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Quid non ebrietas dissignat? Willaert's didactic demonstration of Syntonic tuning

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ABSTRACT:

> "Quid non ebrietas dissignat? Operta recludit,
> Spes iubet esse ratas, ad proelia trudit inertem,
> Sollicitis animis onus eximit, addocet artes,
> Fecundi calices quem non fecere disertum?"
> (Horace, Epistles I, V, 16–19)
>
> [What cannot be accomplished through drinking? It reveals secrets,
> Fulfils hopes, encourages the unarmed into battle,
> Removes the burden from worried minds, teaches new skills,
> Whom has the wine-cup not made more skilful?]

Willaert's musical setting of the above portion of Horace's Epistle begins with a rhetorical question: "What cannot be accomplished through drinking?" The rhetoric is reaffirmed by the remaining lines that merely give a list of positive attainments that can (as opposed to ones that cannot) be achieved through the wine cup. Ever since this composition was first discussed by Spataro and Aron in 1524, then subsequently by Artusi in 1600, and in more recent years by Levitan, Lowinsky, Bent and others, one question seems to remain essentially rhetorical: why did Willaert compose this piece, and what was he trying to demonstrate? Explanations as to how his notation should be read and interpreted have been advanced, but none of these stems directly from a clearly-perceived compositional objective. The piece has thus been viewed more as an interesting curiosity than as a creation that asserts its own objective agenda through which the curiosities identified could be explained. That, as suggested by the text, the composition "reveals secrets", "fulfils hopes", "removes the burden from worried minds" and "teaches new skills" will become clear. This essay will assert, through analysis and theory, that the question "why did Willaert compose this piece?" is by no means a rhetorical one, but one that requires an answer. In providing an answer the essay will reveal the technical means through which the objective was achieved. The understanding of that objective—and its technical attainment—will lead to a more wide-ranging reappraisal of Willaert's compositional processes and his unique sound world.

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[1] It is a double irony that Artusi's discussion of Willaert's secular motet "Quid non ebrietas dissignat?" was offered in a polemic book extolling what he considered to be the superior virtues of the old music as opposed to the inferiority of the modern (especially that of Monteverdi).(1) The double irony is that not only was it through this discussion that Willaert's composition was preserved at all, but also it seems that the piece (despite having been written no fewer than eighty years earlier) was actually too advanced and sophisticated for Artusi properly to understand it.

[2] Before examining the piece, and briefly reviewing some of the ideas it has generated, a short account of its notable peculiarity will be offered. Artusi offered only two untexted voices—Cantus and Tenor—although Aron considered that these formed two lines only of what he judged to be a four-voice composition.(2) Lowinsky published a surviving printed Altus voice (with text), and provided an edition of the now three extant lines to which he added an editorial Bassus.(3) The Tenor voice (only) progresses flatwards by the successive introduction of flats on B, E, A, D, G and finally C. After having reached C-flat (at the exact halfway point) the remaining notes of the Tenor have to be performed one degree lower in pitch than they appear visually. Eventually the Tenor comes to rest on what looks like E while the Cantus cadences unambiguously on D. All writers from earliest times to the present are firmly agreed (for obvious reasons) that the two notes must form a final octave, and that whatever the last note of the Tenor may look like it must definitely actually sound as D. The question that has therefore exercised all minds is how the second half of the Tenor (from the note that follows the C-flat) should be read, understood and performed.

[3] Inevitably it is this apparent subjectivity and uncertainty that has aroused differing views and solutions. Levitan pointed out that Artusi believed that the composition should be sung in equal temperament since he (Artusi) observed that Spataro (albeit disapprovingly) considered C-flat as being the same as paramese (i.e. B-natural).(4) Lowinsky, in his edition and discussion of the piece, concurred with the view of an intended equal-temperament performance. On the other hand, Bent rejected this view and saw the piece as an exercise in solmization and *musica ficta*.(5) Her views have been echoed by Dorothy Keiser(6) and Rob Wegman,(7) and the latter has published an analysis seeking to demonstrate that the Tenor completes a circumnavigation of the Guidonian Hand. The former, too, views the composition in relation to the recent circumnavigation of the globe in 1492. Nonetheless there is a persistent alternative view that the intended sound world was that of equal temperament, the peculiarity and ambiguity of the notation seemingly reflecting this.

[4] This essay will now posit a very different analysis and rationale that asserts the following: a) any supposed intellectual or causal connection with hexachord theory and solmization is misguided and actually leads to an improper understanding and realization of the piece; b) the presumption of equal temperament is misplaced and alien to the composer's thinking and expectations; c) attempts to implant a motive for composing the motet by making allusions to "global circumnavigation" (or other extraneous events) are both unnecessary and indicative of a failure to have understood Willaert's real (and indeed transparent) motive for composing the piece in the way he did; and d) subjective decisions about the performance of the second half of the Tenor melody are completely unnecessary because Willaert has—in reality—identified unambiguously and clearly the exact pitch (accurate to within the value of a schisma) of every single note he has presented, together with all the melodic intervals required.

[5] That Spataro could not understand Willaert's purpose is shown in his condemnation of the composer's apparently ill-judged assumption (as Spataro saw it) that the final note of the Tenor could form an octave with the Cantus D: Spataro went to pains to complain that when E is flattened to E-flat the pitch is lowered by a major semitone. When it is again lowered by a further flat, the pitch is depressed by a further major semitone. Having measured on his monochord the position of E lowered by two major semitones, Spataro was able correctly to observe that the resulting pitch was lower than D by a Pythagorean comma.(8) This observation indicates (perhaps unsurprisingly) that Spataro was making the assumption that Willaert's musical judgments were (or should at all have been) Pythagorean. As will presently be demonstrated, this assumption is only partly true. The reality is that Willaert's thinking is deliberately Pythagorean only up until the arrival of the C-flat, but thereafter it is deliberately Ptolemaic. The following analysis will show that the very purpose in constructing the Tenor so as to reach Pythagorean C-flat is to teach singers a method of attaining—within their own old-fashioned and limited Pythagorean framework—the pure major (5:4) and minor (6:5) thirds characteristic of Ptolemy's tetrachords. In order for this to be accomplished by singers who are unused to producing Ptolemaic intervals, Willaert has constructed a Pythagorean matrix whereby the desired 5:4 major third G-B (with the B lowered by a comma) is arrived at by replacing the B with a C-flat (a B would have been only a minor semitone lower than C, but C-flat lies a *major* semitone lower in pitch). The Tenor note that follows the C-flat is sung as F-flat, and again this now stands in place of an E lowered by a comma that would form a 5:4 major third with C. The remainder of the Tenor proceeds exactly with the tones and semitones literally indicated in the notation, but all now flattened by unnotated *musica ficta*. The result of reading all the flats that exist, but

applying a further flattening of pitch by a major semitone each time, further extends this narrowing of interval (in relation to the Cantus) by a comma. Willaert's Tenor, therefore, requires the use of what might be termed "double *ficta*": the first layer is provided in the notation of the first half by the written flats, while the second layer is then added in the second half by the singer to the still-present first layer, but without further notation. The first layer of flats is "written", while the second layer is merely "performed".

[6] A clear understanding of Willaert's design and execution is (as suggested above) actually hindered if a hexachord-based view is assumed. The reasons why this deduction is inapplicable are simple to explain. Hexachords are built only from four identical tones (9:8) separated by an intervening minor semitone (256:243); but Ptolemaic Syntonic tetrachords—as will be illustrated presently—comprise not only two tones of differing size (9:8 and 10:9) but also a single *major* semitone (16:15). Normal hexachords therefore cannot provide a basis for the cognition and accurate pitching of tones of differing size, or of semitones of the correct size (in Ptolemaic terms). A more obvious reason why hexachord evaluation is inappropriate lies, however, in the fact that Willaert has used only a tetrachord matrix as the structural means of attaining the desired Ptolemaic consonances. This structure may be briefly explained and exemplified.

[7] A diatonic tetrachord, whether Pythagorean or Ptolemaic, is a four-note cell comprising the following rising intervals: semitone-tone-tone. Their disposition is regularly described by early theorists as follows: when two adjacent tetrachords fill out an octave they are disjunct (i.e. they are separated by a further tone, such as in the configuration E-A/B-e which fills the octave E-e but in so doing adds the extra tone A-B in the middle); but when two tetrachords span only a seventh they are conjunct (i.e. B-E/E-A, where the heptachord B-A is spanned by two conjoined tetrachords which share the same common note E, termed *synaphe*). Whether tetrachords are conjoined or disjoined, the resulting melody is diatonic.[(9)]

[8] While Willaert's Tenor, therefore, is no less diatonic than his Cantus, its structure is very different. This is because the first half of the Tenor (unlike the Cantus) disposes its diatonic tetrachords heptachordally, as shown in **Example 1**. Here the standard tetrachord scales are displayed first, showing the Hypaton and Meson conjoined tetrachords (with a *synaphe* on E) and then respectively the added Diezeugmenon (i.e. "disjoined") with its disjunction (A-B) and synemmenon (i.e. "conjoined" on A) tetrachords. The former spans an octave (E-e), while the latter a seventh (E-d).

[9] The second system, however, shows how Willaert structurally attains his C-flat by constructing a series of seven tetrachords, all of which are now conjoined. This forms a series of overlapping pairs, each of which spans a heptachord, and each successive one adds a further flat in the series. Each extra flat asserts that the note which lies a semitone below functions as a *synaphe*, and the consequent assertion of each new point of conjunction ("coniuncta") is indicated in the graphic by a number from 1 to 6.

[10] The purpose of each new flat, then, is to convert an expected point of disjunction into a new point of conjunction. First, the *disiuncta* D-E (within the tetrachord matrix A-D/E-A, including the B-flat) is converted to a new *coniuncta* by the arrival of E-flat (now causing a heptachordal disposition of the tetrachords A-D/D-G, including the previous B-flat and now the new E-flat). This process accumulates as each new flat in the series is created by each new *coniuncta*. When these seven tetrachords are performed with standard Pythagorean intervals, the C-flat inevitably reached now lies a comma lower in pitch than the note B-natural (which it replaces harmonically). This is because Pythagorean B-natural lies only a minor semitone lower in pitch than C, while Pythagorean C-flat is a *major* semitone lower. The difference between the two semitones is a Pythagorean comma. The effect of this comma inflection is to change the diatonic tuning from Pythagorean to Syntonic (even though the performance has been attained through the strict application of Pythagorean intervals).

[11] As will be shown below in [19] - [21], the Ptolemaic (syntonic diatonic) and Pythagorean (diatonic) scales are what might be termed "closed" and entirely separate entities. The former achieves greater consonance by restricting its tetrachordal intervals to superparticular ratios, and this yields major semitones (16:15) and larger minor thirds (6:5), together with smaller major thirds (5:4). The latter uses minor semitones (256:243), narrower minor thirds (32:27) and wider major thirds (81:64). In effect the two systems, while using identical tetrachord constructions (in which identical Classical names are applied) provide differing tunings. The outer two notes of all tetrachords retain the pitches common to both systems, but the inner pairs differ. The inner notes of tetrachords in the Ptolemaic scale are exactly a syntonic comma higher in pitch than the corresponding notes in the Pythagorean scale, and this small but crucial difference eliminates the harshness (by syntonic standards) of the Pythagorean thirds and sixths, thereby making the purity of their consonance match that of the fourths, fifths and octaves. But "in-tuneness" is not the same as "being in perfect consonance" because dissonances must also be in tune (even though they are deliberately dissonant). A conflict therefore arises between the syntonicist's view of "in-tuneness" (predicated on the assumption that all harmonies will be purely consonant) and that of the Pythagoreans (who are still happy

to recognize the impurity of thirds and sixths which their theorists continue routinely to describe as "colored dissonances"). How, therefore, might a syntonically-disposed composer set about providing a didactic piece of vocal music so carefully designed that even a Pythagorean-trained singer would a) be compelled (despite rather than because of his training) to find himself singing—unexpectedly—purely in tune (by *syntonic* rather than Pythagorean standards), b) find the experience so overwhelming both in its novelty and effect that he might immediately wish to continue the pleasure, and c) be instantly rewarded by a composition that—from the very moment of syntonic enlightenment—then carefully steers him instructively so as to achieve the desired goal?

[12] The proposition of this essay (indicated in its title) is, of course, that this indeed was Willaert's explicit objective, and a harmonic and acoustic analysis will in due course be offered to support this proposition. In the meantime consideration must be given to the technical manner in which Willaert could have reconciled the two seemingly separate tuning systems so that a transition from one (Pythagorean) to the other (Syntonic) would be simple, inevitable and irreversible. Only under these conditions could the composer achieve such tight control that the performer would (however innocently and unknowingly) inevitably move from one performance practice to another. As signaled above, the arrival at C-flat (thereafter to be used as a substitute for B-natural) provides the earliest opportunity within the Pythagorean system to provide a pitch that in any way equates with a syntonically tuned third or sixth. (All other similarly flattened notes lie even further flatwards in the chain.) This clear point of intersection, attained at the exact halfway point in the composition, marks the final stage in the flatwards movement of the Tenor, and also the point of termination in the application new notated flats. *Pythagorean C-flat now equates with syntonically-tuned B-natural, as does the ensuing performed (but unnotated) F-flat with syntonically-tuned E*. While, therefore, the base pitch has remained entirely constant, the tuning parameters have now changed. The Pythagorean singer, in carefully placing his Pythagorean pitches relative to each other, has now (thanks only to Willaert) actually begun to sing *syntonically*. Willaert has thereby achieved something comparable acoustically with what Leonardo da Vinci attempted graphically in his *Vitruvian Man* when he squared the circle. The circle that Willaert has squared is a "tuning circle", but as with Leonardo's essay what is unimportant is that the squaring is not absolutely accurate. Willaert's notated C-flat is in fact accurate in absolute pitch to within the very small interval of a schisma (being the minute difference between the Pythagorean and Syntonic commas—approximately 2 cents). This small discrepancy is illustrated in **Example 2** and its associated audio file. While the first simultaneity here is a perfectly acceptable pure compound major third, as the C-flat move fractionally higher to syntonic B-natural the harmony becomes purer, yielding an absolutely exact 5:4 compound third. While the upper B-natural is now held, the lower voice then sounds a Pythagorean C-flat, and this can be heard slightly out of phase with the upper part. The two sounds lie exactly one octave plus one schisma apart. While to many ears this will still form an acceptable octave, nobody will fail to hear that the sound produced by the slight mismatch changes color and that a steady beat (of a tempo approximating to eighth-note=72) is produced.

[13] Willaert has therefore devised a means of notating comma inflection. While it is true that the exact notation of Syntonic comma inflection cannot be attained graphically, Willaert has realized that the notation of Pythagorean comma inflection certainly can. The difference is almost negligible, and the likelihood is that any singer with even modest perception would in any case arrive at the consonance and instinctively render it absolutely in tune. What Willaert has done is to use a traditional singer's Pythagoreanism against him by constructing a melodic matrix in such a way that its purely Pythagorean execution will actually cause the resulting harmony to be Ptolemaic. The singer—probably for the first time in his life—will unexpectedly discover that his precise Pythagorean intervals will have led him to produce consonances of a purity that he has never before attained. But he will have been foolish to have assumed that this was the result only of his own unexpected excellence as a singer; the reality is that the outcome is entirely attributable to the skill and planning of the composer.

[14] An understanding of the tetrachord structure of Willaert's Tenor as revealed through Example 1 provides the real key to understanding his notation. It will be observed that each new conjoined tetrachord, in adding its flat, acquires its status only through the presumption that the previous tetrachord (to which it has been, and remains, conjoined) is still in operation. When the sixth conjoined tetrachord arrives (with its C-flat), the assumption has to be that all earlier ones still apply and that the tetrachord structure is an overall transparent and solid one. In expressing this tetrachord matrix in modern notation, we now have to recognize the differences of convention that apply. Modern notation requires the global addition of a flat to be indicated not only by signaling the arrival of the new flat itself, but also by reasserting the continued presence of the old one. When, for example, we modulate from the key of F major to B-flat major, the new key has to be signaled not merely by the insertion of a flat on E, but also by the (tautologous by sixteenth-century standards) reassertion of the flat already existing on B. Hence we move from a "1-flat" situation to a "2-flat" one. But the repetition of the first on B is one of convention only, and is not in any way needed musically since no cancellation of this has been indicated. We could therefore rewrite Example 1 as indicated in **Example 3**. Here it can be seen that the new signatures not only present new flats, but also restate flats that

are already assumed from the previous signature. This restatement is one of modern convention only, and by 16th-century standards is quite unnecessary. When, however, we translate Willaert's Tenor notation into its modern equivalent, we also have to take into account modern conventions. Hence the arrival of each new conjunct tetrachord needs to be indicated by a change of signature in which not only is the new flat indicated, but also the flats that already exist. This can be seen in **Example 4a**. The presentation of Example 4a shows clearly how Willaert's notation (first staff) corresponds with its modern equivalent (second staff). What to us moderns is indicated by staff 2 was, to Willaert's contemporaries, conveyed by staff 1. They mean exactly the same.

[15] This analysis reveals an important observation that challenges previous analyses of this Tenor. First and foremost is the clear indication that the final note—*as actually presented notationally*—is E-flat and not E-natural. So when various writers have described the notation as requiring the performance of notes "one degree lower in pitch" (indicating an uncertainty over whether it is a tone or a semitone), we can now clearly observe that the difference in pitch required is always a semitone (and never a tone). This can be achieved simply by the addition of the second layer of *ficta* that Willaert assumed would be added in performance (this being the reason why he left his notation to stand a semitone higher than the performance pitches required). The manner of actual performance required is indicated in **Example 4b**. It must be remembered that the indicated editorial flats are now *in addition* to the still-present notated flats as indicated by the six-flat signature that has been attained. The beauty of Willaert's structure, however, is that the singer does not need to worry at all about how this second *ficta* layer has to be conceptualized. He can venture with complete confidence "unarmed into battle" because he only needs to descend a perfect fifth from the C-flat (thereby applying the first flattening to the written F) and thereafter read Willaert's notation *exactly as presented*, with all its still-current *coniunctae*. He will, in fact, merely be transposing (without any effort whatsoever) all the remaining notes a semitone lower in pitch, with no worry about having to make individual decisions as to whether a particular note is, or is not, inflected any differently from any other. But Willaert's particular genius lies in his presumption that when the singer flattens these notes, he will be doing so by the value of a Pythagorean major semitone, thereby providing automatically the desired comma inflection.

[16] But why did Willaert not fully notate the second layer of *ficta* in addition to the first, thereby leaving the second half of the Tenor to be notationally presented a semitone higher than the required sung pitches? There is a clear technical reason why Willaert a) only notated flats as far down the chain as C-flat, and b) left the remaining notated pitches to stand a semitone higher than the sounds he required from the singer. Notated *musica ficta*, whether indicated by a sharp or flat, can only exist between two *musica recta* notes that lie a tone apart. The most distant pitch flatwards that would agree with this principle is the note C-flat (which is placed between the two *recta* notes B-flat and C).[(10)] Were Willaert to have continued his *ficta* requirements through the notation, he would have needed to proceed with F-flat (which is not bounded by *recta* notes lying a tone apart, since E-flat is fictive), and progress then through double flats (none of which could possibly be bounded by *recta* notes separated by a tone). This technical limitation does not, however, extend to "performed" (but unwritten) *ficta*. The clear signal for invoking the application of "performed" (only) *ficta* following the Tenor C-flat is the visual descent of the diminished 5th (C-flat/F) which would need to be changed (in performance only) into a perfect 5th by the singing of an F also flattened by a Pythagorean major semitone (thereby attaining Willaert's goal of the pitch E lowered by a comma). Such a use of the performed pitch "F-flat" then produces a simultaneity with the Cantus G in which the aural effect is a (compound) minor third widened by a Pythagorean comma (yielding a tolerably pure 6:5 minor third). It is at this moment (already signaled by the preceding notated C-flat) that Willaert has accomplished his objective in asserting the transformation to Syntonic tuning (which then remains valid for the duration of the piece).

SYNTONIC TUNING: "Addocet artes" (teaches new skills)

[17] The second half of Willaert's motet (specifically from the arrival of the Tenor C-flat) invokes a fundamentally different sound world from the first half. That the first section is entirely Pythagorean is proved by the evidence given above which shows the structural purpose as having been to arrive exactly at the Pythagorean pitch "C-flat". In the soundscape of the first section, therefore, all the tones are of the same size (9:8), and all the semitones are minor (256:243). Ditones (major thirds) will inevitably be dissonant (81:64) as will semiditones (minor thirds, with the ratio 32:27). The inversions of these intervals will also be dissonant by the same degrees. Only by preserving these traditional Pythagorean intervals will the singer of the Tenor correctly arrive at his exactly-pitched C-flat, and only via the same means will the singer of the Cantus attain his exactly-pitched G. When both have been accomplished (by Pythagorean means only) Willaert will have succeeded in making the two singers arrive (whether they expected it or not) at the interval of a "pure minor sixth" (C-flat/G, being heard as "B (lowered by a comma)/G").

[18] But the resulting interval of a "pure minor sixth" (8:5) is now *not* Pythagorean (because, as shown in paragraph [17] above, the Pythagorean minor sixth has the dissonant ratio of 128:81 since it is an inversion of the major third whose ratio is 81:64). What Willaert has now invoked, therefore, is the very different soundscape of Syntonic tuning (usually described by the term "Just Intonation"). The successful performance of Just Intonation (JI) requires new skills, and it is easy to see how Willaert has provided in this composition the means of acquiring and using these. The exact nature of the different skills required must first briefly be explained, because they are not in any way more "intuitive" or "natural" than the skills required for Pythagorean tuning. They are not merely different, but are actually more complex. Only when the rules and procedures of JI are understood, and can be applied by performers, will the resulting soundscape match that assumed by a particular composer at the point when he carefully structured his composition according to this particular sound world (as opposed to the majority of other contemporary composers who did not, and remained faithful to the Pythagorean sound world).

[19] The Syntonic diatonic tetrachord of Ptolemy (which is the structural basis for JI) differs from the Pythagorean diatonic tetrachord in one crucial way: unlike the Pythagorean tetrachord (in which the only consonant interval is the fourth), the Ptolemaic tetrachord uses pitch classes in which all pitches have a pure harmonic relationship with one or other of the outer notes. This is ensured because each interval is structured so as to provide a simple superparticular ratio. The tetrachord B-C-D-E is accorded the following intervals in the ratios indicated: semitone (16:15)—tone (9:8)—tone (10:9). This yields the following pure consonances: the major third (C-E) is 5:4, the minor third (B-D) is 6:5 and the fourth (B-E) is 4:3.

[20] The one crucial interval magnitude that changes the Pythagorean tetrachord into the Ptolemaic Syntonic tetrachord (thereby invoking the sound world of JI) is the magnitude of the Syntonic comma whose ratio is 81:80. It can be applied in two ways: a) the two inner notes (in this case C and D) can both be raised by a Syntonic comma; or b) the two outer notes (here B and E) can be lowered by a Syntonic comma. It is important to bear in mind that whichever alternative is adopted in no way changes the base pitch of the piece within which it is used; the Syntonic inflection merely brings the thirds and sixths into consonance so as to match the consonances already employed by the use of fourths, fifths and octaves. At least two of the pitches will maintain the base pitch standard of the composition within which they are being used. The only intervals that will remain unchanged (in this case) are B-E (4:3) and C-D (9:8). The other two intervals will each have been changed by the value of a Syntonic comma (81:80). So the semitone B-C will have been increased in size by 81:80 (i.e. the value by which either the C has been raised, or the B lowered, depending upon whether a) or b) above has been applied) yielding the ratio 16:15. The minor third B-D will have been widened also by the Syntonic comma and result in the pure interval of 6:5, and the major third C-E will have been narrowed by a Syntonic comma giving the interval ratio 5:4. Additionally, the tone D-E will now be smaller than the tone C-D (thereby introducing into the diatonic system a major and a minor tone) since it, too, will have been narrowed by the same Syntonic comma.

[21] The difference in soundscape that JI invokes is striking: the sour effect of the Pythagorean minor third—perceptibly (by syntonic standards) too small—is removed, and the harshness of the Pythagorean major third—perceptibly (by the same standards) too wide—is tempered. **Example 5**, and its associated audio example, illustrates the differences graphically and audibly. The first extract (a) provides a Pythagorean tetrachord used both melodically and harmonically; the second (b) repeats the first, but this time tuned syntonically. The melodic presentation of the tetrachord tuned syntonically presents the following clear differences from that of the Pythagorean-tuned one: the semitone is audibly larger, and the two tones are of different size (C-D is major, and D-E minor). When these pitch classes are then (in the audio for Example 5) performed harmonically the effect of Syntonic tuning becomes even more pronounced: both thirds are perfectly in tune (the minor having been widened, the major narrowed).

[22] The issues surrounding the performance of JI are therefore significantly more complex than those that apply to Pythagorean performance. The following new skills are required of the singer: a) the ability accurately to perform a diatonic semitone adjudged as larger than a Pythagorean minor semitone, but smaller than a Pythagorean major semitone (indeed one that has the exact ratio of 16:15, and is perceptibly larger than half a 9:8 tone); b) an ability to perform accurately two different sizes of tone (the larger being equivalent to the Pythagorean 9:8 tone, and the smaller having the exact ratio of 10:9). It is at this point that the traditional foundations of hexachord theory and practice must surely cease to provide a valid basis for musical cognition, evaluation and performance.

[23] The inapplicability of traditional solmization to the musical world of JI is easy to explain (and this bears upon a correct understanding of this Willaert motet). If a tetrachord is solmized, the syllables that must be applied are mi-fa-sol-la. But the Syntonic tetrachord asserts that the interval sizes of fa-sol and sol-la will be different (one will be 9:8 and the other 10:9). The hexachord system achieves its practicability from the premise that all tones are the *same* size, and that fa-sol in the hard

hexachord (C-D) will yield the same pitch classes as sol-la in the soft hexachord (again C-D, with the same 9:8 interval ratio). In order for singers to be able to determine which tones are major and which minor, they would need to achieve a structural melodic cognition *prior to* making decisions as to how their solmization will be applied. They would discover that sometimes what they might choose to sing as "fa-sol" and at other times "sol-la" will be variously major or minor (with no connection as to which in terms of the syllables they choose to apply), and they will need to have decided which is which, and where, *before* they apply the syllables. Furthermore they will need to have assumed in advance that the step mi-fa now provides the non-Pythagorean larger semitone whose ratio is 16:15. The position would then be that singers would no longer be able to use the hexachord system and the Hand as a tool for *arriving at* an understanding of melodic structure and a delivery of its preordained pitch relationships. In a Pythagorean context where all tones are of one common size, as are all diatonic semitones, the Hand provides a simple method of cognition and delivery; but in a Syntonic framework in which the interval structure is more sophisticated the foundations of hexachord theory fail to provide the correct technical framework. Since, moreover, the relative pitches of the notes sung to either fa-sol or sol-la will be variable according to context (musical, not hexachordal), it is clear that solmization can no longer be used as the primary tool for accurate intonation of pitch. The question then must arise as to whether, since the correct musical cognition must now be independent from the hexachord system, solmization was of any further practical use (at least within the Syntonic context of JI).

[24] At the point where Willaert sets Horace's words "addocet artes", we can see what these "new skills" are and the way in which the composer goes about "teaching" them. He does not rely upon an assumed ability the singer might supposedly have, but steers him carefully and inevitably to pitch each note accurately within its ordained harmonic context. The result is that the "new" intervals (i.e. the diatonic major semitone and the minor tone) are learnt through the inescapability of needing (under the composer's close and tight control) to provide successive pitches that match the clearly articulated harmonic movement and context.

POLYDIATONICISM and the Squaring of the Circle

[25] Before observing Willaert's strategy for teaching the new intervals, it is necessary to consider what the new pitches are and how they have been constructed. As has been shown above, Willaert has maintained a single default scale for the Cantus,[(11)] but has carefully steered the Tenor consistently flatwards towards the goal of C-flat (so that it can then function as a B lowered by a comma). In order to explain the harmonic matrix that he has constructed, I here introduce the new technical term "Polydiatonicism". As the first half of the piece progresses, and new *coniunctae* are successively introduced, the Tenor—while remaining completely diatonic—increasingly uses diatonic pitch material that differs from the diatonic pitches still being used in the Cantus. By the time C-flat arises, the two concurrent scales being used are totally different. The Cantus is still using the default pitches including the B-flat (as set by the signature), and remains essentially a "white-note" diatonic scale. The Tenor, however, has by this time adopted an essentially "black-note" diatonic scale with only a single "white note" (F). All other pitches have now been flattened. While both lines maintain a clear diatonic structure (since no semitone occurs that is not scalically surrounded by at least two whole tones), the two diatonic matrices are completely different. While the texture is polyphonic, the harmonic combination is additionally polydiatonic.

[26] This polydiatonicism changes, however, as soon as the C-flat arises. Up until then, Willaert has contrived the polydiatonicism to function harmonically by a careful combination of differing melodic materials so as to form consonances. These consonances frequently present interesting and unusual cross relations (particularly through the interplay of D-flat and D-natural, giving a feeling of "major/minor" alternation). From the arrival of the C-flat, however, the polydiatonicism becomes entirely graphic (the Tenor now notationally continuing as if a semitone too high for the remainder of the piece, and visibly still asserting its "black-note" pitches). But the addition of the second (performed-only) *ficta* layer now inflects the actual sung pitch material back into exact alignment with the scale that has remained constant in the Cantus. But there has now been a very subtle change in the pitch classes used. What was previously Pythagorean A has now become Pythagorean B-double flat (which lies a comma lower than A). Similarly, what has become Pythagorean A-double flat is now a comma lower than the previous Pythagorean G. The same difference affects E because this now aligns with what the Tenor singer has asserted as "Pythagorean F-flat" (lower by a comma than E). Both voices are therefore now using exactly the same audible pitch materials, even though one of them (the Tenor) is arriving at them by the application of double *ficta* (the first layer notated by the accumulation of six written flats, and the second by the singer's further addition of an unwritten *ficta* flat to every remaining written note).

[27] The resulting tetrachords are now structured with different intervals from the previous Pythagorean ones, as illustrated in **Example 6**. It can be seen that the synemmenon tetrachord (A-B flat-C-D) now has its outer notes (A and D) flattened

by a comma. In performance the difference will inevitably be a Syntonic comma (only a schisma different from the Pythagorean comma that Willaert has actually specified notationally) because this magnitude will bring the consonances into exact purity. The rising intervals will therefore be as follows: major semitone (16:15)—major tone (9:8)—minor tone (10:9). Since the tetrachord structure is now fully octachordal, there is a disjunction between D and E that will also be a major tone (9:8). The next tetrachord (E-A) also has its outer notes lowered by a comma, but it can be seen that here the G is also lowered. The interval combination is slightly different as follows: major semitone (16:15)—minor tone (10:9)—major tone (9:8). The reason why the intervals are in a slightly different order is simply because Willaert needs frequently to use the combination G/D and requires that this should form an exact 3:2 perfect fifth. He has therefore placed the minor tone below the major in this tetrachord. The interval/pitch pattern presented by these two disjunct tetrachords is merely repeated for each octave above and below, according to the compass of the voices.[(12)]

[28] In teaching the singer the new intervals, Willaert needs to demonstrate not only their magnitudes but also where such intervals are positioned in the scale. The first new interval—the major semitone (16:15)—is more straightforward in that its positioning in the scale is obviously fixed at the base of each tetrachord. It will occur with the pitches E-F and A-B flat.[(13)] All that is needed is practice in singing the intervals at the correct (non-Pythagorean) size. Willaert wastes no time, and the first thing he asks of the Tenor, having descended from the C-flat, is to sing this interval both rising and falling (via the written notes F/G flat/F to be performed a semitone lower via added *ficta*). The correct intonation is not difficult since the singer has now already experienced the effect of pure and in-tune tertial harmonies from his two previous notes. By keeping the thirds pure, he will effortlessly intone a correct 16:15 semitone, and will realize from the experience that this same magnitude must now be applied to all remaining diatonic semitones. Willaert's immediate exercise is shown in **Example 7**.

[29] The correct cognition and execution of the minor tone (10:9) is more challenging since not only is this a new interval but also its correct and fixed location within the scale needs to be understood (since it will inevitably occur next to another tone within the diatonic scale that will be major). Within the Tenor range, there is only one position where the minor tone is applied. Example 6 shows this to be the step F/G (still read as G-flat/A-flat), since the remaining notes are all contained within the sounded range D/B-flat (read as E-flat/C-flat). How does Willaert indicate this position?

[30] In the original notation of the Tenor voice, the insertion of flats in the first half is of structural importance (as shown above) in unfolding the heptachordal structure of the tetrachords that allows the attainment of Pythagorean C-flat. But there are two remaining notated flats in the second half.[(14)] Of these, the first is placed before low E indicating a normal flattening. Its insertion is not merely "cautionary" however, because low E has not before had a flat placed in front of it (this having been restricted to the upper octave only). So it is a fully functional flat (even though its performance is concurrently subjected to double *ficta* by the singer). Three notes later, however, a further apparently "cautionary" flat is placed in front of A (which has previously been flattened). Although this may not seem necessary in quite the same way, it does nonetheless have a functional purpose. The use of a flat (as in every other previous case) is to indicate a narrowing of interval between the note bearing the symbol and the pitch that lies immediately below it in the scale (a tone being made into a semitone). In the case of this apparently "cautionary" flat, the narrowing has a more subtle meaning: that of indicating the presence of a minor tone (10:9) instead of the normal Pythagorean (major) tone (9:8). The singer will therefore observe that the tone (which he must sing in order to provide structural diatonic harmony with the Cantus) will be slightly narrowed to form a minor tone, and that the position of the minor tone will henceforth be located between what he reads as G-flat and A-flat (actually of course sung as F/G since he will be applying his double *ficta*). The narrowing is indicated by the visual reassertion of the flat in front of A, but the omission of that (which is still nonetheless operative) in front of G.

FOUR-VOICE VERSION

[31] As a conclusion to this essay, a brief reconsideration of Willaert's piece in its four-voice version will be offered. Although only the Altus appears in a contemporary print,[(15)] there must also have been a Bassus. As mentioned above, Aron considered the two-voice version given to him by Spataro to be probably only part of a four-voice texture. The question of authorship of the Altus and (still lost) Bassus needs some comment, because it is not unusual during this era for extra voices to be added by other composers to pre-existent compositions. Lowinsky observed that the printed source for the Altus (only) was likely to date from c. 1530, and we must assume that its survival indicates that a Bassus must have been in circulation also at this time. What will be clear from the reconstruction to be offered is that whoever provided these two other voices must have fully understood Willaert's intentions by providing two further voices that exactly correspond with these intentions. Yet we know that some of the best theoretical minds of the time (Spataro, Aron, Cavazzoni and later Artusi) showed no clear evidence of having been able to see Willaert's point. Indeed Artusi and Spataro clearly did not, while Aron

remains at best reticent. So who as early as c. 1530 could have understood the point of the composition, and its structural articulation? It was certainly none of those who rehearsed and exchanged their views on the piece from as early as 1524, and as late as 1600. The prime (and not unexpected) candidate is surely Willaert himself. There are, moreover, structural aspects that indicate that the four-voice texture was the original concept, even though the piece can certainly stand as an exercise in two-voice counterpoint (which it clearly did for Spataro).

[32] The Syntonic structure of the second half is actually clarified by the surviving Altus, and (as Lowinsky discovered) the restoration of a Bassus is not too difficult. At the point where the Tenor C-flat (functioning harmonically as a B-natural) falls by its perfect fifth to F-flat (functioning harmonically as E), the Altus skillfully enters on C to fulfill the voice-leading requirements asserted by the Tenor C-flat (=B) with its "leading-note" effect. Until then the Altus kept discreetly out of the way during a brief period of silence. This is shown in **Example 8**. As the phrase shown in Example 8 proceeds, the last dying embers of Pythagorean tuning can be identified in measure 23 on beat 3. Here a chord of C (in which all notes are lowered by a comma) actually produces Pythagorean intervals for the last time in the piece. Willaert rarely makes use of the harmonic combination of C/G (here the C is temporarily lowered, but later—in measure 29—it is the G that is raised) because in the scale he has established the two do not make a pure fifth (the G being lowered, but the C left by default at base pitch). Most other harmonic uses of G are in association with D (whose default is similarly lowered by a comma). This final use of Pythagorean tuning is shown in **Example 9**. From that moment onwards, all tunings are pure and Willaert shows a complete control of comma inflection in his structuring of the harmony and counterpoint. The "new skills" have now been demonstrated and rehearsed, and the singers need only continue to apply them in the ways they have just learnt. They will find that all semitones are large (16:15), minor tones (10:9) occur between C/D and F/G, and all other tones are major (9:8). When Willaert's music is thenceforth sung with these interval values and positions, the harmony will consist of pure thirds, fourths, fifths, sixths and octaves.

[33] Lowinsky's edition of the piece in its four-voice version is not only the earliest, but is also the only available edition that correctly realizes the interval structure of the Tenor voice.(16) Unshackled by the solmization-based approach of later commentators, his melodic deduction (though totally inferred from its perceived context within the four-voice texture) actually accords exactly with the interval structure proposed in this article (but here based upon a quite different view of the structural purpose and execution).

[34] In conclusion, I here offer a new edition and performance of Willaert's motet that preserves exactly the tuning I have argued as having been Willaert's goal of attainment.(17) While the Cantus and Altus voices are exactly as presented by Lowinsky, the Tenor has been renotated. The Bassus is new, although many similarities will be noted with Lowinsky's version as well as some important differences, especially in the range.(18) While Lowinsky regarded the Bassus as essentially a smooth counter melody to the Tenor, I have treated it (as Willaert treated the Altus) more like a *Contra*, and consequently its function is to provide a "filling in" role at certain points. What should be perfectly clear from the audio for **Example 10** is the remarkable change of tuning that suddenly takes place from the moment the Tenor reaches its C-flat. This quite audible change of soundscape should, more than any historical or theoretical argument, convince the listener that Willaert's whole purpose was to assert his view of the superiority of the Syntonic sound world over that of the Pythagorean by placing the two in direct opposition to each other. His clever attainment of the Syntonic sound world by the exact notation of pitches to be conceived in terms of the Pythagorean shows the utmost precision in squaring the tuning circle. His care in teaching the singer how to use the new intervals "reveals secrets" through the "teaching of new skills". Willaert has also "removed the burden from worried minds" by presenting a melody that is completely interval specific, and requires nothing other than a single, simple move into the "double *ficta*" region by taking a perfect instead of a (notated) diminished fifth. He has otherwise done all the work for the singer. Any singer who comes through this experience will be one fully able to apply the acquired skills to other music using the Syntonic scale. His former confidence as one merely going "unarmed into battle" will now have been strengthened by a technical understanding and attainment that will have changed his whole musical outlook.

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Footnotes

1. *L'Artusi overo delle imperfettioni della moderna musica* (Venice, 1600), ff. 21–21v. The complete text, together with full graphics, is available online at the following URL: http://WWW.music.indiana.edu/smi/seicento/ARTIMP_TEXT.html.
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2. The two voices as printed by Artusi can be viewed online at the following URL: http://www.music.indiana.edu/smi/seicento/ARTIMP_04GF.gif.
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3. Edward Lowinsky, "Adrian Willaert's Chromatic 'duo' Re-examined", *Tijdschrift voor Muziekwetenschap,* 18 (1956–9), pages 1–36.
Return to text

4. Joseph S. Levitan, "Adrian Willaert's Famous Duo *Quidnam ebrietas*", *Tijdschrift der Vereeniging voor Nederlandshe Muziekgescheidenis,* 15 (1938–9), pages 166–233.
Return to text

5. Margaret Bent, "Diatonic *Ficta*", *Early Music History* 4 (1984), pages 16–20.
Return to text

6. Dorothy Keiser, "The Character of Exploration: Adrian Willaert's 'Quid non ebrietas'", *Musical Repercussions of 1492* ed. Carol E. Robertson (1992), page 185.
Return to text

7. Rob Wegman, "Music Ficta", *Companion to Medieval and Renaissance Music* ed. T. Knighton and D. Fallows (London 1992), pages 270–1.
Return to text

8. This, and many other observations derived from the correspondences between Spataro and Aron, is discussed in greater length in Edward Lowinsky, "Adrian Willaert's Chromatic 'duo' Re-examined".
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9. When a melody arises from the use of diatonic tetrachords its resulting diatonicism regulates the disposition of tones and semitones so that each semitone is surrounded (if the pitch material is presented as a scale) by a minimum of two and a maximum of three undivided tones. If the tetrachords are disjunct, there will be three undivided tones in the series. Where tetrachords are conjunct there will be only two.
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10. Similarly (though irrelevant to this composition) the most distant pitch in the chain sharpwards to which *ficta* notation could be applied is A-sharp (occurring between the two *recta* notes A and B).
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11. All voices are given a default signature of one flat and this indicates that the default pitch material will be a scale that employs the synemmenon tetrachord with the B-flat and not the Diezeugmenon with B-natural. This will assert a disjunction of tetrachords on the notes D-E (D being the highest note of the synemmenon and E the lowest note of the Meson). Only the Tenor voice applies structured modifications to this default as it adds its further flats. The other voices remain faithful to the default, thereby retaining the simple "white-note" scale with an added B-flat.
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12. A full account of Syntonic tuning is given by Willaert's distinguished pupil, the theorist Zarlino in his *Le Istitutioni Harmoniche*, part 3. Full texts and graphics of this work are available online at http://www.music.indiana.edu/smi/cinquecento. This will not be discussed in this essay, but will form part of the supporting evidence presented in a later essay that develops further the findings revealed here.
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13. The singer of the Tenor will still be reading these semitones as F-G flat and B flat-C flat (sung a semitone lower by double *ficta*).

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14. These flats are also shown in Example 7 above near the end of staff 1.
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15. Altus partbook of *Libro primo de la fortuna* discussed in Edward Lowinsky, "Adrian Willaert's Chromatic 'duo' Re-examined".
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16. His Tenor was correct, but for the wrong reasons. His four-voice rendition made the Tenor's interval structure more or less inevitable, but the insertion of multiple editorial flats and double-flats obscures the simplicity and clarity of the original notation, and misunderstands the structural purpose of the resulting melodic inflections in terms of the transformation to Syntonic tuning. Indeed, Lowinsky assumed the use of equal temperament. The editorial flats also presume that the notational default (in the second half) is "white-note" whereas we can now see that an understanding of the tetrachord structure reveals it to be essentially "black-note".
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17. The pitches are computer generated, and a detailed explanation of the processes used to produce this, and all other audio examples accompanying this study, will be offered in a future article.
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18. Lowinsky's Bassus adopted a range of an octave plus a sixth, and this was much greater than that found in the other voices.
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Prepared by Brent Yorgason, Managing Editor and Rebecca Flore and Tahirih Motazedian, Editorial Assistants