1989

A Response from the Custodians: More Thoughts on the Stanford Temperaments

Robert Bates

Kimberly Marshall

Follow this and additional works at: <https://scholarship.claremont.edu/ppr>

Part of the [Music Practice Commons](#)

Recommended Citation

Bates, Robert and Marshall, Kimberly (1989) "A Response from the Custodians: More Thoughts on the Stanford Temperaments," *Performance Practice Review*. Vol. 2: No. 2, Article 6. DOI: 10.5642/perfpr.198902.02.6

Available at: <https://scholarship.claremont.edu/ppr/vol2/iss2/6>

This Article is brought to you for free and open access by the Current Journals at Scholarship @ Claremont. It has been accepted for inclusion in Performance Practice Review by an authorized editor of Scholarship @ Claremont. For more information, please contact scholarship@cuc.claremont.edu.

A Response from the Custodians: More Thoughts on the Stanford Temperaments*

Robert Bates and Kimberly Marshall

In an article appearing in the first issue of this journal, Mark Lindley provides a cogent argument for modifying the two temperaments of the Stanford Fisk organ, built in 1984; he urges its "custodians" to consider the implementation of a more historically-rooted proposal.¹ As musicians regularly using the Stanford organ, we welcome this opportunity to respond to the stimulating issues raised by a scholar of Lindley's stature. Although we had no part in the original design or implementation of the present tuning systems, we have performed and taught regularly on the instrument since 1986; this experience has been invaluable in assessing the merits of the present temperaments and in determining what type of changes could most improve the organ's ability to render the Renaissance and Baroque repertoire.

* The authors accept equal responsibility for the content of this article and would like to thank Roland Hutchinson, a Ph.D. candidate at Stanford, for his generous help in its preparation. They are also grateful to Harald Vogel for his critique, received during the final stage in the preparation of this article; his concerns can be addressed in detail only at a later date.

1. Mark Lindley, "A Suggested Improvement for the Fisk Organ at Stanford," *Performance Practice Review* 1 (Spring, Fall, 1988): 107-32.

Two tuning systems are available on the Stanford Fisk organ. (The Brustpositiv division is exceptional because it is limited to one system.) Although loosely based on historical models, the temperaments were devised by Charles Fisk and Harald Vogel especially for the Stanford organ.² One system, a modification of meantone, is appropriate for Renaissance and early Baroque music (Figure 1a); the other, a well-temperament, is appropriate for the late Baroque repertoire (Figure 1b). The two systems use the same pitches for diatonic notes, while the pipes for chromatic notes vary — a lever over the organist's head makes possible the shift from one set of pipes to the other.

FIGURE 1: PRESENT STANFORD TEMPERAMENTS

2. The following articles document the Stanford Fisk and its tunings: Robert Cornell, "Stanford: A Rare Opportunity for Organ Building," *Diapason* 75, no. 6 (June, 1984): 12-13; James Welch, "The Organs of Memorial Church, Stanford University," *American Organist* 18, no. 4 (April, 1984): 177-79 (specification on p. 145); Harald Vogel, "Tuning and Temperament in the North German School of the Seventeenth and Eighteenth Centuries," *Charles Brenton Fisk: Organ Builder* (Easthampton, MA, 1986), vol. 1, 248, 250, and 264-65.

+ or -1/5 = + or -1/5 Pythagorean comma

-1/4 = -1/4 syntonic comma

0 = pure

Five years of recitals, demonstrations, and master classes have confirmed the value of this original conception. Specialists delight in performing a vast range of early music, students gain insight into the tonal material of the organ repertoire, and the general public responds to the effects engendered by two very different tuning systems. In short, we are convinced that the idea of creating a modern, dual-temperament organ was brilliant. Judging from the meticulous study that Lindley has lavished on the tunings of this instrument, we suspect that he is equally impressed by the project. The fifth anniversary of the organ's installation provides an excellent occasion for considering the possibility of "fine tuning" the systems, and we are grateful to Lindley for the timeliness of his article.

Lindley praises the instrument's voicing and timbres, but criticizes both of the temperaments adopted "as unworthy of an organ of this calibre and significance."³ While this criticism seems excessive to us, we find merit in his ideas, and in this response we shall examine his arguments in detail, relate them to the performance of organ repertoire at Stanford, and consider possible alternatives to his proposed changes.

* * *

3. Lindley, "A Suggested Improvement," 108.

Lindley faults the first system, our so-called meantone, because it is irregular. It therefore violates a fundamental principle of regular Renaissance systems: meantone fifths are tempered equally, resulting in two and only two sizes of semitone.⁴ In Stanford's meantone ("Vogel V") the fifths containing diatonic notes (F - C - G - D - A - E - B) are tempered by one-fifth of a Pythagorean comma, while the fifths containing one or more chromatic notes (B - F# - C# - G# and E^b - B^b - F) are tempered by one-fourth of a syntonic comma (Figure 1a). This mixing of two sizes of fifth creates more than two sizes of semitone and distorts the impression of regular meantone.

Originally, a strict one-fifth Pythagorean comma system was envisaged for the Stanford organ. Discussions with employees of the Fisk company, Harald Vogel and Manuel Rosales reveal that, soon before the organ's installation, the temperament was tested using chromatic Renaissance repertoire. The effect was less expressive than on instruments in quarter-comma meantone, such as the Wellesley instrument built by Fisk in 1981. To achieve a similar result at Stanford, the decision was made to temper the fifths containing chromatic notes by one-fourth syntonic comma, thereby creating more contrast between the diatonic and chromatic semitones.⁵ Chromatic lines became "funkier" (to borrow Lindley's colorful adjective), but no "funkier" than they would be in pure quarter-comma meantone. The builders did not attempt "to make them [the semitones] as unequal as possible," as Lindley maintains.⁶ Because the diatonic fifths are tempered by only one-fifth comma, none of the semitones on the Fisk organ is either as large or as small as those in quarter-comma meantone. It can be argued that the compromise dulls the effectiveness of certain leading tones, particularly C# and G#, because the accumulation of one-quarter comma fifths makes these notes lower in pitch than other leading tones in the system. C# and G# are not, however, as low as they would be in regular quarter-comma meantone.

Our experience performing Renaissance music on the organ yields three closely-related observations. First, as discussed above, some leading

4. Lindley, "A Suggested Improvement," 112-13, discusses one irregular temperament in detail, that of Michael Praetorius (*De Organographia*, 1619), where two fifths (F# - C# and C# - G#) are modified. He correctly shows that the Praetorian system in no way resembles Stanford's meantone.

5. Our files at Stanford contain a document dated 4/6/84 and signed by Harald Vogel, giving instructions to change the tempering of the chromatic fifths to one-quarter comma meantone. For additional information about Stanford's meantone, see Cornell, 13.

6. Lindley, "A Suggested Improvement," 113.

tones are more effective than others: higher notes create stronger inflections and heighten the sense of cadential resolution. This variety among leading tones is characteristic of well-temperament and of historically-rooted modified meantone systems, not of strict meantone where the tuning of all authentic cadences is identical.

Second, just as some leading tones inflect more strongly than others, some chords are better in tune than others. Since at Stanford one-quarter comma tempering is used for the sharps and flats, thirds become progressively purer as one moves through the circle of fifths (for example, from D - F# to A - C# to E - G#). The sudden appearance of a sharp or flat may produce a chord that, in context, is particularly pure. In Example 1, the E-major chord attracts attention; indeed, it sounds purer than the final C-major sonority.

EXAMPLE 1: Ending of Guillet's *Première Fantasia*,
Mode Dorien authentique

Third, chromatic lines vary in expressivity, particularly if the sizes of diatonic and chromatic semitones do not correspond when a motive is treated imitatively. This is shown in Example 2, where we have analyzed the subject and answer of Sweelinck's *Chromatic Fantasia*, as heard at Stanford. In regular meantone all chromatic lines consist of an alternation between two sizes; our irregular meantone contains eight. The differences are subtle but telling: when listening to a performance of such music at Stanford, few people could empirically assess such small discrepancies, but most would agree that a slight variance between subject and answer is apparent.

EXAMPLE 2: Expressivity of Semitones

- 4 = most expressive semitones
(largest diatonic; smallest chromatic)
- 3 = less expressive semitones
(smaller diatonic; larger chromatic)
- 2 = even less expressive semitones
(even smaller diatonic; even larger chromatic)
- 1 = least expressive semitones
(smallest diatonic; largest chromatic)

Modified meantone systems were, of course, used during the seventeenth century. Such systems do lend variety among leading tones, a slight difference in the purity of thirds, and a subtle distinction among chromatic semitones. But to our knowledge, these systems were quite different from that employed at Stanford. In the historical temperaments, the modifications to meantone expand rather than constrict the system: altered fifths are tuned wider than those forming the foundation of the system, not narrower. These alterations improve the quality of the "new" notes that gradually appear in the organ repertoire, especially $D^\sharp$ and A^b . At Stanford, on the other hand, the modifications work to the disadvantage of these notes. The Stanford system seems to have stemmed from a desire to make one-fifth comma meantone sound as close as possible to the "ideal" one-quarter comma system, rather than from a taste for historically-rooted modified meantone systems.

We therefore agree with Lindley's suggestion to regularize the temperament; our proposal, based on one-fifth Pythagorean comma, is shown as Figure 2a. We would, of course, welcome any evidence indicating that the *type of modified meantone found at Stanford* has historical precedents.

FIGURE 2: PROPOSED STANFORD TEMPERAMENTS

Lindley's main criticism concerns the well-temperament. Because they share diatonic notes, the two systems on the Stanford Fisk are interdependent and must be considered together. The shade of meantone chosen for the instrument determines the tempering of the diatonic fifths of both systems and therefore provides the foundation for the well-temperament. As Lindley states, the meantone system must "provide a suitable basis, among the diatonic notes, for a late-baroque unequal temperament in which all the keys can be used even though

their scales are intoned differently."⁷ Quarter-comma meantone was originally rejected as a possibility for Stanford's meantone because it could not provide a foundation for a truly circulating system.

Lindley proposes that all meantone fifths be tempered less than is currently the case, i.e. less than one-fifth Pythagorean comma. Since chords containing notes outside the meantone system become more in tune as the tempering of the fifths decreases, the effect of Lindley's alteration would be to create a smoother well-temperament, with fewer truly harsh keys. If this is indeed our only goal, Lindley advice should be followed. However we fear that this would have a deleterious effect on the Renaissance repertoire which sounds most euphonous with pure major thirds. It is true that when fifths are tempered less than one-quarter comma, major thirds may draw in tune on the organ — but only if their pipes are placed close to each other (when the windchests are divided into a "C - side" and a "C# - side"). With five extra pipes per octave at Stanford, this was not possible; in fact, pipes forming three of the meantone major thirds (E^b - G, A - C#, and E - G#) are located on opposite sides of the case.⁸ Thus, were Lindley's proposal adopted, the well-temperament would be smoother, but the major thirds in meantone would be audibly less pure.

Tempering the fifths less would also reduce the contrast between the two tuning systems, undermining the very spirit of the project. Let us not forget that meantone based on one-fifth and one-sixth syntonic comma was sometimes advocated and implemented during the Baroque as a circulating system. Like the irregular systems of the late Baroque, these shades of regular meantone enabled organists to play in both natural and transposed keys. Etienne Loulié (1698) felt that transposed keys were "supportable" in one-fifth comma meantone while the intervals used for the natural keys were stretched the least acceptable distance from pure.⁹ Similarly, Gottfried Silbermann is known to have used one-sixth comma meantone well into the eighteenth century, though it is true that some musicians found it "incompatible with modern practice."¹⁰ Thus one-sixth comma meantone is especially appropriate for music of the tonal

7. Lindley, "A Suggested Improvement," 108.

8. Robert Cornell explains in "Stanford," p. 13: "It would be hopeless to expect in an organ with 17 notes per octave serving two different tuning systems that one would find it possible to locate pipes of nearly every interval close enough so that they will draw into perfect tune."

9. [Etienne] Loulié, *Nouveau système de musique ou nouvelle division du monocorde* . . . (Paris, 1698), 26-29.

10. Georg Andreas Sorge, *Gespräch zwischen einem Musico theoretico und einem Studioso musices* (Lobenstein, 1748), 32; cited in Lindley, "A Suggested Improvement," 117.

period, even though it was known during the Renaissance.¹¹ Its implementation at Stanford would reduce the contrast between the two temperaments, partially undermining the project's *raison d'être*: a shift of the tuning lever should transport us from the universe of modality to that of the major/minor system.

Lindley criticizes the Fisk's well-temperament because it is not smooth enough for late-Baroque German music, and because certain frequently-used chords, especially A-major, are not well enough in tune for French Baroque music. These criticisms are well-founded and Lindley's solution (i.e., tempering the diatonic fifths by one-sixth syntonic comma and fine-tuning the chromatic fifths) rectifies these problems admirably. Yet, as noted above, we do not wish to sacrifice the contrast between the two Stanford temperaments and therefore we advocate maintaining the present tempering of the diatonic fifths by one-fifth Pythagorean comma. Even accepting this restriction, however, we believe that fine-tuning one chromatic note will help to create a slightly smoother system — one more in line with Werckmeister's scheme for chromatic music, included by Lindley in his article. As for French Baroque music, we have developed an entirely different solution which will be disclosed shortly.

Predictably, Lindley's discussion of suitable well-temperaments for late-Baroque German music draws heavily from those appropriate to the music of J. S. Bach, particularly Neidhart and Werckmeister. While we cannot reproduce these temperaments on the Stanford Fisk if the diatonic fifths are set at one-fifth Pythagorean comma, we can change the tuning of chromatic fifths to bring the well-temperament more in line with their systems. Let us compare the tuning of major thirds using at least one chromatic note in Werckmeister's tuning for chromatic music with that of the well-temperament on the Stanford Fisk. (We base our discussion on Lindley's Figures 12 and 13, pp. 120 and 123).

11. Lindley, "A Suggested Improvement," 111.

TABLE 1 A comparison of major thirds involving chromatic notes in well-temperament.

	Werckmeister's tuning for chromatic music	Vogel 5/W
<div style="text-align: center;">F</div> <div style="text-align: center;">-</div> <div style="text-align: center;">C[#]/D^b</div> <div style="text-align: center;">-</div> <div>A</div>	<div style="text-align: center;">11</div> <div style="text-align: center;">\</div> <div style="text-align: center;">8</div>	<div style="text-align: center;">11</div> <div style="text-align: center;">\</div> <div style="text-align: center;">8.6</div>
<div style="text-align: center;">C</div> <div style="text-align: center;">-</div> <div style="text-align: center;">G[#]/A^b</div> <div style="text-align: center;">-</div> <div>E</div>	<div style="text-align: center;">11</div> <div style="text-align: center;">\</div> <div style="text-align: center;">8</div>	<div style="text-align: center;">11</div> <div style="text-align: center;">\</div> <div style="text-align: center;">8.6</div>
<div style="text-align: center;">G</div> <div style="text-align: center;">-</div> <div style="text-align: center;">D[#]/E^b</div> <div style="text-align: center;">-</div> <div>B</div>	<div style="text-align: center;">8</div> <div style="text-align: center;">\</div> <div style="text-align: center;">8</div>	<div style="text-align: center;">8.6</div> <div style="text-align: center;">\</div> <div style="text-align: center;">11</div>
<div style="text-align: center;">D</div> <div style="text-align: center;">-</div> <div style="text-align: center;">A[#]/B^b</div> <div style="text-align: center;">-</div> <div style="text-align: center;">F[#]</div> <div style="text-align: center;">-</div> <div>D</div>	<div style="text-align: center;">5</div> <div style="text-align: center;">\</div> <div style="text-align: center;">11</div> <div style="text-align: center;">\</div> <div style="text-align: center;">5</div>	<div style="text-align: center;">6.2</div> <div style="text-align: center;">\</div> <div style="text-align: center;">11</div> <div style="text-align: center;">\</div> <div style="text-align: center;">3.8</div>

Table 1 shows the tempering of thirds expressed in the units of impurity used in Lindley's figures. (Each unit is one-twelfth of the Pythagorean comma, which equals one-eleventh of the syntonic comma and one-twenty-first of the lesser diesis.¹²) Thirds using C[#]/D^b and those using

12. Lindley, "A Suggested Improvement," 108-09.

$G\#/A^b$ are essentially identical in the two systems. A sizeable discrepancy, however, may be seen between those using $D\#/E^b$. In Werckmeister, both $B - D\#$ and $E^b - G$ are identically tempered at 8 units larger than pure;¹³ at Stanford, on the other hand, the two thirds are noticeably different: $B - D\#$ is 11 units larger than pure, while $E^b - G$ is only 8.6. This difference coincides with our experience: E^b -major (and C-minor) chords rarely seem discordant, while we are frequently disturbed by the harshness of B-major chords. The third $B - D\#$ is tempered the same as $F\# - A\#$, $D^b - F$, and $A^b - C$, yet it is used far more frequently. Consider its prevalence in the common key of E-minor; no other chord raises the eyebrows of visiting organists as often as B major!

Because the sixth $B - G$ is wider at Stanford than in Werckmeister's system for chromatic music, we cannot duplicate his placement of $E^b/D\#$. But like Werckmeister, we can position this note precisely midway between B and G. In his system, E^b and $D\#$ have equal status, since $B - D\#$ is as pure as $E^b - G$. In the Stanford well-temperament, the third $E^b - G$ is one-fifth Pythagorean comma narrower than $B - D\#$, which is tuned as the Pythagorean third. By placing $E^b/D\#$ one-tenth comma lower than is currently the case, it will be exactly halfway between B and G. This adjustment is shown in our proposed well-temperament, Figure 2b. Here $B - D\#$ is improved at the expense of $E^b - G$, and both are 9.8 units larger than pure.

Although two more thirds ($D - F\#$ and $B^b - D$) vary between the systems, as seen in Table 1, they are both relatively pure and neither presents any particular musical problem. As will be shown later, raising $B^b/A\#$ will adversely affect our proposed French temperament.

Our proposed change in the placement of $E^b/D\#$ provides greater variety in the sizes of fifths, thirds, and semitones, helping to remedy another of Lindley's criticisms of the Stanford well-temperament.¹⁴ In addition, the proposal smooths the transition from good to bad keys by creating six, rather than five, sizes of major thirds. Major thirds increase from the nearly pure one-fifth Pythagorean comma meantone third to the discordant Pythagorean third: (1) $C - E$, $G - B$, and $F - A$; (2) $D - F\#$; (3) $B^b - D$; (4) $A - C\#$ and $E - G\#$; (5) $E^b - G$ and $B - D\#$; and (6) $F\# - A\#$, $D^b - F$, and $A^b - C$. This change also improves the temperament's ability to render French music, as will soon be clear.

13. $E^b/D\#$ forms almost equally-tempered thirds with G and B in two of Neidhardt's schemes. See Lindley, "A Suggested Improvement," 115, Figures 9 and 10.

14. Lindley, "A Suggested Improvement," 129.

* * *

In the historical French well-temperaments there was considerable contrast between "good" and "bad" keys, as Lindley has explained.¹⁵ But this discrepancy was larger than one might surmise from his discussion. He emphasizes Rameau's *tempérament ordinaire*, where seven fifths remain as in meantone, preserving the purity of much of the old system and therefore resulting in some distinctly harsh keys. There is evidence, however, for even more conservative systems — ones containing nine or even ten meantone fifths. Four such temperaments may be associated with the organ: two were described by composers of published organ music, Chaumont (1695) and Corrette (1753), one was used by the organbuilder Vincent in Rouen (1712), and one appeared in a French organbuilding manual (1746). Although Lindley feels that there is no evidence to suggest that the organ was tuned differently from the harpsichord (and presumably from other instruments),¹⁶ the conservative nature of these temperaments is well worth noting.¹⁷

In the *Méthode d'accorder le clavessin* from his *Pièces d'Orgue* of 1695, Lambert Chaumont describes both regular meantone and a modification of meantone which improves A $\sharp$ and D $\sharp$ at the expense of B $\flat$ and E $\flat$.¹⁸ The modified system is shown as Figure 3a.

FIGURE 3: FOUR FRENCH MODIFIED-MEANTONE TEMPERAMENTS

15. Lindley, "A Suggested Improvement," 123-29.

16. Lindley, "A Suggested Improvement," 127, note 35.

17. In *Le Maître de Clavecin* (Paris, 1753; Bologna, 1970), 89, Michel Corrette points out the harshness of impure thirds when played on the organ in his description of equal temperament: "... [in equal temperament] the thirds are too large, rendering this new temperament hard on the ear, especially on the organ where the sounds are sustained."

18. Lambert Chaumont, *Pièces d'Orgue sur les Huits Tons* (Paris, 1695; Paris, 1970), 148.

A different modification of meantone is suggested by Michel Corrette in *Le Maître de Clavecin* of 1753.²¹ In his system, C# - G# is purer than the meantone fifths. By raising the G#, Corrette improves the purity of thirds containing A^b. Thus, three fifths altered from meantone produce a more serviceable A#, D#, and A^b, notes normally outside the old meantone system. Corrette unambiguously specifies that eight fifths be tempered by one-quarter comma: "*Cette Partition consiste à temperer 11. quintes, huites qu'on diminue de chacune un quart de Comma . . .*"²² He is unclear, however, about how much each of the remaining three fifths must be tempered, as may be seen in our depiction of his temperament (Figure 3c).

A system remarkably similar to that of Corrette is found in an organbuilder's manual, dated June 1, 1746. Entitled *Manière très facile pour apprendre La Facture d'orgue*, the text was written at the Abbey of St. Etienne in Caen by an anonymous author with the initials P. B. C.²³ The excerpt may be the most concrete information we have concerning the tuning of organs in eighteenth-century France. Because this source is so significant, albeit so little-known, we include the complete text as follows,²⁴ with our translation.

21. Corrette, *Le Maître de Clavecin*, 85-87.

22. Corrette, *Le Maître de Clavecin*, 86.

23. Transcribed in Norbert Dufourcq, *Le livre de l'orgue français* (Paris, 1971), vol. 1, 649-85.

24. Dufourcq, *Le livre de l'orgue français*, 678-9 and Plate XLI; original manuscript, folios 117-18.

LA MANIERE DACORDE POUR
FAIRE LA PARTION JUSTE

Il faut premierment maitre lute du milieu du clavier en ton ensuite maitre son octave dans bas juste ensuite sa quinte en montand qui est le sol cette quinte soit batante ensuite la quinte du sol en montand qui est le rê cette quinte doit être batante ensuite son octave dans bas qui soit juste prendre la quinte qui est le la, cette quinte batante prendre sa quinte qui est le my cette quinte batante ensuite son octave qui soit juste ensuite sa quinte qui est le sy qui doit être batante la quinte du sy est le fa dieze en montand qui doit être batante ensuite son octave dans bas qui soit juste prendre sa quinte prendre sa quinte [sic] en en [sic] montand qui est l'ute dieze quelle soit batante ensuite son octave dans bas ensuite sa quinte qui est le sol dieze²⁵ qui doit être un peut forcé on reste la toute ces quinte doit battre egalle et les octave bien juste il faut reprendre votre ut du milieu avec sa quinte dans bas qui est le fa naturel cette quinte soit batante ensuite son octave dans haut prendre sa quinte en descendans qui est le sy bemol cette doit être juste ensuite sa quinte en descendans qui est le my bemol cette quinte doit être forcé ensuite son octave dan haut juste le reste par octave.

THE MANNER OF SETTING A
GOOD TEMPERAMENT

First you must tune middle C to the desired pitch. Then tune the octave below so that it is pure. Then tune the fifth above which is G so that it beats. Then tune the fifth above G which is D; this fifth must beat. Then tune the octave below so that it is pure. Take the fifth [above] which is A and tune it so that it beats. Take the fifth [above] which is E and tune it so that it beats. Then tune its octave [below] so that it is pure. Then tune its fifth which is B so that it beats. The fifth above B is F $\sharp$; it must beat. Then tune its lower octave so that it is pure. Take the upper fifth which is C $\sharp$ and tune it so that it beats. Then tune its lower octave. Then tune its fifth [above] which is G $\sharp$ so that it is a bit wide. The rest of these fifths must beat equally and the octaves must be completely pure. You must then return to your middle C. Tune its fifth below which is F natural so that it beats. Then tune its upper octave. Take its fifth below which is B $\flat$; this must be pure. Then tune its lower fifth which is E $\flat$; this fifth must be wide. Then tune its upper octave pure and the rest in octaves.

Like Corrette, Anonymous of Caen alters B $\flat$, E $\flat$, and G $\sharp$ from meantone. In this fourth French system, there is less ambiguity regarding the sizes of the fifths F - B $\flat$, B $\flat$ - E $\flat$, and C $\sharp$ - G $\sharp$. Again, we have used one-fifth Pythagorean comma meantone as the foundation of the system because the author is unclear in this regard (Figure 3d).

25. "La dieze" erroneously appears instead of "sol dieze" in Dufourcq, 679. We have also corrected this mistake in our English translation.

An examination of the four temperaments in Figure 3 reveals clear similarities.

Considering the vast quantity of French Classical music that is played on the Stanford Fisk, it is frustrating that these historical temperaments stand midway between our meantone and well-tempered systems. As shown above, only two or three notes are altered from meantone in these models, but when we play music using any of these notes it is necessary to employ a well-temperament with five altered notes, thereby losing the purity of A-major and D-major chords. It is a pity that we cannot maintain most of the meantone system while selectively drawing on only two or three notes from the well-temperament.

Even now it may be possible to modify the mechanical device that changes from one temperament to the other so that it shifts in three stages: (1) meantone, (2) a French Classical system, and (3) well-temperament. Without adding a single pipe, we could have a third temperament — firmly based on historical models — in order to realize the French repertoire more convincingly. In this way we could have our *brioche* and eat it too!

Yet it is only fair to point out that this solution demands a reconstruction of the shifting mechanism; only after further analysis by the Fisk Company will we know whether such a reconstruction is not simply within the realm of possibility, but also practical now that the organ has been built.

By drawing selectively upon notes present in our well-temperament the French systems naturally emerge. A tuning along the lines of Chaumont

(and to a lesser extent Vincent) results from the use of well-tempered $B^b/A^\sharp$ and $E^b/D^\sharp$ together with ten notes of meantone (Figure 4a). If we add well-tempered $G^\sharp/A^b$ to this system we obtain one along the lines of Corrette and Anonymous of Caen (Figure 4b). The latter, with its $A^b/G^\sharp$, is more versatile than the former, but the former is more beautiful in pieces where E-major chords are predominant, such as Nicolas DeGrigny's and François Couperin's "Gloria" or "Cunctipotens

FIGURE 4: TWO OPTIONS FOR A FRENCH TEMPERAMENT AT STANFORD

genitor Deus."²⁶ Either of these options would also prove valuable for the vast corpus of seventeenth-century organ music from other countries that extends only a note or two beyond twelve-note meantone.

It is worth mentioning that in both of the proposals, F# - A# is one-fifth Pythagorean comma wider than the widest third currently in Stanford's well-temperament, the Pythagorean third. This preserves the character of F#-A# in the four historical models, where it seems to be similarly wide.

How well would the proposals in Figure 4 suit the repertoire that is currently played on the Fisk? The French music of greatest concern to organists at Stanford was composed between 1660 and 1710. The conservative nature of the historical French tunings (two as late as the mid-eighteenth century) is reflected in this repertoire, which remained remarkably conservative in its use of sharps and flats beyond those available in twelve-note meantone. The twenty-one organ books published in France during this half century reveal a gradual increase in the use of sharps and flats outside meantone. Table 2 is a list of these books; Table 3 indicates the first occurrence of each note beyond meantone in each tone (or key of the major/minor system), and the context(s) in which it first appears.²⁷ For example, in tone eight on G, A# first appeared in 1689 (book 12 of Table 2, Jullien's *Premier Livre d'Orgue*); the context is V / V / V / V / V. Only the context of the first appearance of a note in a particular tone or key is included.

TABLE 2. Books containing organ music published in France from 1660 to 1710.

No.	Date	Composer	Title
1	1660	Roberday	Fugues et caprices
2	1665	Nivers	Premier livre d'orgue
3	1667	Nivers	Second livre d'orgue
4	1675	Nivers	Troisième livre d'orgue

26. This system proved successful in a very convincing performance of De Grigny's "Gloria" by Annette Richards, a doctoral student at Stanford. Ms. Richards ingeniously imitated Chaumont's temperament by asking her registrant to shift the tuning lever from meantone to well-temperament whenever a D# appeared in the score; a particularly striking improvement over the continuous use of well-temperament was heard at the final E-major chord of each verset.

27. Tables 2 and 3 are taken from Robert F. Bates, "From Mode to Key: A Study of Seventeenth-Century French Liturgical Organ Music and Music Theory" (Ph.D. diss., Stanford University, 1986), 99 and 110. For a detailed discussion of the increasing uses of these "new" notes, see pp. 101-31.

5	1676	Lebègue	Premier livre d'orgue
6	[1678]	Lebègue	Second livre d'orgue
7	1682	Gigault	Livre de musique à la Vierge (two books)
8	[1685]	Lebègue	Troisième livre d'orgue
9	1685	Gigault	Livre de musique pour l'orgue
10	1688	Raison	Livre d'orgue contenant cinq messes
11	[1689]	D'Anglebert	Pièces de clavecin
12	[1689]	Jullien	Premier livre d'orgue
13	[1689]	Boyvin	Premier livre d'orgue
14	1690	F. Couperin	Pièces d'orgue
15	1695	Chaumont	Pièces d'orgue
16	1699	Grigny	Premier livre d'orgue
17	1700	Boyvin	Second livre d'orgue
18	1703	G. Corrette	Messe du 8e ton
19	1706	Guilain	Pièces d'orgue pour le Magnificat
20	1708	Dumage	Premier livre d'orgue
21	[1710]	Clérambault	Premier livre d'orgue

TABLE 3. Uses of new notes in published organ music (1660-1710)

Note	Book	Date	Tone (when indicated)	Final/ Type of Third	Context
-----	-----	-----	-----	-----	-----
D#	1	1660	-	D/Major	V/II
D#	1	1660	-	A/Minor	V/V
D#	2	1665	4	E/Minor	V/V/A min.
D#	2	1665	1	E/Minor	V/I
D#	2	1665	6	G/Major	V/VI
D#	2	1665	6	A/Major	V/V
A#	2	1665	1	E/Minor	V/V
D#	3	1667	*	F#/Minor	V/VII
D#	4	1675	6 or 8	G/Major	V/VI
D#	5	1676	5	C/Major	V/V/VI
A ^b	6	[1678]	2	G/Minor	b6 in IV
A#	7	1682	-	D/Major	V/VI
E#	7	1682	-	D/Major	V/III (un- clear)

* Tone 3 chant (*Pange lingua*)

D#	8	[1685]	-	A/Major	V/V
A#	8	[1685]	-	A/Major	V/II
A ^b	8	[1685]	-	B ^b /Major	V7/IV, b6 in II, min. V
A ^b	8	[1685]	-	C/Minor	b6, V7/III
A#	9	1685	4	E/Minor	V/V/V/ A min.
A ^b	9	1685	6	F/Major	b6 in min. V
A ^b	9	1685	8	F/Major	b6 in II/B ^b maj., V7/ IV/B ^b maj.
A ^b	9	1685	**	D/Minor	b6 in IV/ G min.
A#	12	[1689]	5	C/Major	V/II/VI
A#	12	[1689]	8	G/Major	V/V/V/V/ V
A ^b	12	[1689]	5	C/Major	b6 in min. I
D ^b	16	1699	***	F/Major	Min. I of B ^b
A#	17	1700	3	A/Minor	V/V/V (un- clear)
D#	21	[1710]	1	D/Minor	V/V/V

Table 3 shows the importance of D# (the note most frequently used outside the meantone system), A# and A^b. While D# and A^b are both essential notes in home keys (e.g., D# in E minor; A^b in C minor), A# is always confined to internal contexts (e.g., V/V in E minor and V/VI in D major). These subordinate uses correspond to the impure third, F# - A# in the historical tunings discussed above. A resistance to the use of F#-major chords at final cadences is revealed in Nivers's short versets for "Amen or Deo gratias" in twelve different tones; each verset concludes with a major chord, except for the one on tone four transposed to F#, which ends on an archaic-sounding open fifth (Example 3).

** Second half of *Te Deum*, constructed as tone 4 on D

*** Tone 8 chant (*Veni creator*)

EXAMPLE 3: Nivers, 4. ton sur le # d'f

Besides $D^\sharp$, $A^\sharp$, and A^b , the note D^b is also found in organ music of the period, as seen in the antepenultimate listing of Table 3, Grigny's *Livre d'Orgue* of 1699. This unique use occurs in only one measure of the fugue on *Veni Creator*, within the context of a B^b -minor chord in second inversion. Since the impurity of minor thirds is less objectionable than that of major thirds, and since the musical context in which the note is found is highly embellished, DeGrigny's D^b sounds perfectly acceptable in meantone. The only other note to consider is $E^\sharp$, which rarely occurs, and then only in modulations away from the home key of D major. It is interesting that when this note was first employed, by Gigault, it did not form a major third with $C^\sharp$, but rather a minor third with $G^\sharp$. Of the historical temperaments, only Vincent's shows any adjustment to $F/E^\sharp$ (Figure 3b above); because our diatonic notes are fixed, there is no question of adjusting this note in our proposals.²⁸

It is now clear that the French organ music most often performed corresponds well to our options for an intermediate system (Figure 4). Our proposals thereby correct three of Lindley's criticisms of the Stanford well-temperament as applied to French music: (1) $A - C^\sharp$ is no longer larger than in equal temperament, since it remains unchanged from meantone; (2) $E^b - B^b$ is no longer pure, but is widened to improve $D^\sharp$, a note used as often as E^b by the turn of the century in France; and (3) in our second option (Figure 4b), $C^\sharp - G^\sharp$ is no longer smaller than $F^\sharp - C^\sharp$, but is significantly wider.

It might appear from some of the French sources discussed by Lindley that the historical models upon which we base our proposals are not comprehensive enough in terms of usable keys. In 1691 Jacques Ozanam classified B minor as a "*mode naturel*" and B^b minor and B major as

28. While we cannot change the tuning of $F/E^\sharp$ on the Stanford Fisk, the purity of the $C^\sharp$ -major chord may be improved by using the well-temperament, with its $C^\sharp/D^b$ and $G^\sharp/A^b$. Thus, if our French proposals proved inadequate for the few pieces using prominent $E^\sharp$ s, they could still be performed using the full well-temperament.

"modes naturels par les chromatiques."²⁹ While these "natural" keys would sound impure in our proposals, these were apparently never used as home keys by organists during the period 1660-1710, as shown in Table 3. Similarly, one might assume from Marc Antoine Charpentier's characterizations of B^b minor ("obscure et terrible") and E^b minor ("horrible Affreux")³⁰ that musicians performed in these keys. If French organists played in such "terrible" and "horrifying" keys, they certainly did not dare commit them to print. Our proposed systems do not accommodate such extreme keys; but the second option suits all the "*tons transposez*" described by the organist Jacques Boyvin as "the most bearable and the most in use": C minor, D major, E and F minor, A and B^b major.³¹

* * *

Our proposals concerning the Stanford tunings may be summarized as follows: (1) We agree with Lindley that the meantone should be regularized, but we prefer one-fifth Pythagorean comma to his one-sixth syntonic comma. (2) We propose lowering the chromatic note between D and E in the well-temperament so that it functions equally well as a D[#] and as an E^b. (3) We advocate modifying the tuning mechanism to make available a third temperament for French music. One option uses the B^b/A[#] and the E^b/D[#] of well-temperament together with meantone C[#], F[#], and G[#]; the other adds well-tempered G[#]/A^b.

We recognize that our solutions cannot rectify all of Lindley's criticisms. Some late-Baroque works will never sound ideal in a well-temperament based on one-fifth Pythagorean comma, and their performance might best be avoided on the Stanford Fisk. Yet we feel that more is gained from this instrument's ability to render the vast meantone repertoire than the few pieces in distant keys from the late Baroque. Lindley's concern about the performance of French repertoire, however, is addressed in our proposed French tunings (Figure 4).

While the endless possibilities for the Stanford tunings will doubtless inspire "solutions" *ad infinitum*, we are convinced that any choice of systems will sound out of tune to some. Equal temperament has been engrained into all of us since birth; for some, any other system sounds harsh and discordant. Let us not forget the furor that accompanied the adoption of equal temperament in the eighteenth century. A rare

29. Cited in Lindley, "A Suggested Improvement," 125.

30. Cited in Lindley, "A Suggested Improvement," 127.

31. Lindley, "A Suggested Improvement," 125-27.

glimpse of the trauma is provided by a certain Cousin de Contamine, who attacks the modern "Greek" musician — no doubt Rameau — for using equal temperament.

I knew a *Symphoniste* whose bile became irritated every time he cooperated in the performance of pieces by this composer, and sometimes to the point that he was agitated with convulsions for close to twelve hours.³²

To our knowledge no one has yet suffered this fate from listening to the Stanford Fisk.

Since every temperament is necessarily a compromise, any system adopted will demand the acclimation of its listeners. As Rameau advised his readers: "... accustom yourselves to the new temperament, and soon you will no longer sense anything that may now displease you."³³ Just as Rameau was convinced of the musical value of equal temperament, so too are we convinced that an organ tuned in two (or even three!) unequal temperaments opens new vistas for musical expression. It is a tribute to Charles Fisk that his visionary multi-temperament organ is still the subject of such stimulating debate. And whether or not its tuning systems are ever modified, the new organ at Stanford will remain a lasting monument to the genius of its builder.

32. [Cousin de Contamine], *Traité Critique du Plain-Chant* (Paris, 1749), 26: "J'ai connu un Symphoniste, en qui la bile s'irritoit toutes les fois qu'il coopéroit à l'exécution des pièces de ce Compositeur, & quelquefois au point qu'il étoit agité de mouvemens convulsifs pendant près de douze heures."

33. Jean-Philippe Rameau, *Génération harmonique* (Paris, 1737; *Complete Theoretical Writings*, n.p., 1968, *Miscellanea* 3, vol. 3), 103 of original, 66 of reprint: "... accoutumez-vous au nouveau Tempéramment, bien-tôt vous n'y sentirez plus rien de tout ce qui peut vous y déplaire à présent ..."