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Bach's Keyboard Instruments

Was the *Well-Tempered Clavier* Performable on a Fretted Clavichord?

Richard Loucks

The question of which instrument to use for the *Well-Tempered Clavier*¹ is quite vexing, and has elicited a number of different answers (paraphrased below), none of which appears to be provable:

Bach had preferences, but we can never know them.²

It was composed for the benefit of keyboard players.³

¹Johann Sebastian Bach, *Das wohltemperirte Clavier*, Part one, 1722: Part two, 1744. *Johann Sebastian Bachs Werke*, Series 14, vol. 3 (Leipzig: Bach-Gesellschaft, 1866). Reprint (New York: Dover, 1983).

²Cecilia Auerbach, *Die deutsche Clavichordkunst des 18. Jahrhunderts*, 3rd ed. (Kassel: Bärenreiter, 1959), 24.

³John Barnes, letter to the author, March 31, 1988.

Each prelude and fugue may be assigned to the organ, harpsichord, or clavichord according to differing criteria.⁴

Composed for all keyboard instruments.⁵

Composed for harpsichord.⁶

"Music for its own sake," playable on any "appropriate" clavier, C-c".⁷

Experience on the most suitable instrument illuminates the interpretation, even when it must be performed on another.⁸

Suitable for the piano.⁹

Harpsichord, but it is questionable whether Bach had a "correct" instrument in mind.¹⁰

With regard to the clavichord, opinions tend to be based on subjective evaluations of the character of the instrument, e.g., its supposed

⁴Erwin Bodky, *The Interpretation of Bach's Keyboard Works* (Cambridge: Harvard University Press, 1960), ch. 2. Bodky also mentions Hans Brandt-Buys's opinion that the entire work was meant for organ (see p. 55).

⁵Kenneth Cooper, *The Clavichord in the Eighteenth Century* (Ann Arbor: University Microfilms, 1971), 95.

⁶Wanda Landowska, *Music of the Past*, translated by William Aspenwald Bradley (New York: Alfred A. Knopf, 1924), 196-7.

⁷Robert L. Marshall, "Organ or 'Klavier'? Instrumental Prescriptions in the Sources of Bach's Keyboard Works," *J. S. Bach as Organist*, George Stauffer and Ernest May, eds. (Bloomington: Indiana University Press, 1986), 236. His opinion is reminiscent of that of Paul Hindemith regarding the *Art of Fugue*, that it was meant simply for musicians to ponder, at best without an instrument; see *A Composer's World* (Cambridge: Harvard University Press, 1952).

⁸Wilfred Mellers, *Bach and the Dance of God* (New York: Oxford University Press, 1981), 39.

⁹Julius August Philipp Spitta, *Johann Sebastian Bach* (Leipzig, 1873-80), Eng. trans. (1884-85), 2d ed., vol. 2: 44-45.

¹⁰Peter Williams, "J. S. Bach's *Well-Tempered Clavier*: a New Approach: [part] 1." *Early Music* 11 (1983), 48, 49.

proclivity for expressive rather than brilliant music. Problems of fretting or historical availability of varieties of the instrument are also adduced, but usually in quite general terms.¹¹

Among the few who have demonstrated that the *Well-Tempered Clavier* can be played convincingly on the clavichord are Arnold Dolmetsch and Edwin Ripin, and I deem their remarks significant enough to quote.

A search through the Forty-eight Preludes and Fugues of "Das wohltemperirte Klavier" . . . will show that the passages that would suffer in that way [i.e., be unplayable on a fretted clavichord] are rare.¹²

In all of Books I and II, there appear to be only three examples where both notes of a pair served by the same string [i.e., a fretted clavichord] are struck simultaneously and, accordingly, where the performer could not get around the problem by releasing one of the notes before its note was sounded.¹³

Unfortunately, neither of them tells us where in the *Well-Tempered Clavier* these problems appear. Nor is it explained why Dolmetsch and Ripin play fretted rather than fret-free clavichords. From a closer examination of the instrument and the musical work itself is it possible that one can form an opinion about whether or not J. S. Bach played on one or on both kinds of clavichord?

There is more than mere supposition on the part of those who would like to believe that the clavichord is suitable for the *Well-Tempered Clavier* and other keyboard music of Bach. Most of us are willing to accept that Bach knew the instrument because of its ubiquity in his time and his knowledge of all things musical. There are also at least two references to his relationship with this instrument. Forkel's well-known biography (1802) contains the remark that the clavichord was Bach's favorite

¹¹For information about clavichords--their history, varieties and operation--see *New Grove Dictionary of Music and Musicians*, s.v. "clavichord;" *New Grove Dictionary of Musical Instruments*, s.v. "clavichord."

¹²Arnold Dolmetsch, *The Interpretation of Music of the XVII and XVIII Centuries* (London: Novello, 1916; reprint, 1946), 435.

¹³Edwin M. Ripin, "A Reassessment of the Fretted Clavichord," *Galpin Society Journal* 23 (1970), 43.

instrument.¹⁴ And the *Specificatio*, the inventory of Bach's estate, refers to three claviers, probably clavichords, that he gave to his son Johann Christian.¹⁵ In neither of these, however, is a clavichord described.

Choice of Instrument

Having no detailed information about Bach's clavichord we must choose as the basis for our study a type of antique instrument compatible with his time and place that reasonably could have been known to him. We can then try to determine whether or not it is apt for his music. Two questions immediately arise: (1) did Bach have access to clavichords with sufficient range to play the *Well-Tempered Clavier*?; and (2) did he play a fretted or unfretted clavichord?

(1) For Volume I the range must be chromatic from C to c^{'''}. This excludes the ubiquitous C/E-c^{'''} clavichords (with short octave), because they lack C#, Eb, F#, and G#.¹⁶ There is no movement among the ninety-six preludes and fugues that does not make use of one or more of these notes. Even instruments with a broken octave must be excluded, because they still lack C# and Eb, rather common notes in Volume I.¹⁷ Van Der Meer's useful article lists only one chromatic C-c^{'''} instrument that qualifies by reason of its date: that of Johann Jakob Donat of

¹⁴Johann Nikolaus Forkel, *Über Johann Sebastian Bachs Leben, Kunst und Kunstwerk* (Leipzig: 1802); *Life of Johann Sebastian Bach*, trans. by A. C. F. Kollman (London: 1820). Hans David and Arthur Mendel, *The Bach Reader* (New York: Norton, 1945), 311.

¹⁵Werner Neumann and Hans-Joachim Schulze, *Fremdschriftliche und gedruckte Dokumente zur Lebensgeschichte Johann Sebastian Bachs, 1685-1750*. *Bach Dokumente* (Kassel: Bärenreiter, 1969), vol. 2, pp. 21, 492, 503-504.

¹⁶Short octave keyboards eliminated bass notes for which there was little use. This was particularly important as a money-saving practice in organ building, because the missing pipes were among the largest and costliest. The lowest five notes of the keyboard were arranged as follows: the lowest key, which visually is E, sounds C (C/E); visual F sounds F; visual F# sounds D (D/F#); visual G sounds G; visual G# sounds E (E/G#).

¹⁷I am using the term broken octave to denote a short octave in which D/F# is split into two keys (a rear key and a front key) that produce both notes. Likewise E/G# is split so that both can be used. However, C# and Eb still are missing.

Leipzig, 1700.¹⁸ This, at least, places the chromatic C-c'' gamut in Bach's area and time. Volume II, however, requires a chromatic range from A' to d''. Van der Meer cites only two extant clavichords with keyboards that descend to A', both from 1787.¹⁹ However, the more common range from f'' further down to F' was used in an instrument made at least as early as 1742 by Hieronymous Albrecht Hass of Hamburg.²⁰ If we take the evidence of this instrument as an indication that others also existed it is possible that Bach could have known of one in time for the compilation of Volume 2, which is dated 1744. Moreover, extremely low notes are few in the *Well-Tempered Clavier*, and usually they can be played an octave higher on an instrument that descends only to C. Knowing, therefore, that most of the music is possible on instruments available at the time we will not allow range alone to disqualify the clavichord for Volume 2.

(2) Our second task is to determine whether a fretted or unfretted clavichord might have been used. The sticky problem, of course, is that the fretted clavichord was not designed to be at home in many of the twenty-four major and minor keys that Bach employed. Erwin Bodky, who writes that the *Well-Tempered Clavier* "could never have been written for a *gebunden* clavichord,"²¹ no doubt expresses the conclusion of many who have wrestled with this question. Bodky concluded that Bach must have had an unfretted clavichord at hand. He presents evidence that an unfretted instrument was in existence as early as 1700, and this is confirmed by Hanns Neupert, who cites tuning instructions for both fretted and unfretted clavichords in Werckmeister's *Generalbass* of 1698 and 1715.²² In particular Bodky asserts that Gottfried Silbermann, the organ builder and acquaintance of Bach, produced an unfretted

¹⁸John Henry Van Der Meer, "The Dating of German Clavichords." *Organ Yearbook* 6 (1975), 102. For a description of the instrument see Hubert Henkel, *Clavichorde* (Leipzig: VEB Deutscher Verlag, 1981), 37-38.

¹⁹See "Compass," par. 9. The instruments both by Christian Gottlob Hubert are presently at Nuremberg. Cf. Wolfgang Strack, "Christian Gottlob Hubert and His Instruments." *Galpin Society Journal* 33 (1979), 38-58, nos. 20, 21; and Donald H. Boalch, *Makers of the Harpsichord and Clavichord, 1440-1840*. (Oxford: Clarendon Press, 2d ed., 1974), nos. 12, 12a.

²⁰Van der Meer, "Clavichords," 102.

²¹Bodky, *Interpretation*, 10.

²²Hanns Neupert, *The Clavichord*, trans. Ann P. P. Feldberg (Kassel: Bären-reiter, 1965), 29.

clavichord at least by 1723.²³ Furthermore, Daniel Tobias Faber is known to have made one in Crailsheim about 1725.²⁴ This instrument undoubtedly was rare at this time, however, and Van Der Meer traces its *effective* introduction to Hass's adoption of the unfretted scheme in 1742.²⁵ All of this is by way of indicating that the unfretted instrument must have been rare in 1720-1722, regardless of which Bodky asserts: "It is unthinkable that Bach would not have been familiar with this improvement of the clavichord in 1720 when he began to write the *Inventions* and the first volume of the *Well-Tempered Clavier*."²⁶ Hanns Neupert, however, offers a contradictory hypothesis:

Perhaps the invention [the unfretted clavichord] spread only slowly, for otherwise we would hardly expect to find another organist complaining in 1739 that the impossibility of striking simultaneous notes at the interval of a second on the clavichord undermined its other advantages. It was just in this way that an important work like J. S. Bach's *Wohltemperirte Klavier*, whose first part appeared in 1722, contributed so much to the full musical use of the chromatic, accurately tuned keyboard instrument, in other words, the fret-free clavichord.²⁷

It does seem hard to believe that Bach would have assigned the monumental work on which he was engaged in the years before 1722 to such a rare instrument. Even if he did have an unfretted clavichord, can we assume that his students, for whom the *Well-Tempered Clavier* was standard fare, also possessed such exotica? Surely a concentration of state-of-the-art clavichords would have come down to us in some small observation by one of his acquaintances. No. It seems inescapable that, if the clavichord was used in Bach's circle it normally was the fretted kind. It sets us to looking for the proper model of fretted clavichord to use in pursuing an answer.

²³The instrument was at Markneukirchen when Bodky wrote of it (*Interpretation*, 88). Van der Meer ("Clavichords," 103) agrees that, if the instrument actually bears the date 1723, it is the earliest extant unfretted clavichord.

²⁴Van der Meer, "Clavichords," 104; Boalch, *Makers*, 41.

²⁵Van der Meer, "Clavichords," 103.

²⁶Bodky, *Interpretation*, 32.

²⁷Neupert, *Clavichord*, 28-29.

Fretting patterns at the end of the seventeenth century, when presumably the clavichords that Bach could have used as a child and youth were being made, are bewildering in their variety. The lowest octave (C/E or C to B, more or less) was unfretted because of the mechanical problem involved in cranking the key levers from the equidistant keys, on which one plays, back to the very wide frets that would be necessary in the low range. The tenor register was usually double-fretted, i.e. with two notes played on one course of strings. The older, more traditional clavichords of this period, however, commenced triple (and even quadruple) fretting somewhere around c' (middle C). Ex. 1 (a-d) shows the fretting patterns of a number of such instruments from Hubert Henkel's catalogue of the clavichords in the Leipzig collection.²⁸ No one knows which fretting pattern Bach may have had at hand, and since we are limited to a reasonable expenditure of energy and space we shall look first at one that was sufficiently common to have been known to him: a triple-fretted pattern, well exemplified by the anonymous German clavichord of about 1700 in the Russell Collection in Edinburgh.²⁹ The fretting pattern is shown in Ex. 1(e). Note that in triple-fretted instruments certain whole steps cause fretting conflicts as well as half steps. Analyzing the two preludes and fugues in C major (four movements) against this pattern we find thirty-five places where two notes must be played on the same string. Many can be "gotten around," as Ripin so nicely puts it, but seventeen require considerable care. For G-sharp minor the four movements present twenty-two more, two of which are very difficult to negotiate. The high total of such significant obstacles in this sample of both mean-tone and high-signature keys suggests that a triple-fretted clavichord is not suitable for the *Well-Tempered Clavier*, and we lay it aside.

By 1700, however, double fretted clavichords were becoming common, and because of its proximity to Bach the Donat instrument (Leipzig, 1700) mentioned above comes to mind. In its fretted range it possesses seven courses of strings per octave with d, a, e', a', and e'' unfretted, as in Ex. 1(f). While it is possible that this fretting pattern was common, evidence for another — d, a, d', a', d'' and a'' unfretted — is more abundant, both in extant instruments and documentary sources.³⁰ For

²⁸Henkel, *Clavichorde*, 29-33.

²⁹Sidney Newman and Peter Williams, eds. *The Russell Collection and Other Early Keyboard Instruments in St. Cecilia's Hall* (Edinburgh: Edinburgh University Press, 1968), 47.

³⁰Michael Praetorius, *Syntagma Musicum II, De Organographia*, Parts 1 and 2 (1618, 1619), trans. and ed. by Daniel Z. Crookes (Oxford: Clarendon Press, 1986), 65.

purposes of our analysis, therefore, we choose a design that combines this fretting pattern (D's and A's unfretted above c) with a chromatic compass (C to c'''). As a matter of interest, later we will compare our results with those that are obtained when one uses the Donat fretting as the basis of the project.³¹

The Probability of Fretting Conflicts in the Various Keys

In major scales the minor seconds fall between scale steps 3-4 and 7-8; in the minor scales between 2-3, 5-6 and #7-8. Thus, as shown in paragraph 1 of Table 1, there are three minor seconds in each key signature or, as illustrated for D major and B minor, F#-G, A#-B and C#-D. As a composer changes from one to another key these minor seconds change to different notes. However, the minor second fretting conflicts of a clavichord with D's and A's unfretted never change, as seen in paragraph 2 of Table 1: C-C#, E^b-E, F-F#, G-G#, and B^b-B or their enharmonic equivalents (of which many exist: C-C#, C-D^b, B#-C#). For this reason each pair of keys lies on the fretted clavichord with a different pattern of hazards caused by the fretting conflicts among its scale steps.³² The changes in these patterns are geared to, and thus just as regular and beautiful as those of the key signatures, for which reason the keys in paragraph 3 of Table 1 are laid out in signature order rather than the chromatic scale order that Bach used in the *Well-Tempered*

Moreover, many extant instruments exist, from a C/E clavichord in Leipzig, the fretting pattern of which is shown in Ex. 1(g) (cf. Henkel, *Clavichorde*, no. 11, p. 37), to Hubert of Ansbach/Bayreuth (cf. Strack, "Hubert," 35-38), who made them at least from 1756 to 1789 (see Ex. 1h). Later examples also exist (cf. Van der Meer, "Clavichords," 103).

³¹The clavichord on which the author plays the *Well-Tempered Clavier*, which he made in the shop of John Barnes, Edinburgh, in 1980, is copied from the drawing and letter of David Tannenberg, written between 1780 and 1804 (See Thomas McGeary "David Tannenberg and the Clavichord in the Eighteenth Century," *Organ Yearbook* 13 (1982), 96. However, Tannenberg's instructions and measurements for the keyboard and fretting did not survive. These elements, accordingly, were taken from the 1784 clavichord of Christian Gottlob Hubert now at the Russell Collection of Early Keyboard Instruments in Edinburgh (See Boalch, *Makers*, 77, no. 11, and Strack, "Hubert," 55, no. 17). This instrument is similar to that on which we base our analysis for this study, except that its range rises to f''' and its fretting begins at f-f# rather than c-c#. The fretting pattern is shown in Ex. 1(h).

³²A fretting hazard, for example c'-c#, belongs to a class that includes all of the fretted C-C#s on the instrument. Since there are only five classes of fretted accidentals (C#, Eb, F#, G#, Bb) there are only five classes of fretting hazards.

Clavier. C major and A minor offer no fretting hazards. G major and E minor have one, D#-E, and others are added or subtracted in regular order as one moves up and down the perfect-fifth ladder of key signatures.

For diatonic music we can now rank the keys according to the hazards they face on fretted clavichords. For each key, however, we must also include those other keys to which Bach normally modulated, those whose signatures are closest to the tonic key, both on the flat and sharp sides. For example, a work of Bach composed in a signature of three flats can be expected to draw on a tonal region from two to four flats. The diatonic fretting hazards for a chosen key, therefore, appear in the three keys in Table 1 (par. 3) that include and surround the tonic key;³³ e.g. C minor, G minor, and F minor (and their relative majors), wherein two of the five possible conflicts could be encountered. On this basis the keys distribute themselves on a continuum from no fretting hazards to all five that are possible, as shown in Table 2a.

Parenthetically, it may be interesting at this point to deviate briefly toward a tradition of Iberian, eighteenth-century clavichords, of which several are extant, in which the fretting pattern is C-C#, D-E^b, E, F-F#, G-G#, A-B^b, B; i.e., with E and B unfretted rather than D and A.³⁴ The hazards of this scheme are worked out in Table 2(b). The pattern is identical to that in Table 2(a), but the keys have been rotated two positions toward the flat side, bringing G/e to the condition free of fretting conflicts. Yet a third pattern, represented by Donat (1700) and at least one other extant clavichord, have E and A unfretted.³⁵ Reasons must have existed for these patterns. Neupert believes that the ubiquitous German pattern with D and A unfretted arose from the need for trills and appoggiaturas on the leading tones of the dorian and hypodorian modes, which cadence respectively on D and A.³⁶ For baroque music, however, a reason may be because the two rarer patterns

³³Secondary dominants and other alterations, as well as chromaticism, may add further fretting conflicts to a key, but they arise from the musical style rather than the characteristics of the instrument. We rank the keys, therefore, on the basis of their diatonic materials.

³⁴Gerhard Doderer, *Clavicórdios portuguesas do século dezoito/ Portugiesische Klavichorde des 18. Jahrhunderts* (Lisbon: Fundação Calouste Gulbenkian, 1971).

³⁵Henkel, *Clavicorde*, 71; see Ex. 1(f).

³⁶Neupert, *Clavichord*, 28.

deny a composer the popular suspension of D against E^b, and the Iberian further prohibits A against B^b, devices without which German organ music is unthinkable. The tendency of the fretted clavichord to work better in some keys than in others is a unique example (among the clavier) of an instrument built in a key; just as were, for example, horns and trumpets. Donat (1700) with E and A unfretted is the true "C" instrument. The German and Iberian clavichords now reveal themselves to have been constructed in F and G respectively.

Fretting Conflicts in the *Well-Tempered Clavier*

The foregoing theoretical ranking of the tonal regions according to their fretting hazards is an indication of the risks a composer takes when using different keys on a fretted clavichord. If musical notes were generated randomly, perhaps the occurrence of actual fretting conflicts would agree with the inherent hazards as shown. One's stumbling into potholes and over rocks, however, is determined not only by their distribution in a field, but also by the path one takes and the attention one gives to walking. Similarly the nature of a composer's harmony and keyboard textures influences the appearance of fretting conflicts in his music. It is likely, for example, that a Classic melody accompanied by an Alberti bass will produce fewer fretting conflicts than a Bach fugue because of the lesser likelihood of minor seconds in the former.

Looking at Table 3 one sees that the total of fretting conflicts in the *Well-Tempered Clavier* (col. 2) follows the curve of hazards predicted in column 1 in a general way. The total is low from C minor (3 flats) to A major (3 sharps). Thus we see that in traditional keys of mean-tone music the *Well-Tempered Clavier* is quite free of fretting conflicts. From C-sharp minor (4 sharps) to E-flat major (3 flats), less usual keys for that time, fretting conflicts in the *Well-Tempered Clavier* are by comparison higher.

While thinking about the conspicuous increase of fretting conflicts in the high-signature keys (col. 2) as compared to their occurrence in the mean-tone keys, one wonders whether Bach modified his keyboard writing in either group. Attention is drawn to Table 4, where the keys with the largest totals of fretting conflicts are transposed to their nearest mean-tone neighbors. Amazingly the number of fretting conflicts drops to zero or one, exactly congruent with the movements that currently stand in the lower signatures. It seems clear that Bach was thinking primarily musically, rather than in instrumental context.

High key signatures, therefore, produce fretting conflicts in the *Well-Tempered Clavier* just as predicted by theory. If we consider other factors that also are at work we can make a list of conditions favorable to the creation of fretting conflicts:

1. High key signatures;
2. Thick textures that compress voices into close proximity, thus producing minor seconds;
3. Contrapuntal textures (linear, imitative counterpoint with abundant contrapuntal dissonance, logical development, and reiteration of motives, as well as suspensions);
4. Lavish use of the nearly-related keys, thus adding their fretting conflicts to those of the tonic key. Use of parallel and foreign keys (Ex. 3c);
5. Chromaticism, which increases the number of minor seconds available;
6. Long, complicated works.

Conversely, factors that inhibit fretting conflicts are:

1. Low key signatures;
2. Thin textures of two and three parts, and open structure, wherein minor seconds are infrequent;
3. Homophonic textures; chordally influenced melodies, as in harmonic preludes, dance-influenced forms and the unaccompanied passage-work in fantasias;
4. Limited use of the nearly-related keys, and avoidance of parallel and foreign keys;
5. Predominantly diatonic music, which limits the minor seconds to the theoretical group;
6. Shorter, simpler works.

In the interaction of the two lists above one finds an explanation for those keys in which there are fewer fretting conflicts than expected: C, a, G, e, D, b, A, B^b. Quite spectacular, however, are certain single movements in high-signature keys that contain *no* fretting conflicts: II, 3

Prelude in C#; I, 13 Prelude in F#; II, 8 Prelude in d#; and others listed in Table 5. In these Bach's textures and other factors listed above have combined to counter completely the natural tendency of a key to produce fretting conflicts. Nevertheless, despite these exceptional movements the data are so close to what one infers from theory as to suggest that Bach was wholly unconcerned with the problem of avoiding fretting conflicts. Rather, they accrued in dense or sparse numbers only as a result of Bach's overriding attention to his musical ideas, keys, textures, and their mutual developments.³⁷

Playability of Fretting Conflicts

The presence of fretting conflicts, however, is not a measure of playability because, fortunately, the majority of them cause no problem in performance. The fingers strike the keys exactly as specified in the score, but normally only the upper note of a fretted minor second will be heard, not the dissonance that Bach wrote. A little experience with the instrument shows that there are only a few ways that the two notes of minor seconds can relate to each other (listed in increasing order of their deleterious effect on the music):

Type a. First we note that not all minor seconds cause fretting conflicts; e.g. in C#-D, D-E^b, E-F, F#-G, G#-A, A-B^b, and B-C the two notes lie on different courses of strings, and both sound, just as when played on the other claviers. (Ex. 2 shows the first and last minor seconds in the *Well-Tempered Clavier*, both of which are type a).

Among the fretted notes, however, the following occur:

Type b. The lower note of the fretted minor second sounds first, then the upper note moves into place to create the fretting conflict (Ex. 3). Usually this type causes no change in the fingering, and the effect is musically satisfying. Normally the simpler harmony that results is so good that one is not even aware that a dissonance is missing. The rhythmic momentum propels one's attention forward, and even familiar passages slip by without notice.

³⁷Some, of course, will find in this statement an argument that Bach did not, after all, compose the *Well-Tempered Clavier* specifically for the clavichord. No one knows, to be sure, whether Bach intended the work for a particular instrument. The aptness of the clavichord for this music, and its consequent probability of use, is all that I am intending to demonstrate in this article.

Type c. The upper note of a fretted minor second sounds first, then the lower moves into place to create the conflict (Ex. 4). This causes a serious problem: the tangent for the upper note is already in contact with the strings when the tangent for the lower note strikes outside the sounding length of string. Sometimes an ugly sound is produced, but on many clavichords the *upper* note sounds again rather than the one played; that is, the player hears a different note than he or she expects. The player first must clear away the upper tangent to let the lower function. Releasing the upper key is seldom awkward, but being contrary to one's expectations and sight-reading reflexes it is unnatural. In some instances, however, the music suffers seriously as, for instance, when the upper note is a long value in an important line. Dropping it breaks the melody which, upon resumption of its motion, sounds like a new entrance (Ex. 4a). Examples 4(a) and 4(b) show a Bachian idiom, a suspension of type b which is repeated, creating an unplayable type c conflict. Ex. 4(b) is particularly misleading: f#['] is a cadence tone in the soprano voice, but when it is released to play e#['] the soprano melds with the alto and loses its identity. (Ex. 4(e) is similar.) Ex. 4(c) shows that the situation is not ameliorated by using a rest rather than a tie. In the two lower parts a^b (tenor, 2nd beat) cannot be held: the ear can only hear a scale fragment from a^b to d. Examples 4(d-j) illustrate various other dissonances that cause type c fretting conflicts, several of which are quite difficult to play. Ex. 4(k) is an especially serious case, since the occlusion of d#['] in the bass mars the final announcement of the subject. This example might better be included with the conflicts of type e.

Type d. In *appoggiaturas* and other rare cases it can happen that *both notes of a fretted minor second are struck simultaneously*. Of course only the upper note sounds. It may be possible to live with the omission of the lower, but if an approximation of the dissonance is desired, it seems that the only recourse is to arpeggiate the two notes. At least both are heard, but the effect usually is out of style and clumsy. In Ex. 5 the reasonable tempi of these movements permit arpeggiation. If one finds the effect distasteful it is perhaps better to play the passages as written and let *appoggiaturas* turn into pseudo-suspensions.

Type e. When type d fretting conflicts occur in the course of important thematic material there is sometimes no opportunity for a successful realization of the score. Ex. 6 shows two such cases, which are described below.

How can these fretting conflicts be overcome? First it is necessary to point out that the normal keyboard techniques of the harpsichord, organ,

and piano often require one to release a key before the full duration shown in the notation. In Ex. 3(e) the c" in the alto on the first beat of measure 94 must be released in order to play the c" that follows in the soprano, which effectively eliminates the dissonance, regardless of the instrument in use. The same can be seen in Ex. 3(g), where the last four minor seconds could not be heard on either a clavichord, harpsichord, or organ, nor on a piano unless the pedal were in use. For this reason many fretting conflicts seen in the notation never cause problems in performance. Where they do, however, the player must resort to faking; that is, somehow to make all of the written notes sound, even though the dissonance cannot be produced. In this sense clavichord technique is no different than that needed to play Bach on the other claviers. Whether or not something can be played hinges on the performer's expertise in creating an illusion. Classification of fretting conflicts, therefore, is subjective. In this paper a flexible policy is adopted: if the music comes out essentially meaningful when performed according to the score (i.e. fingered normally) the lack of dissonance is ignored and the result is deemed acceptable. If, however, the music must be refingered, such as by removing a note as required in type c clashes, it is considered to be difficult, and if the structure of the music thereby is altered, impossible.³⁸

Under these criteria only the two passages of type e strike me as truly formidable. In Example 6(a) the thematic motive in the tenor part collides with an expressive melodic ornament in the soprano. Rewriting the soprano to place the after-turn of the trill on the third rather than the fourth sixteenth solves the fretting problem but is contrary to Bach's careful notation of the ornament. In Example 6(b) Bach begins a stretto (tenor to bass) and requires the player to alight simultaneously on c' and d^b'. The rhythm is too fast for effective arpeggiation of the interval and, even if that is done elegantly, c' is lost as an effective thematic tone (see also Ex. 4k, as mentioned above).

As explained, the fretting conflicts described above occur on a clavichord with seven courses of strings per octave, with accidentals fretted onto five of them, and D's and A's unfretted. In Table 6 the incidence of each type of fretting conflict is given both for this fretting pattern and the Donat instrument (E's and A's unfretted), which was made in Leipzig about twenty years before Bach took up his post at the Thomaskirche. A comparison shows that the Donat is marginally better for the *Well-*

³⁸If the reader cannot accept this policy, or if the solutions suggested for ex. 4-5 are not satisfactory, then for him or her the clavichord is not a suitable instrument for the *Well-Tempered Clavier*.

Tempered Clavier in types b and c. Most of the serious type d and e conflicts are the same on the two instruments. Therefore, the results of this study seem to be as valid for the Donat as for the clavichord on which the analysis is based.



It appears that both Dolmetsch and Ripin did their work well. In types d and e my analysis of minor seconds in the *Well-Tempered Clavier* provides seven fretting conflicts of the order that I think they referred to in the quotations at the head of this paper.³⁹ I presume that my list includes theirs. They, however, may have had different fretting schemes than the ones we have considered, or they may have found fretting conflicts that I missed. Nevertheless I find it remarkable that in my list of 357 minor seconds (of which 179 cause fretting conflicts) only two or three appear to be genuinely unplayable. Remembering, therefore, that the fretted clavichord was ubiquitous in Bach's time, my conclusion is that it was held to be a suitable instrument for the *Well-Tempered Clavier*. I am certain that Bach was able to perform this work on it, and skillfully. He very likely did so frequently.

³⁹Type d: 17-94-1, 78-4-3, 79-17-1, 186-5-1; type e: 44-2-4, 165-42-4. Also include 107-68-4, in which the notes are not struck together, but which nevertheless, is very troublesome.

TABLE ONE

The Probability of Fretting Conflicts in Various Keys Using a Pairwise Fretted Clavichord with D's and A's Unfretted

1. The scale steps on which simultaneous minor seconds naturally occur in Bach.

<i>In major keys:</i>	<i>In minor keys:</i>
	
D: 3 4 7 8	b: 5 6 #7 8 2 3

2. The fretting conflicts on the clavichord, shown in black notes, in the octave c'-c''.



3. How the minor seconds of the 24 keys match the fretting conflicts of the clavichord.

The following table summarizes the fretting conflict labels for each key signature shown in the image:

Key Signature	Fretting Conflict Label
C/a	3/5 4/6, #7 8, 7/28/9
G/e	#7 8, 7/28/9, 3/5 4/6
D/b	7/28/3, 3/5 4/6, #7 8
A/f#	3/5 4/2, #7 8, 7/28/3
E/c#	#7 8, 7/28/3, 3/5 4/6
B/g#	3/5 4/6, #7 8, 7/28/3
F#/d#	#7 8, 7/28/3, 3/5 4/6
e b	#7 8, 2 3, 5 6
C#	7 8, 3 4
b b	2 3, 5 6
A/bf	3/5 4/6, #7 8, 7/28/9
E/bc	7/28/3, 3/5 4/6, #7 8
B/bg	3/5 4/6, #7 8, 7/2 8/3
F/d	#7 8, 7/28/3, 3/5 4/6

TABLE TWO

Fretting Hazards

a. The keys ranked according to the number of hazards (potential fretting conflicts) among the notes of their diatonic scales, and the scales of their closest modulations.

No fretting hazards	F/d			
One fretting hazard	C/a (d#-e)	Bb/g	(g-	ab)
Two fretting hazards	G/e (d#-e, a#-b)	Eb/c	(g-ab,	c-db)
Three fretting hazards	D/b (d#-e, a#-b, e#-f#)	Ab/f (f-gb)	(g-ab,	c-db,
Four fretting hazards	A/f# (d#- e, a#-b, e#-f#, b#-c#)	C#/bb f-	(g-ab, gb,	c-db, bb-cb)
Five fretting hazards	E/c# (d#- e, a#-b, e#-f#, b#-c#, fx-g#)	F#/d#/eb c- bb-cb,	db,	(g-ab, f-gb, eb-fb)
	B/g#			

b. The keys ranked according to the fretting pattern of Iberian clavichords.

No fretting conflicts	G/e		
One fretting conflict D/b (e#- f#)	C/a		(a-bb)
Two fretting conflicts	A/f# (e#- f#, b#-c#)	F/d	(a-bb, d-eb)
Three fretting conflicts fx-g#)	E/c# (e#- f#, b#- c#, g-ab)	Bb/g	(a-bb, d-eb,
Four fretting conflicts fx-g#, cx-d#)	B/g# (e#- f#, b#-c#, g-	Eb/c ab,	(a-bb, d-eb, c-db)
Five fretting conflicts	F#/d#/eb (e#-f#, b#-c#, fx-g#, gx-a#)	Ab/f ab,	(a-bb, d-eb, c-db,
	f-gb)		
	C#/bb		

TABLE THREE

Fretting Conflicts in the *Well-Tempered Clavier*

Comparison of: (1) fretting hazards (cf. Table 2); and (2) total fretting conflicts in the four movements of the *Well-Tempered Clavier* that were composed in each key.

	Keys in signature order	(1)	(2)
	C	1	0
	a	1	0
1#	G	2	0
	e	2	1
2#	D	3	1
	b	3	0
3#	A	4	2
	f#	4	4
4#	E	5	7
	c#	5	23
5#	B	5	19
	g#	5	12
6#/6 ^b	F#	5	11
	d#/e ^b	5	14
7#/5 ^b	C#	4	11
	b ^b	4	23
4 ^b	A ^b	3	15
	f	3	18
3 ^b	E ^b	2	13
	c	2	2
2 ^b	B ^b	1	0
	g	1	1
1 ^b	F	0	0
	d	0	0

TABLE FOUR

The Effect of Transposition to Low Signature Keys of Movements that Contain Many Fretting Conflicts.

<u>Original Key</u>	<u>Transposed</u>			
c#	c:	1 conflict	(1-b2)	d: 0 conflicts
B	Bb:	1	" (6-b7)	C: 0 "
g#	g:	0	"	a: 0 "
F#	F:	0	"	G: 1 " (#5-6)
D#/Eb	d:	0	"	e: 1 " (#7-8)
C#	C:	0	"	D: 0 "
bb	b:	1	" (#7-8)	a: 0 "
Ab	A:	0	"	G: 0 "
f				e: 1 " (#4-5)
Eb				D: 0 "

TABLE FIVE

Preludes and Fugues That Contain No Fretting Conflicts, Listed in the Order of Keys (the asterisks denote those that have no minor seconds at all).

Major Keys			Minor Keys		
I-1	Prelude Fugue	C	I-2	* Prelude Fugue	c
II-1	Prelude Fugue		II-2	* Prelude	
II-3	* Prelude	C#	I-6	* Prelude Fugue	d
I-5	* Prelude * Fugue	D	II-6	Prelude Fugue	

II-5	Fugue		II-8	* Prelude	d#
II-7	* Prelude	E ^b	I-10	* Prelude * Fugue	e
I-9	* Prelude Fugue	E	II-10	* Prelude	
I-11	* Prelude Fugue	F	I-14	* Prelude	f#
II-11	Prelude Fugue		II-14	* Prelude	
I-13	* Prelude	F#	I-16	Prelude Fugue	g
II-13	* Prelude		II-16	Prelude	
I-15	Prelude Fugue	G	I-20	Prelude Fugue	a
II-15	* Prelude Fugue		II-20	* Prelude Fugue	
II-19	Prelude Fugue	A	I-24	Prelude Fugue	b
I-21	* Prelude * Fugue	B ^b	II-24	* Prelude Fugue	
II-21	Prelude Fugue	B ^b			
II-23	* Prelude	B			

53 Movements have no fretting conflicts. Of these 23 have no minor seconds.

TABLE SIX

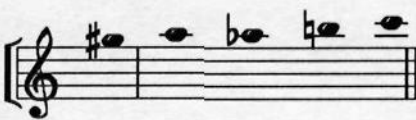
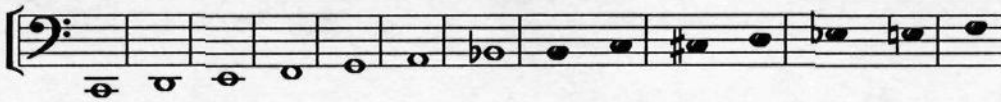
Comparison of Fretting Conflicts in the *Well-Tempered Clavier* as Played on the Analysis (DA Unfretted) and Donat (Ea Unfretted) Instruments

Fretting conflicts	Analysis instrument	Donat 1700
	Range: C-c'''	Range: C-c'''
	Unfretted: C-B, d, a d', a', d'', a''	Unfretted: C-B,d,a c', a', c''
Type b	116	98
Type c	56	44
Type d	5	5
Type e	2	2

EXAMPLES

Ex. 1. Fretting patterns: ♯ = fretted. ♮ = unfretted. Each measure represents one course of strings.

a. Leipzig Collection No. 5: German, second half of 17th century



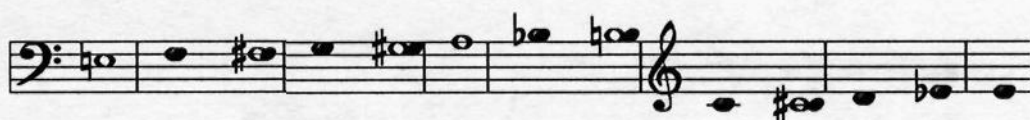
b. Leipzig No. 6: German, second half of 17th century

Four staves of musical notation for Leipzig No. 6. The first staff is in bass clef with a 4/4 time signature, containing a sequence of eighth and quarter notes. The second staff continues the bass line and introduces a treble clef staff. The third staff continues the treble line. The fourth staff is a short continuation of the treble line, ending with a double bar line.

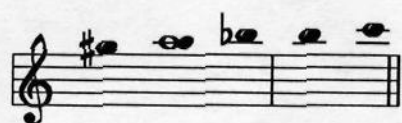
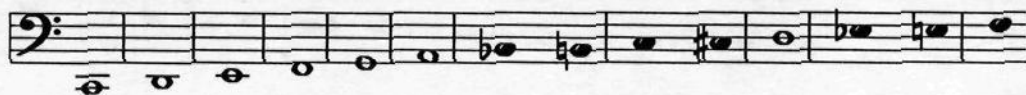
c. Leipzig No. 7: Anonymous, second half of 17th century

Four staves of musical notation for Leipzig No. 7. The first staff is in bass clef with a 4/4 time signature, containing a sequence of eighth and quarter notes. The second staff continues the bass line and introduces a treble clef staff. The third staff continues the treble line. The fourth staff is a short continuation of the treble line, ending with a double bar line.

d. Leipzig No. 8: German, end of 17th century



e. Russell Collection: Anonymous, about 1700



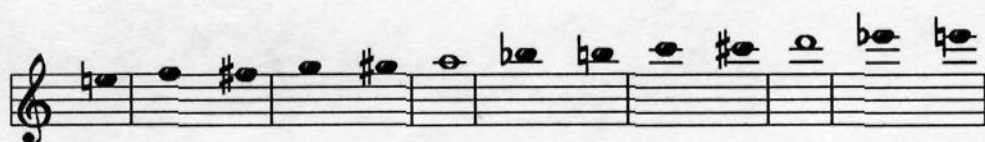
f. Leipzig collection No. 12: Johann Jacob Donat, Leipzig, 1700



g. Leipzig No. 11, second half of the 17th century



h. Russell Collection: Christian Gottlob Hubert, 1784



In the examples that follow page, measure, and beat references are to Bach 1866 or Bach 1983.

Ex. 2. Type a minor seconds. No fretting conflict.

a. I 1 C Prelude, 3-8 (C) (Vol. 1, No. 1, C major, Prelude, page 3, measure 8, common meter)



b. II 24 b Fugue, 202-87-1 (3/8) (Vol. 2, No. 24, B minor, Fugue, page 202, measure 87, beat 1, 3/8 meter)



Ex. 3. Type b minor seconds. The lower note of the minor second sounds first, then the upper voice moves into place to create the fretting conflict.

a. I 3 C# Fugue, 12-25-3 (C), descending passing tone in soprano



b. I 13 F# Fugue, 49-26-2 (C), seventh chord

X



c. I 22 b^b Fugue, 80-32-1 (ϕ), suspension in alto; 80-34-1, upper neighbor tone in alto; 80-35-1, ascending passing tone in tenor (type c)

1. Note use of foreign key, A^b minor.



d. II 13 F# Fugue, 145-49-1 (♭), suspension in alto; 145-50-2, lower neighbor tone in alto; 145-51-1, suspension in bass.



e. II 22 b^b Fugue, 191-94-1 (3/2), appoggiatura (accented passing tone) in soprano; 191-94-2, suspension in alto.

X X

f. I 4 c^\sharp Prelude, 14-13-2 (6/4), lower neighbor tone (g^\sharp) in soprano ornament

g. II 17 A^b Prelude, 162-52-2, 3 (3/4) and 162-54-2, 3, lower neighbor tones in soprano

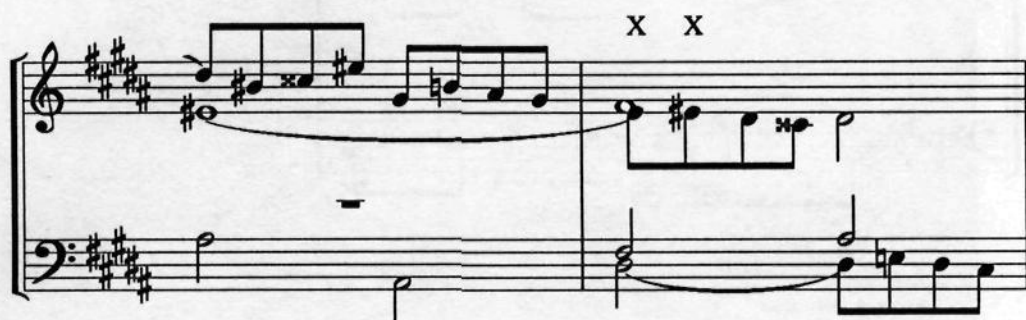


Ex. 4. Type c minor seconds. The upper note of the minor second sounds first, then the lower voice moves into place to create the fretting conflict. The first three show idiomatic type c's in combination with type b.

a. II 23 B Fugue, 194-24-1 (♯), suspension in alto (type b) and its repetition (type c)



b. II 23 B Fugue, 197-85-1 (♯): suspension in alto (type b) and its repetition (type c)



c. I 7 E^b Prelude, 29-63-1, 2 (C): suspension in bass (type b) and its repetition (type c)

The musical score for example c consists of two systems of piano music in E-flat major (three flats). The first system shows a suspension in the bass, marked with an 'X'. The second system shows its repetition, also marked with an 'X'. Both systems feature a treble and bass staff with various musical notations including notes, rests, and accidentals.

d. I 7 E^b Prelude, 29-56-2 (C): descending passing tone in soprano. Since the parts are crossed the soprano is masked by the alto.

The musical score for example d consists of two systems of piano music in E-flat major (three flats). The first system shows a descending passing tone in the soprano, marked with an 'X'. The second system shows its repetition, also marked with an 'X'. Both systems feature a treble and bass staff with various musical notations including notes, rests, and accidentals.

e. I 19 A Prelude, 67-16-1 (C): implied descending passing tone in bass



f. I 14 f# Fugue, 51-30-1 (6/4): ascending passing tone in tenor



g. II 3 C# Fugue, 103-24-3 (C): implied lower neighbor tone in alto

The musical score for g. II 3 C# Fugue, 103-24-3 (C) is presented in two systems. The key signature is C major (one sharp, F#) and the time signature is 3/4. The first system shows the treble and bass staves with a melodic line in the treble and a supporting bass line. The second system continues the piece, with an 'X' marking a specific measure in the treble staff. The notation includes various note values, rests, and accidentals.

h. II 8 d# Fugue, 122-16-1 (C): upper neighbor tone in tenor

The musical score for h. II 8 d# Fugue, 122-16-1 (C) is presented in two systems. The key signature is C major (one sharp, F#) and the time signature is 3/4. The first system shows the treble and bass staves with a melodic line in the treble and a supporting bass line. The second system continues the piece, with an 'X' marking a specific measure in the treble staff. The notation includes various note values, rests, and accidentals.

i. I 4 c# Fugue, 17-81-2 (C): escape tone in alto

The image displays two systems of musical notation for a fugue in C major, 4/4 time. Both systems are written for a grand staff, consisting of a treble and a bass clef. The key signature is one sharp (F#), and the time signature is 4/4. The first system shows a melodic line in the treble staff with eighth-note patterns and a half-note phrase, while the bass staff provides a harmonic accompaniment with quarter and eighth notes. The second system continues the piece, featuring a more complex melodic line in the treble staff with a marked 'X' above a specific note, and a corresponding bass line. The notation includes various musical symbols such as clefs, key signatures, time signatures, and note values.

j. II 2 c Fugue, 99-21-3 (C): reaching tone in tenor



k. II 4 c# Fugue, 107-68-4 (12/16): reaching tone in bass

The first system of musical notation consists of two staves. The top staff is in treble clef with a key signature of three sharps (F#, C#, G#). It contains a series of eighth and sixteenth notes, ending with a dotted quarter note marked with an 'X' above it. The bottom staff is in bass clef with the same key signature, featuring a continuous eighth-note pattern.

The second system of musical notation consists of two staves. The top staff continues the melodic line with various note values and rests. The bottom staff continues the eighth-note pattern from the first system, with some notes beamed together.

The third system of musical notation consists of two staves. The top staff shows a few notes followed by rests. The bottom staff shows a few notes followed by rests, mirroring the structure of the top staff in this system.

Ex. 5. Type d minor seconds, struck simultaneously

a. I 4 c# Fugue, 17-94-1 (C): appoggiatura in alto



b. I 22 b^b Prelude, 78-4-3 (C): appoggiatura in bass



Ex. 6. Type e minor seconds, fretting conflicts which spoil thematic material

a. I 12 f Prelude, 44-2-4 (C). Lower neighbor tone in soprano ornament ruins motive in tenor

The first system of musical notation consists of two staves. The top staff is in treble clef with a key signature of three flats (B-flat, E-flat, A-flat). It contains a melodic line with eighth and sixteenth notes, including some beamed sixteenth notes. The bottom staff is in bass clef with the same key signature, featuring a simpler line with quarter and eighth notes. The two staves are connected by a brace on the left.

The second system of musical notation also consists of two staves in the same key signature and clefs as the first system. The top staff features a melodic line with a slur over a group of notes, followed by a note marked with a wavy line (~) and then a note marked with an 'X'. The bottom staff continues the accompaniment with eighth and sixteenth notes. The two staves are connected by a brace on the left.

b. II 17 A^b Fugue, 165-42-4 (C). Ascending appoggiatura in tenor destroys subject in bass

