increasingly encouraged the introduction of something like equal temperament for organs, nevertheless for the harpsichord player it remained essential to be able to tune quickly and easily. As a frequent and skilled tuner himself, Bach may well have 'tweaked' his tuning over the years so that it remained easy to carry out, but became increasingly 'modern'. Scholars have suggested that subtle differences between the two books of the 48 reflect this.

Finally, pitch should be mentioned too: Mattheson wrote that, in addition to key-character caused by unequal tuning, the very pitch could affect the emotional charge of music – albeit to a smaller degree. At a time when pitches in use in different contexts (for example, in domestic music or in churches) might vary by as much as an interval of a third, this was true. But in a situation where one becomes used to hearing everything at a single pitch, this argument loses its force. Today we are accustomed to two or three adjacent pitches at most, and, as in Bach's household, one will predominate. In this situation it is the nature of the tuning used which will have the most dramatic effect on the ear.

A tangible link to J.S. Bach?

Harpsichordists have always tended to tune their own instrument. Johann Philipp Kirnberger was one of Bach's most important pupils, and according to Marpurg, Bach's teaching of keyboard skills included tuning. Kirnberger discussed equal temperament when writing on tunings late in life in the 1770s. He also published three unequal tunings, which seem to reflect an attempt to re-discover something forgotten, rather than clearly recalled: the first is primitive, the second modified but still unrefined. Although some scholars reject the idea, the third, now known as Kirnberger III, might reflect something of Bach's own system, even at a distance of more than thirty years. Kirnberger arrived to study with Bach in 1739, aged 18, and developed a lifelong reverence for his teacher as the greatest of musicians. This offers a strong suggestion that his third system might be close to Bach's own: unlike most of his contemporaries he seems to have retained an allegiance to an unequal, conservative tuning system. It is similar to Rousseau's, but with a few stretched fifths rendered pure instead, reducing the extreme nature of some 'flat' keys.

Rather tellingly, Marpurg, writing of course after its publication, mentions that "Kirnberger's famous temperament was highly praised but not used by anyone." Of course not, since by 1770, an highly unequal temperament was an anachronism in Germany. For some, a reason for rejecting this harmonious yet characterful system has been the pure third C - E at its heart. But the Well Tempered Clavier begins in the key of C, and a particularly rich tuning in the 'home' key is highly

appropriate. C is the starting point when tuning in meantone. It is probable that for serious keyboard-players of Bach's time, a subconscious feeling about the 'home' key of C, including middle C's location as the central note on the keyboard, was deeply rooted.

This is all, of course, no more than a series of educated guesses. How unfortunate, from our point of view (some might say 'significant'), that Kirnberger did not mention Bach as connected to his third tuning system. But, rather as Carl Philipp Emanuel Bach paid tribute by writing that all his knowledge came from his esteemed father, Kirnberger acknowledged his teacher as the source of all his. Despite its late date, Kirnberger III reflects a 'transitional' phase in the history of tuning – one which, although still diverse, was gaining ground in Germany in 1722.

If we give serious consideration to Kirnberger's tuning as a candidate, we might doubt that Bach's own feelings about the tuning of harpsichords had changed much between the completion of the two books of the 48 – since the second book appeared around the time of Kirnberger's stay as a student in Leipzig. Some claim that Kirnberger only produced his third tuning system to respond to criticism of his second, but even if true, that need not remove its validity for the present exercise. Conservative his system may be, but it is flexible. As a means of obtaining this flexibility, two kinds of richness are obtained by different means: for the most commonly-heard major keys (C, G, and F in particular), thirds which are pure or nearly pure are offset by distinctly reduced fifths, as happens in meantone. For the remaining keys, however, a sharpened third (some are very wide indeed) are compensated for by a pure or almost pure fifth. This latter compromise is akin to that which today's ears accept when hearing equal temperament, where the uniformity of the keys is a significant help.

The two 'kinds' of key just described, themselves naturally have very different characters. Bach could have followed the example of others, and arranged the pieces following a cycle of fifths, which would have reduced the impact of each shift of key. In fact, by moving chromatically up the scale from one tonality to the next, he ensured that a strong contrast of character is automatically presented with most such transitions. One of Bach's pupils, H.N. Gerber, told his son how Bach had played Book I through to him on no fewer than three occasions, but such extended performances in Bach's household must surely have been rare. Even so, such contrasts can be easily enjoyed when playing even two pieces consecutively.

Presenting a recording of this mighty work is a challenge and a privilege for any keyboard player, and for most of us, making only a single recording is an unfortunate necessity. This demands a choice of tuning system. Most recordings of the Well-tempered Clavier have until now employed either equal temperament or a relatively 'modern' tuning system. There is no claim here that the tuning used is the one which Bach specifically had in mind. Indeed, I suspect that he would have been happy for a number of well-tempered systems to be used. However, my own performance will feature the use of Kirnberger III: a tuning felt to be appropriate to the approach Bach himself may have still had, even at the time of completing Book II of the Well-tempered Clavier. The conservative nature of Kirnberger's tuning, if we choose to link it to Bach, suggests that Bach's approach to harpsichord-tuning may have not changed significantly from that of 1722, when he assembled the first book. In any case, it is the musical effect which counts. For sheer harmonic interest, and the enhancement of mood in a significant number of the pieces, I have found Kirnberger's system to be revelatory.