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# The Stanford Organ: A Synthesis of Views, The Stanford Eclectic Tunings

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# The Stanford Eclectic Tunings

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In his beautiful instrument at Stanford University's Memorial Church, Charles Fisk undertook to build an organ whose nuances of tuning would suit both high-Renaissance and high-baroque music. A few months before his death in December, 1983, he wrote that the instrument should successfully render music "from Praetorius to Bach."[1] No one style of tempered tuning could possibly suit such a broad repertoire, so he provided a mechanism to incorporate two different systems that share the same pipes for the diatonic notes. Specific temperaments were newly devised by Harald Vogel, whose influence and enthusiasm were largely responsible for the creation of this unique instrument.

In two articles published in this journal, we have proposed tunings that we felt would be better suited historically to the repertoire,[2] and while

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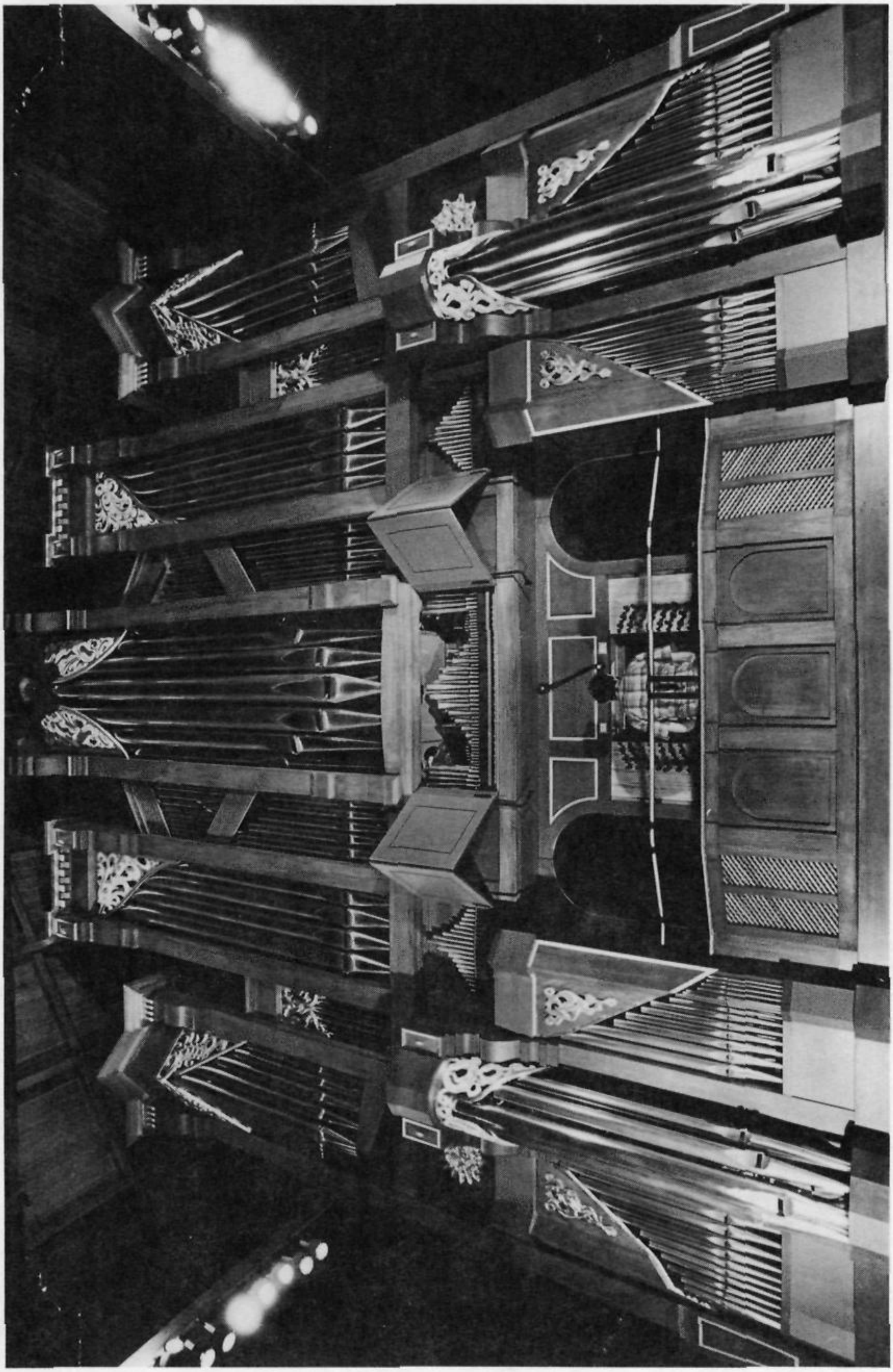
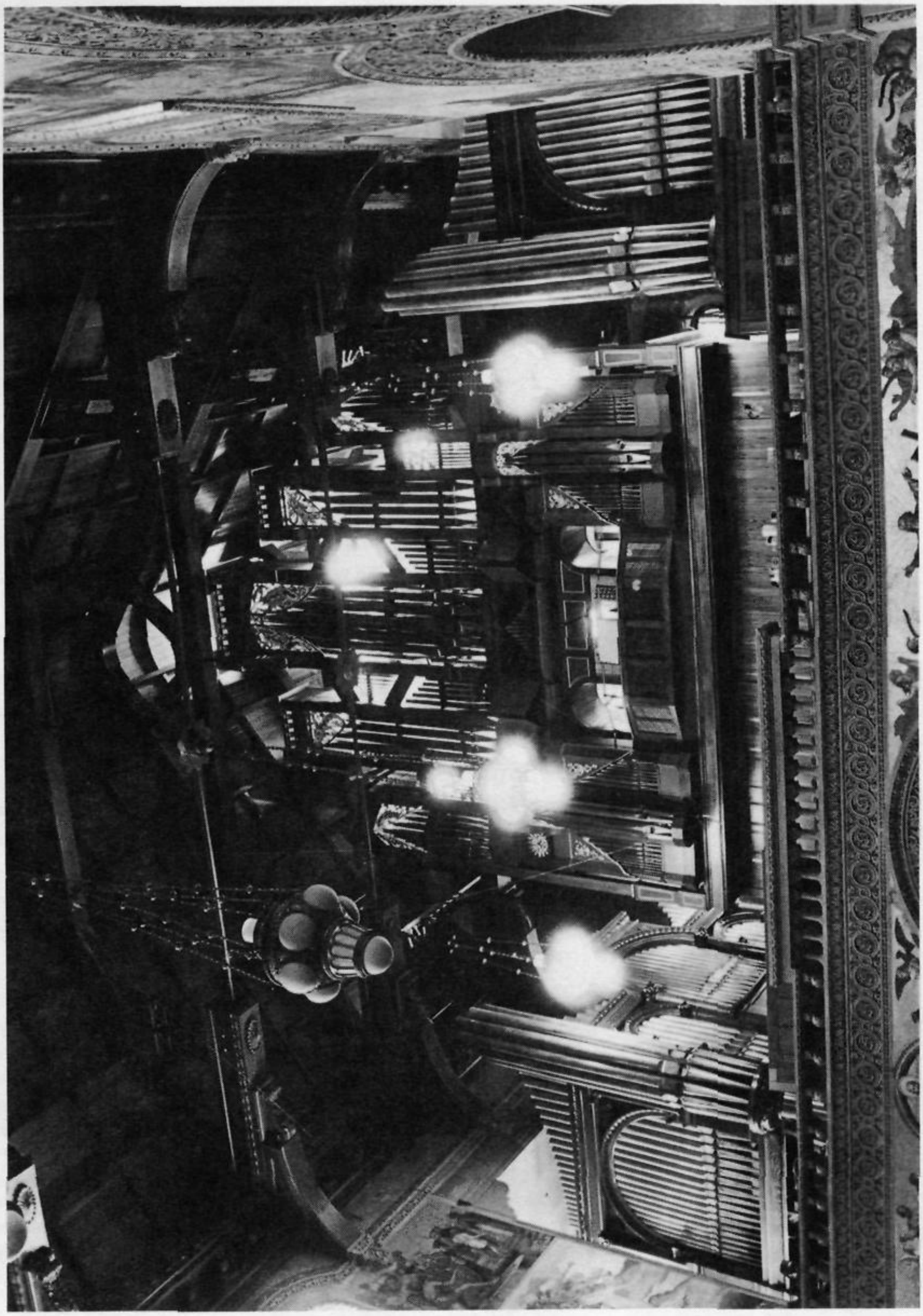
[1]Letter from Charles Fisk to Herbert Nanney, March 21, 1983, in *Charles Brenton Fisk: Organ Builder,* ed. Barbara Owen (Easthampton, MA, 1986), vol. 2, p. 74.

[2]Mark Lindley, "A Suggested Improvement for the Fisk Organ at Stanford," *Performance Practice Review* 1 (1988): 107-32. Robert Bates and Kimberly Marshall, "A Response from the Custodians: More Thoughts on the Stanford Temperaments," *Performance Practice Review* 2 (1989): 147-69.

## THE FISK ORGAN OF STANFORD UNIVERSITY





we each have our own, somewhat different musical perceptions and leanings, we have now devised a joint solution, which is the subject of this article. Since no verbal description can adequately convey musical subtleties, we have recorded a set of musical examples on two stops of the Stanford Fisk, played both in the original and in our new tunings; these recordings are available to subscribers who wish to make comparisons.[3]

Our arguments are presented here in three stages: (1) the diatonic scales, (2) the chromatic notes for the Renaissance tuning and (3) the chromatic notes for the late-baroque tuning.

**The Diatonic Notes**

According to every competent contemporary account of 16th-century keyboard tuning, the diatonic notes were temperated "regularly," that is, with uniform 5ths.[4] The tuning of the diatonic notes on the Fisk Organ should, therefore, be regular, and our task is merely to determine the size of these 5ths.

To summarize our previous discussions concerning the tempering of the 5ths: we have already shown that (1) a chain of four pure 5ths entails a major 3rd larger than pure by nearly 1/9 whole-tone (the "syntonic comma"), an excess which must be mitigated by tuning the diatonic 5ths slightly smaller than pure. (2) In French keyboard tunings of c.1700 as described by Sauveur and Loulié,[5] the 5ths and major 3rds (among the

[3]Subscribers to *Performance Practice Review* can obtain a cassette tape for $8.00 from *Performance Practice Review*, The Claremont Graduate School, 139 E. 7th St., Claremont, CA 91711-4405.

[4]See chapters 2-3 ("Vorstufen zur Quantitativen Theorie der Temperierung," and "Von Zarlino bis Stevin: die Kodifizierung Regulärer Stimmungen") in Mark Lindley, *Stimmung und Temperatur* (in Frieder Zaminer, ed., *Geschichte der Musiktheorie*, vol. 6, *Hören, Messen und Rechnen in der frühen Neuzeit* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1987). Specifically, we imply that Ludovico Fogliano's irregular scheme (*Musica Theorica*, Venice, 1529, f. 35v) was not musically valid—a point made by Gioseffo Zarlino when he published the first mathematically coherent model for a regular temperament (*Istitutioni Harmoniche*, Venice, 1558, p. 128: "lo istrumento verrebbe ad esser proportionato inequalmente: conciosia che si udirebbe in lui la Diapente . . . con due intervalli l'uno maggiore dell'altro"). And, we imply that the geometrical scheme of Cyriacus Schneegass (*Nova & Exquisita Monochordi Dimensio*, Erfurt, 1590) was really intended to yield a regular tuning (see Lindley, *op. cit.*, 166-67).

[5]Étienne Loulié, *Nouveau Sistème de Musique* (Paris, 1698), 28, described the tempering of the 5ths by 1/5 of the syntonic comma and said this way of tuning was "plus en usage qu'aucune autre." Joseph Sauveur made an equivalent assertion at great length, with reference to keyboard tuners and the theoretical division of the octave into 43 equal parts (see Table 1 below), in his "Table Générale des Sistèmes Tempérés de Musique"

diatonic notes) were tempered by about the same amount, that is by about 1/5 of the syntonic comma; this is shown in Figure 3. (The unit of measure used in these figures is the "schisma,"[6] which for all practical purposes is 1/11 of the syntonic comma.) (3) Among the German musicians and theorists who were closest to J.S. Bach (and also among 18th-century Italian experts),[7] the tendency was to temper the diatonic 5ths by about 1/6 of the "Pythagorean comma," or 9% less than did the French.

Fig. 1. 5ths tempered by 1/4 of the syntonic comma (Zarlino *et al.*)

A 2.75 E 2.75 B

0 0 0

F 2.75 C 2.75 G 2.75 D 2.75 A

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*Mémoires de Mathématique et de Physique . . . de l'Académie Royale des Sciences . . . m.dccxi* (Paris, 1714), 314-15. In summarizing an earlier account by Sauveur of the 43 division, the secretary of the Académie Royale, Bernard de Fontanelle, said that "les Facteurs d'Orgues, & de Clavecins suivent le Sistème de M. Sauveur," *Histoire de l'Académie Royale des Sciences. Année m.dcvii* (Paris, 1708), 119.

[6]The schisma is the difference between the Pythagorean and syntonic commas and amounts to 1/12 of the one and 1/11 of the other; more precisely (logs are base 12):

$$\log (3^{12}/2^{19}) \,/\, [\log (3^{12}/2^{19}) - \log (3^4/(5\cdot 2^4))] = 12.008$$
$$\log (3^4/(5\cdot 2^4)) \,/\, [\log 3^{12}/2^{19}) - \log (3^4/(5\cdot 2^4))] = 11.008 .$$

[7]Georg Andreas Sorge (*Gesprach Zwischen einem Musico Theoretico und einem Studioso Musices*, Lobenstein, 1848) attributed the use of a regular 1/6-comma temperament to Gottfried Silbermann. Telemann, *Mizlers Musikalische Bibliothek* 3 (1752), 713-16, advocated using the intervals of the 55-division (see Table 1 below). The leading contemporary Italian organist and church composer, Francescantonio Vallotti, would temper the six diatonic 5ths by 1/6 comma each and leave the other six pure; the relevant passage is transcribed from Vallotti's manuscript studies by Giancarlo Zanon in Francescantonio Vallotti, *Trattato della Moderna Musica* (Padua: Biblioteca Antoniana, 1950), 195. In a letter of 25 May 1751 (transcribed in Patrizio Barbieri, *Acustica Accordatura e Temperamento nell'Illuminismo Veneto*, Rome: Torre d'Orfeo, 1987, 143 of the second pagination), Vallotti in effect attributed the same kind of 5ths to some contemporary (Italian) organ builders. Alessandro Barca, "Introduzione a una Nuova Teoria di Musica," *Saggi Scientifici e Letterari dell'Accademia delle Scienze, Lettere e Arti in Padova* 1 (1786), 384, called the 1/6-comma tuning "temperamento per comune opinione perfettissimo, quale suole applicarsi alle quinte diatoniche."

**Fig. 2. 5ths tempered by 1/5 of the Pythagorean comma (Vogel)**

**A 2.4 E 2.4 B**

**1.4 1.4 1.4**

**F 2.4 C 2.4 G 2.4 D 2.4 A**

**Fig. 3. 5ths tempered by 1/5 of the syntonic comma (Sauveur *et al.*)**

**A 2.2 E 2.2 B**

**2.2 2.2 2.2**

**F 2.2 C 2.2 G 2.2 D 2.2 A**

**Fig. 4. 5ths tempered by 1/6 of the Pythagorean comma (Telemann *et al.*)**

**A 2 E 2 B**

**3 3 3**

**F 2 C 2 G 2 D 2 A**

**Fig. 5. 5ths tempered by 1/12 of the Pythagorean comma (equal temperament)**

**A 1 E 1 B**

**7 7 7 7**

**F 1 C 1 G 1 D 1 A**

**The Pythagorean comma is the amount by which a chain of twelve pure 5ths exceeds an enharmonic "unison," for instance between $A^b$ and G# when linked by a chain of pure 5ths and/or 4ths. In equal temperament, represented in Figure 5, the 5ths are each tempered by 1/12 of this comma, which is about 9% larger than the syntonic comma.**

**Hence the Germans (see Figure 4) would temper the diatonic major 3rds by about 4 x 9% = 36% more than the French (see Figure 3). We multiply by 4 because in a regular tuning, any change in the tempering of**

the 5ths has a fourfold effect upon that of the major 3rds produced by a chain of four 5ths.

In Vogel's tuning for the Fisk Organ (Figure 2), the diatonic 5ths are tempered by 1/5 of the Pythagorean comma, which is 9% more than in the French tuning (Figure 3), and hence the major 3rds by 36% less. Thus, in the 18th century the French were likely to temper the diatonic major 3rds by about half again as much as in Figure 2, and the German experts of Bach's generation by at least twice as much.[8]

Figures 1-4 represent different shades of regular meantone temperament. For Renaissance music, any of these shades (or even some intermediate shade) is an historically viable option. Figures 3 and 4 both answer to Lanfranco's expert account of meantone tuning (1533),[9] according to which the major 3rds were enlarged to the point that "the ear wants no more of it"; on the other hand, some later 16th-century writers, such as Zarlino and Salinas, prescribed regular temperaments with the major 3rds smaller than in Figure 2—for instance, with the major 3rds pure and the 5ths tempered by 1/4 of the syntonic comma (Figure 1), or with the 3rds smaller than pure by 1/7 of the syntonic comma, and the 5ths by 2/7.[10]

At the same time, however, the tempering of the diatonic notes on the Stanford organ must suit Bach's music—to which Figure 4 answers better

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[8]We say "at least" because in the models of unequal temperament proposed by Sorge and Johann Georg Neidhardt, the tuning of the diatonic notes would be irregular in such a way that F-A and/or G-B would be larger than C-E (see Lindley, *Stimmung und Temperatur*, ch. 7).

[9]Giovanni Maria Lanfranco, *Scintille di Musica* (Brescia, 1533), 132-35: "lo estremo acuto di ciascuna Terza maggiore va alzata in mode; chel senso piu non ne voglia." For documentation that Lanfranco was prescribing a regular tuning with a wolf 5th (and not equal temperament), see Lindley, "Early 16th-Century Keyboard Temperaments," in *Musica disciplina* 28 (1974), 144-47. Arnolt Schlick, *Spiegel der Orgelmacher und Organisten* (Speyer, 1511), ch. 8, also prescribed that the major 3rds among the diatonic notes be somewhat larger than pure, but distinctly less so that in equal temperament (see Lindley, *op. cit.*, 129).

[10]Gioseffo Zarlino, *loc. cit.* in note 4 (for the 2/7-comma temperament) and *Dimostrationi Harmoniche* (Venice, 1571), 151 (for the 1/4-comma temperament); Francesco de Salinas, *De Musica Libri VII* (Salamanca, 1577), 154. Pietro Aron had earlier implied a tempering of the diatonic 5ths by 1/4 of the syntonic comma (*Thoscanello de la Musica*, Venice, 1523, bk. 2, ch. 41).

than Figure 3, and Figure 3 better than Figure 2.[11] But among the historically possible shades of regular tuning for Renaissance music, the one shown in Figure 4 is closest to equal temperament. The major 3rds are larger than pure by nearly half as much as in equal temperament;[12] also, the semitones B-C and E-F are only 10% larger than in equal temperament, whereas in the French tuning (Figure 3,), they are 12% larger, and in Vogel's tuning (Figure 2), 14%. These data appear in Table 1. Since Charles Fisk undoubtedly wanted the instrument's Renaissance tuning to sound quite "un-modern," tempering the diatonic 5ths by only 1/6 comma might be contrary to the spirit of his undertaking. As we have already remarked,[13] it seems a shame to choose a tuning for Renaissance music that might risk conveying a similar aura to that of equal temperament, so we prefer to temper the 5ths a little more.

The scheme using 1/5 syntonic comma (Figure 3) seems to us a sensible compromise for the diatonic notes. On the one hand, its triads sound distinctly more resonant than those of equal temperament, an important point for the Renaissance and early-baroque music.[14] On the other hand, repeat comparisons have convinced us that it is somewhat better than the present tuning (Figure 2), not only for Bach's music, but also for the French-Classical repertoire. This is because when the diatonic 3rds are so nearly pure as in Figure 2, it is difficult to temper all the other 3rds (i.e. those involving chromatic notes) in a way that will accomodate the French repertoire, and impossible to do so for Bach's music. At this point the argument goes beyond the diatonic notes *per se*, however, so we

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[11] This is discussed at length in both our previous articles in this journal: Lindley, "A Suggested Improvement," and Bates and Marshall, "A Response from the Custodians."

[12] Thus, the major 6ths are tempered by more than half as much as in equal temperament. If the 4th and major 3rd are each tempered larger than pure (as in both these tunings), then the major 6th is tempered the sum of the amounts for the 4th and major 3rd, which is 1 + 7 = 8 schismas for equal temperament and 2 + 3 = 5 schismas for the 1/6-comma temperament.

[13] Robert Bates and Kimberly Marshall, "A Response from the Custodians: More Thoughts on the Stanford Temperaments," *Performance Practice Review* 2 (1989): 154-5.

[14] One aspect of this resonance is that since the major 3rds, 4ths, and 5ths are tempered by the same amount (and the major 6ths by twice that amount), in many dispositions of a triad their "proportional" rates of beating (including the proportion 1:1) will couple into resonance.

will postpone a more detailed consideration until we come to our discussion of the chromatic notes for the late-baroque tuning.

**The Chromatic Notes for the Renaissance Tuning**

A regular tuning—with the chromatic notes tempered the same as the diatonic ones—is unquestionably the most sensible and authentic choice for Renaissance organ music. The extension of regular 1/5 syntonic comma meantone to all notes is shown in Figure 6. This includes the two additional pitch classes afforded by the split keys for $A^b$-G# and $E^b$-D# on the Brustpositive of the Fisk Organ. We have previously discussed Schlick's and Praetorius's descriptions of tempering among the chromatic notes,[15] but we know of no evidence that these exceptional tunings were very widely used. Moreoever, in the original Stanford tuning shown in Figure 7, the chromatic notes produce an *inversion* of the irregularities approved of by Schlick and Praetorius.[16]

Fig. 6. New Stanford Eclectic (Renaissance)

C# 2.2 G# 2.2 D#

2.2 2.2 2.2

A 2.2 E 2.2 B 2.2 F# 2.2 C#

2.2 2.2 2.2 2.2

F 2.2 C 2.2 G 2.2 D 2.2 A

2.2 2.2 2.2

$A^b$ 2.2 $E^b$ 2.2 $B^b$ 2.2 F

[15]Schlick, *loc. cit.* Michael Praetorius, *Syntagma Musicum*, vol. 2: *De Organographia* (Wolfenbüttel, 1619), 155. By not citing Pietro Aron in this connection, we mean to imply that the apparent irregularities or anomalies in his instructions (*loc. cit.*) are due to mere vagueness rather than to a musical intention (see Lindley, "A Suggested Improvement," 139-44).

[16]Lindley, "A Suggested Improvement," 112-13 (regarding Praetorius) and "Early 16th-Century Keyboard Temperament," 129-139 (regarding Schlick).

Fig. 7. Vogel "V/M"

C# 2.75 G# 2.75 D#

0.7 0.35 0

A 2.4 E 2.4 B 2.75 F# 2.75 C#

1.4 1.4 1.4 1.05

F 2.4 C 2.4 G 2.4 D 2.4 A

0.35 0.7 1.05

$A^b$ 2.75 $E^b$ 2.75 $B^b$ 2.75 F

Vogel's musical objective was to heighten the contrast between diatonic and chromatic semitones (that is, between semitones involving two different notes in some diatonic scale, and semitones involving notes with the same letter-name in a chromatic scale). In his tuning, the two types of semitones contrast more than in regular 1/5-Pythagorean-comma meantone. In such a regular tuning the diatonic semitones would be 33.7% larger than the chromatic ones (see Table 1); the diatonic semitones in Vogel's tuning are between 40% and (in the case of D# on the Brustpositive) 50% larger than the chromatic ones. (The difference is more when a more extreme flat or sharp is involved.) The greater contrast does add expressive bite to certain chromatic lines. But repeated listening to chromatic passages played in various regular temperaments has convinced us that the 40%+ contrast between diatonic and chromatic semitones in Mr. Vogel's tuning does not justify its irregularity, which can produce a somewhat unsettling effect for the Renaissance repertoire. Because of the irregular tuning one hears a distracting contrast between various major chords. In Cavazzoni's "Magnificat quarti toni" (Example 1), the three E-major chords stand out because their thirds are lower than those of the other major chords in the passage; in Titelouze's "Iste Confessor" (Example 2), three notes serving as *mi*—G#, F# and B-natural—produce three different effects. In our solution, where all major thirds are equally well in tune, the overall effect is more uniform, reflecting the stable quality of most Renaissance organ music; a composition such as Praetorius's "Es ist ein' Ros'" (Example 3) sounds especially "gentle."

**Ex. 1.** ***Magnificat quarti toni*** **-G. Cavazzoni**

**Magnificat**

**Ex. 2.** *Iste Confessor*, second verset -J. Titelouze

**Ex. 3.** ***Es ist ein' Ros'*** **-M. Praetorius**

While the uniformity of our tuning is at the expense of the greater contrast between diatonic and chromatic semitones in Vogel's tuning, we have found that our 33.7% difference is palpable and heightens the effect of the chromaticisms in a way that seems perfectly natural. This may be heard in the opening of Sweelinck's "Chromatic Fantasy" (Example 4). Likewise, the contrast between consonant and dissonant intervals retains much expressive power, as demonstrated in excerpts from Frescobaldi (Example 5) and Correa (Example 6).

| | 1/4-syntonic comma: | 1/5-Pythagorean comma: | 1/5-syntonic comma: | 1/6-Pythagorean comma: | 1/12-Pythagorean comma: |
|---|---|---|---|---|---|
| diatonic semitone: | 117.1 | 113.7 | 111.7 | 109.8 | 100.0 |
| chromatic semitone: | 76.0 | 80.1 | 83.6 | 86.3 | 100.0 |
| increment: | 50.4% | 40.6% | 33.7% | 27.2% | 0% |
| | 31-division: | 74-division: | 43-division: | 55-division: | 12-division: |
| diatonic semitone: | 116.1 | 113.5 | 111.6 | 109.1 | 100.0 |
| chromatic semitone: | 77.4 | 81.1 | 83.6 | 87.3 | 100.0 |
| increment: | 50% | 40% | 33.3% | 25% | 0% |

## Table 1.

The diatonic and chromatic semitones (reckoned in cents) in several regular tunings. In the top half of the table, each tuning is labelled according to the tempering of the 5ths; in the lower half, some practically equivalent tunings are labelled according to how they divide the octave into equal parts.[17]

[17]In the 31-, 43- and 55-divisions, the chromatic semitone comprises n parts (where n = 2, 3 or 4 respectively); the diatonic semitone, n + 1; the whole-tone, 2n + 1; and the octave (with its five whole-tones and two diatonic semitones), 5(2n + 1) + 2(n + 1) = 12n

**Ex. 4.** ***Fantasia Chromatica*** **-J.P. Sweelinck**


+ 7. For further analysis, see Lindley and Ronald Turner-Smith, *Mathematical Models of Musical Scales: a New Approach* (Bonn, 1992), Section 3, "Equivalence between Harmonic and Equal-Division Systems."


19

Ex. 5. *Toccata Terza* (Libro II) -G. Frescobaldi

Ex. 6. *Tiento de medio registro de baxon de Duodécimo Tono* -Correa de Arauxo

## The Chromatic Notes for the Late-Baroque Tuning

When discussing the chromatic notes in a baroque irregular tuning, we have to be mindful of the amount by which a chain of three *untempered* major 3rds would fall short of an octave and thus entail an impure enharmonic "unison," e.g. between A$^b$ and G# if linked by a chain of pure major 3rds (A$^b$ - C - E - G#). This amount (the "lesser diesis") is 75% more than the Pythagorean comma and thus amounts to 12 + 9 = 21 schismas. In equal temperament they are distributed evenly (7, 7, 7) in each chain of three major 3rds (see Figure 8).

**Fig. 8. Equal temperament**

C# 1 G# 1 D# 1 A#

7 7 7 7

A 1 E 1 B 1 F# 1 C#

7 7 7 7

F 1 C 1 G 1 D 1 A

7 7 7 7

D$^b$ 1 A$^b$ 1 E$^b$ 1 B$^b$ 1 F

Let us consider each of these chains of thirds, starting with B$^b$-D-F#-A#. The French tuned D-F# at most only slightly larger than G-B, but we must raise F# a little more in order to mitigate the tempering of F#-A#. Their "negative" tempering of B$^b$-F, making the 4th smaller than pure and the 5th larger,[18] rendered B$^b$-D rather larger than F-A. This presented little problem in the French-Classical repertoire since, for one thing, flat keys beyond F major were not included in the standard church tones and thus B$^b$-D occurred infrequently as a home key.[19] We do not,

[18] The origins of this practice are described in Lindley, "Mersenne on Keyboard Tuning," *Journal of Music Theory* 24 (1980), 175-79.

[19] For a discussion of the eight church tones and their transpositions, see Robert F. Bates, "Nivers' Tonal Material: Tuning Restrictions and the Development of the Major/Minor System," *Organ Yearbook* 18 (1987): 78-94; and "From Mode to Key: a Study

however, wish to maximize the difference between $B^b$-D and D-F# in the Stanford tuning, because to do so would be inappropriate for the German baroque repertoire, where flat major keys occur more frequently. A French tuning would be out of place, for example, in J. S. Bach's "Valet will ich dir geben," BWV 735, and "Ach bleib bei uns," BWV 649, where the tonic $B^b$-major chords would be noticeably impure.

**Fig. 9. New Stanford Eclectic (Baroque)**

C# 1 G# 1 D# -1.6 A#

6.6 7.8 9 10.6

A 2.2 E 2.2 B 0 F# 0 C#

2.2 2.2 2.2 4.4

F 2.2 C 2.2 G 2.2 D 2.2 A

12.2 11 9.8 6

$D^b$ 1 $A^b$ 1 $E^b$ -1.6 $B^b$ -1.6 F

**Fig. 10. Vogel "V/W"**

C# 2.4 G# 0 D# 0 A#

8.6 8.6 11 11

A 2.4 E 2.4 B 0 F# -2.4 C#

1.4 1.4 1.4 3.8

F 2.4 C 2.4 G 2.4 D 2.4 A

11 11 8.6 6.2

$D^b$ 2.4 $A^b$ 0 $E^b$ 0 $B^b$ -2.4 F

of Seventeenth-Century French Liturgical Organ Music and Music Theory" (Ph.D. diss., Stanford University, 1986), ch. 2.

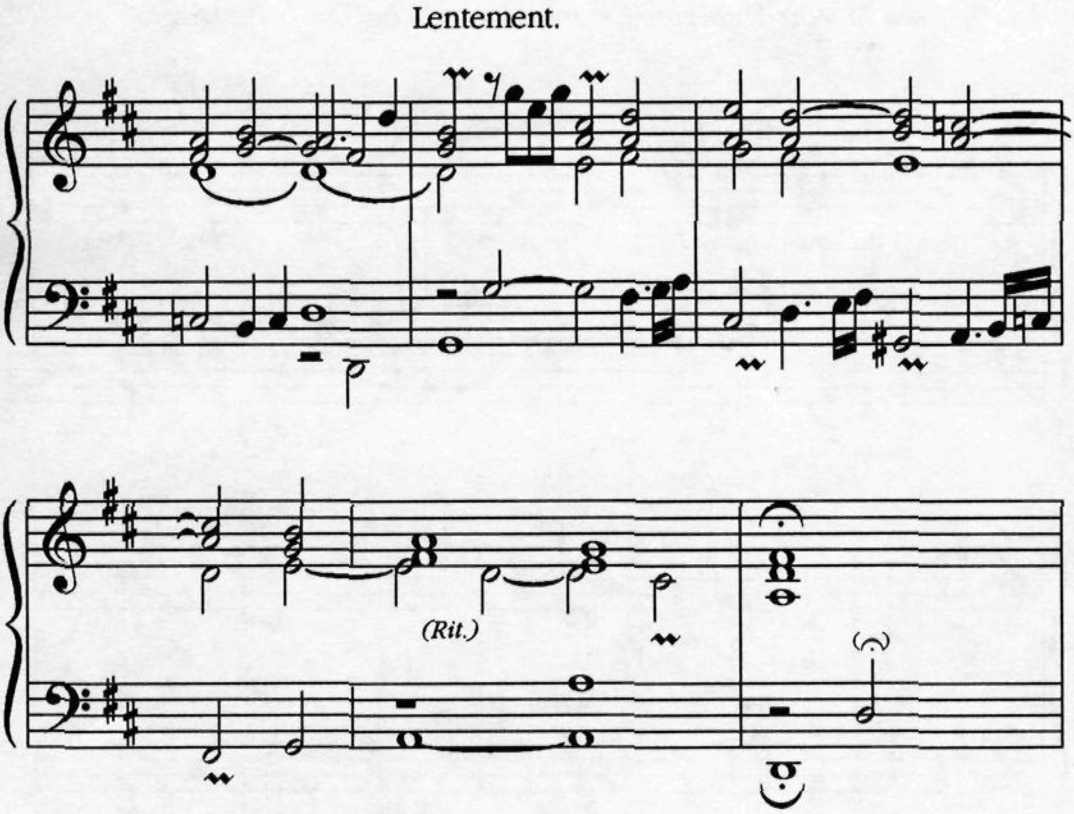
In the New Stanford Eclectic tuning (Figure 9), D-F# is tempered slightly more than in Vogel V/W (Figure 10), and $B^b$-D and F#-A# slightly less. We have recorded, in both tunings, some excerpts from pieces in which these intervals play prominent roles.

*D-F#: Boyvin, "Petit Dialogue meslé de Trios" (Example 7)*

*$B^b$-D: J. S. Bach, harmonization of "Jesu, deine tiefen Wunden" (Example 8)*

*F#-A#: Boyvin, "Pour la Voix humaine" (Example 9) and Buxtehude, "Praeludium in F# minor" Bux WV 146 (Example 10)*

**Ex. 7.** *Petit Dialogue meslé de Trios* (Second Livre, Ton 7) -J. Boyvin




Ex. 8. *Jesu, deine tiefen Wunden* - J.S. Bach

**Ex. 9.** *Pour la Voix Humaine* (Second Livre, Ton 7) -J. Boyvin

Ex. 10. *Praeludium in F# Minor*, Bux WV 146 -D. Buxtehude

The following questions come to mind: Is the D-F# too wide for French music? Is the B$^b$-D too wide for German music? Is the F#-A# too wide for both? We have found that the D-F# and B$^b$-D in both tunings are suited to the music, while our F#-A# is an improvement over the present system.

Similar compromises have to be made for the chain D$^b$-F-A-C#. The French tuned the commonly used interval A-C# distinctly smaller than in equal temperament. This means that their A-C# was much less impure than their D$^b$-F, a situation that satisfied them because they rarely used D$^b$. Indeed, in the music of French-Classical masters from before 1710—which is the part of the repertoire most often performed today—the only known D-flat occurs in Grigny's fugue on "Veni Creator."[20] In German baroque music, however, D-flat appears much more frequently. If we raise C# as much as we dare, the resulting 5th F#-C# (like the 5th B-F#) will be pure (Figure 9). D-F# and A-C# will thus each be tempered more than in the French, but less than in the German style.[21]

The following recorded examples demonstrate the placement of C#/D$^b$ in both tunings.

*A-C#: Boyvin, "Pour la Voix humaine" (Example 9)*

*D$^b$-F: J.S. Bach, "O Mensch bewein' dein' Sünde gross," BWV 622 (Example 11) and J.S. Bach, "Passacaglia in C Minor," BWV 582 (Example 12)*

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[20]See Robert Bates and Kimberly Marshall, "A Response from the Custodians," *Performance Practice Review* 2 (1989): 167.

[21]Sorge and Neidhardt would temper A-C# by 7 or 8 schismas (see Lindley, "Stimmung und Temperatur," 269-75).

**Ex. 11.** ***O Mensch, bewein' dein' Sünde gross*, BWV 622 -J.S. Bach**


**Ex. 12.** *Passacaglia in C minor*, **BWV 582 -J.S. Bach**

Does this tuning render C# a little too high for the French music with its frequent A-major chords? Does it make D-flat a little too low for the German examples? If the answer is "both, ever so slightly," then we have found a good compromise: to improve the one would necessarily damage the other. After repeated comparisons, we have found that the New Stanford baroque tuning yields a slight improvement for the A-major chords that are so frequently encountered in the French repertoire; D-flat, on the other hand, is not rendered offensive in German music, where it is primarily used in B-flat minor chords and dominant seventh chords built on E-flat (Example 11). The Neapolitan sixth chord on D-flat is, however, more dissonant, which does not seem an unwarranted disadvantage (Example 12).

The next chain of thirds to consider is $A^b$-C-E-G#. E-G# must be slightly larger than in equal temperament if $A^b$-C is not to be tempered by more than a syntonic comma. The E-major chord is quite important for French music, where it has structural significance in tones 3 and 4 (*e.g.*, in the ubiquitous settings of the "Cunctipotens Genitor Deus" Gloria). The following are recorded examples of French and German music in which $A^b$/G# plays a prominent role.

*E-G#: Lebègue, "Dessus de Tierce ou Cornet" (Example 13)*

*$A^b$-C: J. S. Bach, "Prelude in E-flat Major," BWV 552 (Example 14)*

**Ex. 13.** *Dessus de Tierce ou Cornet* (Premier Livre, Ton 3) -N. Lebègue

**Ex. 14.** ***Praeludium in E-flat major*, BWV 552 -J.S. Bach**


110
piano
115

Once again we ask whether the chromatic note is in its best position for both repertoires. To our ears, the recordings confirm that G#, hardly better than in Vogel V/W, is still higher than ideal for the French music, while $A^b$ in both systems is as low as can be tolerated in those German pieces where an $A^b$-major triad is used diatonically (Example 14). Since a fully satisfactory G# could be had only at the cost of a sour $A^b$ or else of a different Renaissance tuning (with a higher E), we must be content with only a slightly improved G#. One solution to the problem is to shift the tuning lever to meantone during the course of a piece to obtain satisfactory E-major chords.[22]

There remains one more chain of major thirds to consider: $E^b$-G-B-D#. Figure 9 shows the 5ths from F to D# tempered by a total of (6 x 2.2) + (2 x 1) = 15.2 schismas, which are 3.2 more than the Pythagorean comma. The 5ths $E^b$-$B^b$ and $B^b$-F are rendered perfectly French by dividing these 3.2 schismas evenly between them. By tuning G#-D# as in equal temperament, we obtain a moderate D# vis-à-vis B, of great value in both the French and German repertoires. (The unduly high D# in the present tuning has often been remarked upon, by organists and listeners alike.) The lowish $E^b$ would not be detrimental to Bach's dark uses of C-minor, and in the French repertoire $E^b$-G almost always occurs in C-minor chords. But will it be quite satisfactory for Bach's uses of $E^b$-major? We believe so.

The following recorded examples demonstrate the improvement of $E^b$-D# in music by Bach and Buxtehude:

*B-D#: J.S. Bach, "Fugue in B Minor," BWV 544 (Example 15); Buxtehude, "Ciacona in E Minor" (Example 16)*

*$E^b$-G: J.S. Bach, "O Mensch bewein' dein' Sünde gross" (Example 11); J.S. Bach, "Prelude in E-flat Major," BWV 552 (Example 17)*

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[22]Bates and Marshall, "A Response from the Custodians," *Performance Practice Review* 2 (1989): 164, note 26. The problem is aggravated by the use of a modern pitch standard (A440) in the design of the Fisk Organ (whereas French baroque pitch was characteristically A~410 or A~390). The significance of this can be illustrated by the fact that in equal temperament, if A=440Hz, then the two G#'s nearest to middle C will each beat more than six times per second with the E of the bass clef, but if A=400Hz, then the beating will be just less than six per second. This is important because at about six per second there is a psychoacoustical shift between (1) a vibrato-like, "surging" quality (*i.e.*, in slower beats, we can readily perceive the gradual rise and fall of intensity which constitutes each beat) and (2) an unpleasant, "intermittent" quality (*i.e.*, we perceive somewhat faster beats as a series of sudden, "on-off" changes in intensity). If C-E has to be tempered by less than three schismas, it is decisively more difficult at modern pitch than at a lower Baroque pitch to preserve the quasi-French, surging quality of E-G# without rendering $A^b$-C altogether sour.

*C-E$^b$: J.S. Bach, "Prelude in C Minor," BWV 546 (Example 18)*

**Ex. 15.** *Fugue in B Minor*, BWV 544 -J.S. Bach


**Ex. 16.** *Ciacona in E-Minor*, Bux WV 160 -D. Buxtehude


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**Ex. 17.** *Praeludium in E-flat Major*, BWV 552 -J.S. Bach


205

**Ex. 18.** ***Prelude in C Minor*, BWV 546 -J.S. Bach**

The *tuning of* $E^b$*-major chords and C-minor chords sounds virtually* unchanged, while the B-major chords used so frequently in both the French and German repertoires are noticeably improved.

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Throughout our collaboration we have been scrupulously faithful to Charles Fisk's statement at Stanford: that a *somewhat* eclectic organ — suitable for most of the Renaissance and baroque repertoire — could be built with the appropriate nuances of tuning provided by shifting from one set of chromatic notes (for the earlier parts of the repertoire) to another (for the latter). Far from weakening this statement, we have sought to make it as valid as possible,[23] by some very subtle but efficacious adjustments to the tuning.

The problem addressed in this article calls for some compromises, but we feel that they are warranted because the New Stanford Eclectic Tunings accommodate a broader range of organ music, and thus also of players. May they gain a satisfaction like that of the legendary Hong Kong businessman who was invited to address the London Guild of Tailors and thought it best to order an exceptionally fine suit for the occasion: there was time for only one fitting, at which it was found that the left sleeve was just a little long, and the left trouser leg a little short; so the tailor suggested that he bend his left arm more than the right, and his left leg less. The experts in London were impressed ("He has a characteristic gait, which his tailor has accommodated superbly!") and later, when the lengths were adjusted after a second fitting, he wore the suit with particular enjoyment and appreciation of its exceptional quality.

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[23]The ideal of a pair of keyboard tunings that would accomodate perfectly the entire Renaissance and baroque repertoire cannot be realized, because both in France and in Germany some music was composed for transitional tuning systems. Some 17th-century French keyboard music was composed, after the innovation with regard to $B^b$ and $E^b$, but before the elimination of the wolf 5th by adjusting the other chromatic notes. In the harpsichord repertoire, Louis Couperin's long G-minor Passacaille is such a piece (see section 6 in Lindley, "Temperaments," in the *New Grove Dictionary of Music and Musicians*). Meanwhile, some German organ music may have been composed specifically for Werckmeister's irregular scheme (*Orgel-Probe*, Quedlinburg, 1681, p. 35) with C-G-D-A and B-F# tempered by 1/4 comma each and the other 5ths untempered.

## Musical Examples

1. Cavazzoni, "Magnificat quarti toni"

2. Titelouze, "Iste Confessor," second verset

3. Praetorius, "Es ist ein' Ros'"

4. Sweelinck, "Chromatic Fantasy"

5. Frescobaldi, "Elevation Toccata," Toccata terza, *Libro II*

6. Correa de Arauxo, "Tiento de medio registro de baxon de Duodécimo Tono"

7. Boyvin, "Petit Dialogue meslé de Trios," *Second Livre*, Ton 7

8. J.S. Bach, Chorale 256: "Jesu, deine tiefen Wunden"

9. Boyvin, "Pour la Voix Humaine"

10. Buxtehude, "Praeludium in F#-minor," Bux WV 146

11. J.S. Bach, "O Mensch, bewein' dein' Sünde gross," BWV 622

12. J.S. Bach, "Passacaglia in C minor," BWV 582

13. Lebègue, "Dessus de Tierce ou Cornet," Premier Livre, Ton 3

14. J.S. Bach, "Prelude in E-flat Major," BWV 552 (section in A-flat)

15. J.S. Bach, "Fugue in B minor," BWV 544

16. Buxtehude, "Ciacona in E minor," Bux WV 160

17. J.S. Bach, "Prelude in E-flat Major," BWV 552 (ending)

18. J.S. Bach, "Prelude in C Minor," BWV 546