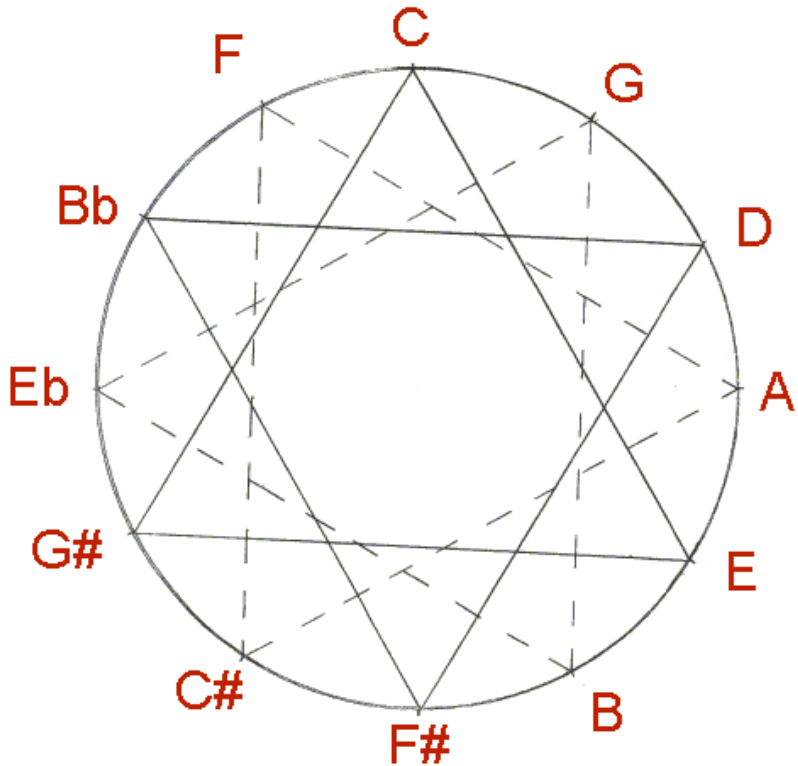


## Why use unequal temperaments on harpsichords and organs?

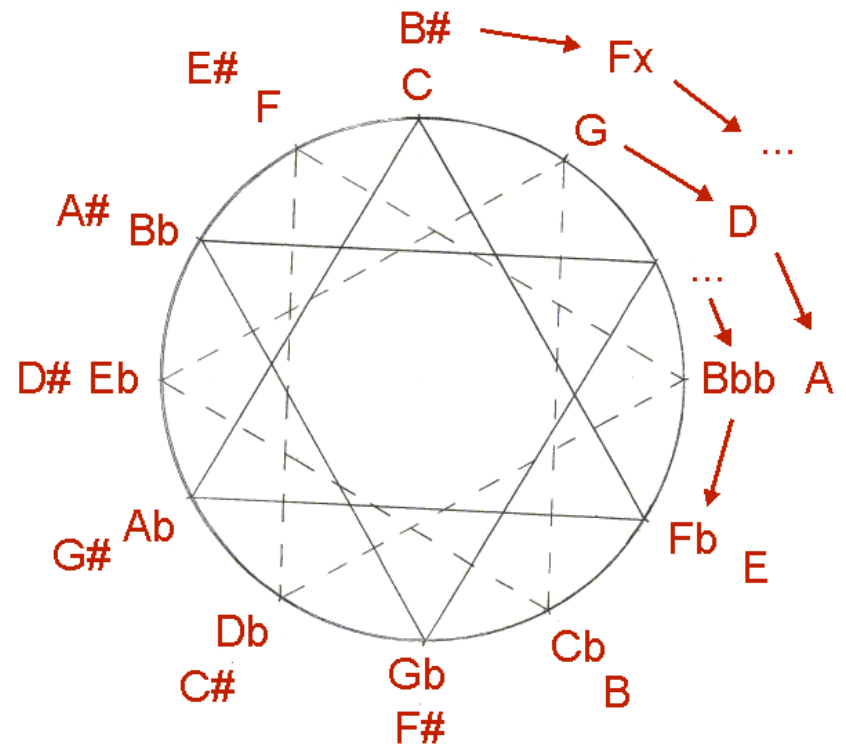
- Better resonance and projection of the instrument
- It compensates for the inability to play dynamic contrasts from note to note
- The melodic and harmonic tensions inspire sensitive players to listen closely, and to shape the musical delivery with appropriate expression
- Differences among the keys help to sustain the listener's interest during a composition, and to provide contrasts during a concert or church service
- It makes the instrument seem “alive”, not merely like a box full of levers
- The keys and scales used most frequently can be better in tune than equal temperament allows
- Good unequal temperaments are easier and much faster to set up than equal temperament is
- The blend with other instruments and voices can be more harmonious
- Historical accuracy: play older compositions in the temperament style for which the music was originally conceived, if this information is reasonably knowable

# Which subset of notes do we need to install into our keyboard instruments?

12 most common note names




Spiral of 5ths



What kind of practical tuning challenges does the *Well-Tempered Clavier* (the book) present?

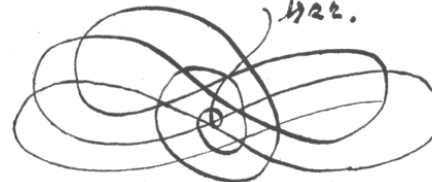
- Bach provided exemplary preludes and fugues in all 24 major and minor scales.
- The book as a whole calls for 27 differently-named notes!
- Most of the preludes and fugues use 13, 14, or more notes...not only a convenient 12.
- Therefore, tasteful compromises MUST be made: for example, in C major, choosing a pitch for the G# and Ab keyboard lever that can serve passably as either one, in all its harmonic and melodic contexts.



Das Wohltemperirte Clavier.

Praeludia, 2<sup>te</sup>

Fugen sind alle Tone mit Semitoria,  
Do soll tertiam majorem als Ut Re Mi anlan;  
gut, als auf tertiam minorem ut Re  
Mi Fa betroffend. Zum  
Nutzen im Gebrauch dieser Lesebeginnen  
Musicalischen Figuren, als auf stören in stören etc.,  
die sich habit fortsetzen besondern  
Zweckes leicht aufführen  
mit vorfolgend von  
Johann Sebastian Bach.  
p.h. 1722. Druck  
Leipzig  
Christoph und Dörflinger  
rectore Anno  
Lauterbach  
Signa.  
1722.



## A roster of all the named notes in the *Well-Tempered Clavier (book 1)* :

C major: 13 notes: Ab, Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#

C minor: 12 notes: Db, Ab, Eb, Bb, F, C, G, D, A, E, B, F#

C# major: 15 notes: A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx, Cx, Gx, Dx, Ax

C# minor: 14 notes: G, D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx, Cx

D major: 14 notes: Bb, F, C, G, D, A, E, B, F#, C#, G#, D#, A#, E#

D minor: 13 notes: Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#, D#

Eb major: 14 notes: Cb, Gb, Db, Ab, Eb, Bb, F, C, G, D, A, E, B, F#

Eb minor/D# minor: 25 notes: Bbb, Fb, Cb, Gb, Db, Ab, Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx, Cx, Gx

E major: 13 notes: C, G, D, A, E, B, F#, C#, G#, D#, A#, E#, B#

E minor: 15 notes: Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#, D#, A#, E#

F major: 12 notes: Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#

F minor: 14 notes: Cb, Gb, Db, Ab, Eb, Bb, F, C, G, D, A, E, B, F#

F# major: 14 notes: D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx, Cx, Gx

F# minor: 14 notes: G, D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx

G major: 14 notes: Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#, D#, A#

G minor: 12 notes: Ab, Eb, Bb, F, C, G, D, A, E, B, F#, C#

Ab major: 12 notes: Gb, Db, Ab, Eb, Bb, F, C, G, D, A, E, B

G# minor: 14 notes: D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx, Cx, Gx

A major: 12 notes: G, D, A, E, B, F#, C#, G#, D#, A#, E#, B#

A minor: 14 notes: Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#, D#, A#

Bb major: 14 notes: Gb, Db, Ab, Eb, Bb, F, C, G, D, A, E, B, F#, C#

Bb minor: 13 notes: Fb, Cb, Gb, Db, Ab, Eb, Bb, F, C, G, D, A, E

B major: 12 notes: D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx

B minor: 17 notes: Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#, D#, A#, E#, B#, Fx

(including 13 different notes already in the statement of the fugue subject!)

**Within the need to play in all 24 different major and minor scales,  
using 27 different notes smoothly:**

- Tune the harpsichord **by ear** as quickly as possible.
- Make the first half of the notes as normal as possible, coming from everyday practice.
- Install the naturals first, because they are the center of melody and harmony.
- Tuning is done by 5ths and 4ths, checking major 3rds as they become available. 5ths are made deliberately narrow, or 4ths wide, so the major 3rds will turn out nicely.
- The first six notes are the hexachord in the home key, the naturals, C major: C-D-E-F-G-A; that's **F-C-G-D-A-E** when working by 5ths/4ths.
- Fit the remaining notes (B and the sharps) into place carefully, compromising them sharpward so they can also serve well as flats.
- That is: they are *tempered less tightly* by 5ths/4ths than the starting 5ths/4ths were. They are more nearly pure, or perhaps some *are* pure.
- What might such a process **look like** on paper?

## My interpretation of Bach's drawing

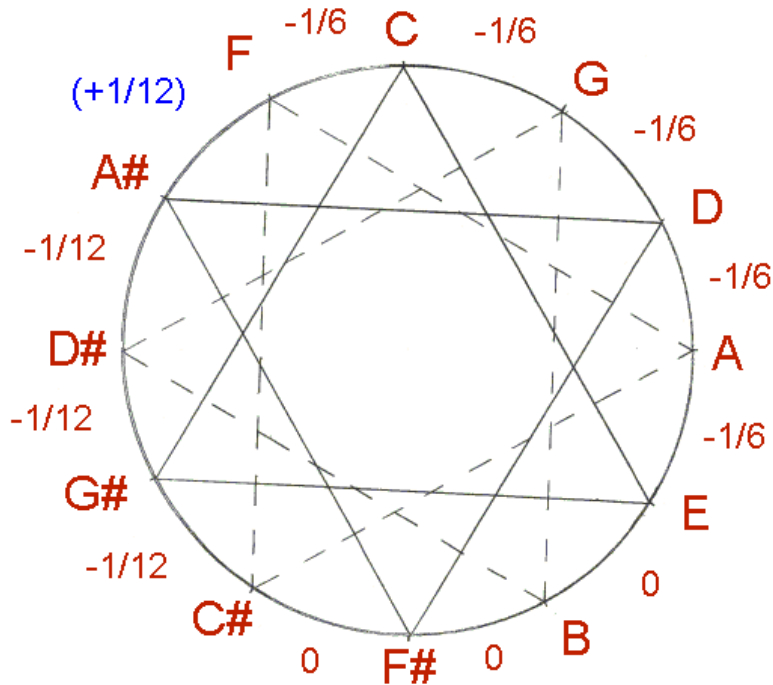
- It is a practical diagram for tuning.
- The adjustments are all practical motions of the wrist, not a pretext for calculations. The tuner works hands-on at the harpsichord, and doesn't need to know any mathematics.
- Bach was demonstrating with this book a *better* tuning method than equal, and better than any of the other expert or amateur systems around him.
- Bach drew the diagram at the bottom of the page, with the page rotated 180 degrees. It is now at the top of the page, upside-down.
- The loops of the drawing indicate how much to temper each 5<sup>th</sup> in turn.
- The beginning notes are the naturals, and are done the same way as normally: **F-C-G-D-A-E** by 5ths, narrowed by the usual amount each.
- The remaining notes are all placed slightly higher than they would have been in that system. This allows them to function well as either sharps or flats.
- **E-B-F#-C#** are pure, because the loops of the drawing are empty.
- The final notes **C#-G#-D#-A#** are fit into position using average 5ths, only very slightly tempered.
- From the point where the 5<sup>th</sup> would be sounding as pure, the tuner nudges the upper note flatward (turning the tuning pin counter-clockwise) by 2, 0, or 1 nudge of the wrist. "About that much."
- The point is to make all 24 major and minor scales (and music in them) playable and beautiful, with a healthy variety of character and with no obviously "out-of-tune" problems.
- The same temperament can be left in place to play the entire book, with all 27 of the different notes it asks for.
- The temperament is not tied to any specific frequency or pitch. The starting C, F, or A can be any convenient tension for the given instrument, and all the rest is derived from there by mechanical motions.



## Some musical outcomes of this temperament:

- Music in sharp keys gets a bright and brilliant sound.
- Music in flat keys is warmer, gentler, and mellower.
- Music in major keys tends to sound smooth, genial, poised.
- Music in minor keys tends to have much stronger contrasts and forceful gestures; then, it relaxes when it moves to major.
- Tonal music has firm arrival points.
- Music has tension and relaxation as it goes along. (By contrast, when the same music is played in equal temperament it has “nowhere to go”, because equal temperament offers only a one-dimensional surface....)
- Chromatic music sounds especially intense.
- Performance is easier: it is not necessary to work so hard to make the musical effects project well. (Bach: “Just hit all the right notes at the right times, and the instrument plays itself.”)
- This temperament works not only for harpsichords and clavichords, but also for organs and pianos.
- If we can assume that a Leipzig organ was in or near this temperament, at least for a few accompanying stops: Bach’s vocal music for his job there emerges with strongly dramatic contrasts. The modulations and the choices of key fit the moods closely. That is to say: the expressive character of this temperament may have inspired some of Bach’s compositional ideas, both instrumental and vocal.
- This temperament also fits (and inspired?) the most volatile and intense music by others in Bach’s family: especially the two oldest sons, Wilhelm Friedemann Bach and Carl Philipp Emanuel Bach.
- CPE Bach described something similar, and possibly this specific temperament, in his own book (*Essay on the True Art of Playing the Keyboard*, 1753): in the correct modern temperament, one “takes away from most of the 5ths a scarcely noticeable bit from their absolute purity...”

## The Bach/Lehman layout



## Resources

- Lehman, Bradley. "Bach's extraordinary temperament: our Rosetta Stone" (Early Music, 2005)
- Lehman. Several other articles in *Clavichord International*, *Diapason*, *BBC Music*, and CD booklet notes.
- Lehman. Web site [www.larips.com](http://www.larips.com) with free copies of the articles, analysis, musical examples, CDs for purchase, YouTube video demonstrations, and more.
- Duffin, Ross. *How Equal Temperament Ruined Harmony (and Why You Should Care)* (Norton, 2007).
- More than 25 recordings since 2004: by Peter Watchorn, Robert Hill, Richard Egarr, Penelope Crawford, Jory Vinikour, Robert Woolley, Bradley Lehman, Julia Brown, Luc Beausejour, et al.
- At least a dozen pipe organs in North America and Europe with this temperament in their permanent installation.