

THEORIES OF TUNING AND ENSEMBLE PRACTICE
 IN ITALIAN DRAMATIC MUSIC OF THE EARLY
 BAROQUE,
 OR,
 OH WHERE, OH WHERE HAVE THE WIND
 INSTRUMENTS GONE?

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In a series of lavish spectacles over the course of the sixteenth century, Florentine musicians developed increasingly complex musical/theatrical entertainments that were one of the important precursors of opera. Along the way, they explored new ways of using instruments to accompany singers. While the earlier *intermedii* made use of contrasting consorts of like instruments, later ones made more and more use of mixed ensembles. It appears that, apart from these special occasions, ordinary performances of madrigals were also accompanied by instruments, although certainly less elaborately.

Although not the focus of this article, church music likewise made use of stringed instruments and wind instruments playing together. Sonatas and canzonas were published either with specified instrumentation that often included a mixture of instruments or for unspecified instrumentation with the indication “for all sorts of instruments.”

It would seem, then, at the dawn of the seventeenth century, that wind instruments were full participants in the newest, grandest, and most innovative music of the time. By the end of the 1630s they were virtually excluded. Why? There were a number of both musical and non-musical factors behind this disappearance. Among these, the implications of new ideas about tuning and classification of instruments has until now not gotten the attention it deserves.

Elaborate musical and theatrical spectacles to commemorate politically significant events were hardly unique to Florence, or even to Italy, but the *intermedii* that were performed along with comedies and pastoral plays in Florence constitute the largest, best described, and best-researched body of such music. The music is still extant for two of these spectacles.¹

Two basic principles that underlie sixteenth-century instrumentation can be seen in these Florentine works. The first can be called the consort principle: families of like instruments, whether viols, recorders, trombones, or other instruments built in various sizes, playing together, very likely with voices, but with no other instruments outside the family. Howard Mayer Brown has called the consort principle the Renaissance’s most important contribution to the practice of instrumentation.² The second principle, which Brown called the foundation principle, grew out of the consort principle and eventually supplanted it. Beyond a certain level of technical difficulty, chordal instruments like the lute cannot literally double the voices in a polyphonic texture. As the century progressed,

doublings became less and less literal, even on keyboard instruments, which were fully capable of playing a polyphonic texture. Once the contrapuntal fabric of the inner voices was replaced by a chordal texture, the principle behind continuo realization was born.

Before the end of the century, the foundation principle had nearly replaced the consort principle as the primary means of organizing an instrumental accompaniment. The consort principle was also weakened by the inclusion of “foreign” instruments in three different ways, all present by 1548. First, weaker or missing instruments of one family were replaced by those of another. There was no soprano trombone, so its place was taken by a cornett. (In this case, the result is not much different from a large version of the loud band of trombones and shawms that had existed for more than a century, except, of course, that the trombones, not the shawms/cornetts, were the basis of the ensemble.) The bass crumhorn was inadequate, so its place was taken by a trombone, etc. Second, two instrumental consorts could accompany voices together, not in alternation, such as a combination of voices, flutes, and viols. Third, chordal instruments could join consorts of melody instruments.

Brown’s proposed reconstruction of the forces necessary to perform the *intermedii* shows the developments described above, as well as the overall growth in the scope of these spectacles and in the number of people needed to perform them. It is summarized in Tables 1-6, with the exception of those pieces for which contemporary descriptions are inadequate to determine the forces needed to play them.³ Even without knowing anything more about the *intermedii* than what appears in the tables, it is obvious that they became longer and more elaborate over the course of the century. In fact, by 1589, each of the *intermedii* featured several musical numbers.

At the same time these principles of instrumentation were developing in Florence and like-minded courts, musicians were beginning to think differently about tuning. In theory, at least, if not in actual practice, Pythagorean tuning was the only tuning system acknowledged in Europe during the Middle Ages. Mathematically, it is derived from manipulating pure fifths (with a ratio of 3:2 between the frequencies of the two notes) within a pure octave (2:1). Subtracting the fifth from the octave yields a fourth (4:3), and subtracting the fourth from the fifth yields a whole tone (9:8). Figure 1 shows the intervals that result from constructing a diatonic scale using these intervals. As a harmonic interval, the major third in Pythagorean tuning is excruciatingly sharp.

Figure 1: Pythagorean tuning

C	D	E	F	G	A	B	C
	9:8	9:8	256:243	9:8	9:8	9:8	256:243

Minor third = 32:27	Perfect fifth = 3:2
Major third = 81:64	Minor sixth = 128:81
Perfect fourth = 4:3	Major sixth = 27:16
Augmented fourth = 729:512	Minor seventh = 16:9
Diminished fifth = 1024:729	Major seventh = 243:128

By the early fifteenth century, thirds had become an indispensable harmonic element. In practice, performers must have tempered them to make them sound better. The first attempt to devise a theory of tuning that departed from the Pythagorean system came in 1482, when Bartolomeo Ramos proposed what today would be regarded as a variant of just intonation, a tuning system based on both pure fifths and pure thirds. Figure 2 shows the intervals that result from a just scale.

Figure 2: Just Intonation

C	D	E	F	G	A	B	C
	9:8	10:9	16:15	9:8	10:9	9:8	16:15

Minor third = 6:5	Perfect fifth = 3:2
Major third = 5:4	Minor sixth = 8:5
Perfect fourth = 4:3	Major sixth = 5:3
Augmented fourth = 45:32	Minor seventh = 9:5 or 16:9
Diminished fifth = 64:45	Major seventh = 15:8

Most of the ratios in just intonation are much simpler than those in Pythagorean tuning, a fact that had great appeal to sixteenth-century theorists. And no triad sounds more beautiful than one in just intonation. Unfortunately, just intonation is an unreachable ideal. As a tuning system, it does not work. Notice first that there are two different sizes of whole tone. Further, notice that all but one of the fifths in the scale consist of two major whole tones, one minor whole tone, and a semitone, but the one from D to A consists of one

major whole tone, two minor whole tones, and a semitone. Therefore, the minor third from D to F is a Pythagorean minor third (32:27) and the fifth has a ratio of 40:27. Both of these intervals are smaller than pure intervals by about a ninth of a tempered tone, or an interval of 81:80, known as the syntonic comma. Performers, of course, would need to sing pure intervals above D just like any other note.⁴

As a practical matter, then, new methods of tuning had to be devised. For keyboard instruments, various kinds of meantone temperaments provided the solution. Essentially, they used as many pure thirds as possible, flattened the fifths a little bit, and divided the whole tone into two different sizes of semitone. In this way, the comma was divided into parts small enough to be essentially inaudible and do minimal damage. Fretted instruments, however, cannot use any of the tuning systems so far described. They must use some sort of equal temperament. There are ample writings in the sixteenth century that propose and defend various tuning systems for singers, keyboard instruments, and fretted instruments,⁵ but none that describe the proper tuning of wind instruments. It is apparent, though, that most wind instrument makers attempted to approximate some kind of meantone tuning.

As early as 1555 Nicola Vicentino noted the problem that these multiple tuning systems caused. At the end of his treatise, almost as an afterthought, he observed,

From the time of the invention of the bowed viol and the lute until now, these instruments have been played with the division of equal semitones. They are played everywhere today. As a result, two errors arise. First, the consonances of the third, and in some places, of the fifth are not just. Second, when they are played with other instruments whose division of the whole tone is into two semitones—one major and one minor—they do not agree, so that, frankly, they never accord with these instruments when they are played together.⁶

Figure 3 compares one common meantone temperament with equal temperament.⁷

Figure 3: Meantone and Equal Temperaments Compared (in cents)

	C	C#	D	E \flat	E	F	F#	G	G#	A	B \flat	B	C
Mean:	0	76	193	310	386	503	579	697	773	890	1007	1083	1200
Equal:	0	100	200	300	400	500	600	700	800	900	1000	1100	1200

Gioseffo Zarlino developed a new classification of instruments based on tuning as part of his lifelong defense of just intonation as the proper tuning system for singers. The

trombone, bowed lira, and violins without frets, he wrote, are all instruments that can play in just intonation as perfectly as singers. If keyboard instruments were designed with sixteen degrees of the octave instead of the common twelve, then they likewise could be played perfectly in tune.⁸ Actually playing anything on such a keyboard would be impractical, of course, so Zarlino admitted that temperament was necessary in order to make all the consonances sound as good as possible.

In a later chapter, Zarlino noted that no one temperament will work for all instruments. Although he had no interest in going into detail about the temperament of each individual instrument, he proposed a classification based on two different principles. First, he subdivided the traditional wind and string classes according to their shape. He divided wind instruments into two categories: the organ, which is put together of many pieces and played with a keyboard, and all others. Some of the others have holes, such as the flute and shawm, and others do not, such as the trumpet and trombone. The trumpet, being made of one piece, can be played only with the skill of the player's lips and breathing. The trombone, having a slide, can change its length.⁹

Zarlino's second principle of classification considers how much influence the player has over the tuning of particular pitches. On some instruments, notably keyboard instruments, the tuning is fixed and stable, and the player has no control over any pitch. On others, the bowed lira, violin and trombone, as mentioned earlier, the player can freely vary the sizes of intervals as required by the music and guided by his ears. Wind instruments with holes and stringed instruments with frets occupy a middle ground offering some possibilities for adjustment.

Ercole Bottrigari elaborated on both Vicentino's observation and Zarlino's classification. His *Il desiderio* is written in the form of a dialog that discusses the following observation:

Having gone a number of times to hear various and diverse musical concerts by voices accompanied by different instruments, I have never experienced the great pleasure which I had imagined and supposed, and which, in fact I had hoped to experience. And today particularly, when I attended this one, such was the case; because, having seen a great apparatus of different kinds of instruments—among them a large Clavicembalo and a large Spinnet, three Lutes of various forms, a great number of Viols and a similar large group of Trombones, two little Rebecs [probably violins] and as many large Flutes, straight and transverse, a large Double Harp and a Lyre—all for accompanying many good voices—there where I had thought I would hear a celestial harmony I heard confusion rather than the contrary, accompanied by a discordance, which has offended me rather than given me pleasure.¹⁰

Much of the rest of the dialog is devoted to explaining why such a large and diverse group of instruments was bound to disappoint the discerning listener. As part of the argument, Bottrigari described instruments of stable pitch (keyboard instruments), instruments of alterable pitch (trombones and violins), and instruments of stable-alterable pitch (fretted string instruments and wind instruments with holes), whose players had more control over the tuning of particular notes than did players of keyboard instruments, but much

less latitude than players of violin and trombone. Instruments of stable pitch were tuned according to “the syntonic diatonic of Ptolemy, tempered however, or divided, according to the custom of the expert makers and tuners of such instruments,”¹¹ that is, meantone temperament.

Instruments of stable-alterable pitch were tuned according to two different principles:

The wind instruments with openings . . . are all one species using the syntonic diatonic of Ptolemy more often than not. Since they cannot possess exact certainty either by the openings or by the breath, . . . we shall pass over them. Nevertheless, I will add that I have spoken with excellent makers of such instruments and I find that they do not have anything firm on which to base a solid argument, but when they bore the holes of such instruments they depend only on their ear, aided by nature, broadening the openings as the need is felt.¹²

In other words there were no treatises describing the tuning of wind instruments comparable to those of Aron, Lanfranco, Zarlino, and others who described keyboard tuning, but makers of wind instruments came as close as possible to meantone tuning through their practical training. Lutes and viols, on the other hand, “sound two equal semitones, that is, a tone divided into two equal semitones according to the idea of Aristoxenus.”¹³ A skilled player could adjust the notes a little bit in the direction of keyboard tuning, but could hardly play satisfactorily in tune with a keyboard instrument without great difficulty.

Trombones, violins, and the human voice, on the other hand, were entirely alterable in tuning. They could use meantone tuning or equal temperament when they had to and could otherwise master any ancient or modern tuning system.

Bottrigari drew a very practical conclusion from his classification of instruments and exploration of the practice of tuning: the three categories of instruments cannot play in tune with each other and therefore should never be used in the same ensemble. Wind instruments can most easily adapt to playing with keyboard instruments as their tuning system is similar, but it is impossible for wind instruments to match intonation with fretted string instruments. “So, if one wishes to double or triple the parts of a chorus one should take (according to my way of thinking) the greatest care never to mate instruments of different species; that is, winds with strings.”¹⁴

It seems especially significant that Bottrigari singles out winds and strings as a forbidden combination. Both are stable-alterable instruments. When their notes were out of tune, there would be no need for either of them to make the entire adjustment. Surely Bottrigari’s warning would be more pertinent to the combination of frets and keyboards. In that case, the lute or viol player would have to adjust much more drastically to match the inflexibly stable keyboard. Yet it is specifically the wind instruments, which were much less likely than either keyboard instruments or fretted instruments to be played by aristocratic amateurs, that his prescription was most likely to exclude from an ensemble.

One would also think that either species of stable-alterable instruments could unite perfectly with the entirely alterable instruments, but Bottrigari does not mention such

combinations. It is evident that violins had not yet supplanted the viols as the principal bowed string instrument and the harpsichord had not yet supplanted the various lutes as the principal provider of chordal harmony. Therefore, the inclusion of trombones in the wind ensemble was the only example of this combination that was commonplace in the late sixteenth century outside of church.

Near the end of his treatise, Bottrigari did mention with approval the large mixed ensembles of the ducal court of Ferrara and the nuns of San Vito, also in Ferrara. These ensembles were made up of a highly stable group of musicians who performed as a large mixed group only rarely, rehearsed many times for each performance, and limited their repertoire to two pieces in the case of the duke's musicians and not much more than that in the case of the nuns. Therefore, he claimed, his glowing report of these concerts in no way contradicts his general disapproval of most mixed ensembles, which lack both the stability and the discipline to overcome the severe problems caused by incompatible tuning systems.¹⁵

One might ask, How much influence did the theorists have with practical musicians? Most of them were themselves practical musicians who were responsible for training other practical musicians. Zarlino, for example, was not only the leading theorist of his generation, he was also *maestro di capella* at San Marco in Venice. Perhaps few people without a university education would have been able to read the dense prose or follow the flights of philosophical speculation in his treatises. But on the other hand, Zarlino could certainly communicate his ideas to his own musical establishment in comprehensible language and expect to be obeyed.

Bottrigari, on the other hand, was not a professional musician at all. He was a wealthy aristocrat who, like other members of his class, had a broad education, wide interests, and plenty of leisure time to develop them.¹⁶ He was, in other words, representative of the class of people who patronized music and paid the bills. As such, to the extent that other aristocrats shared them, his tastes had to have been enormously influential in terms of which musical practices were successful and which ones fell by the wayside. He was, in fact, not alone in his disapproval of large, mixed ensembles.¹⁷ Therefore it is helpful to look at some of the instrumental combinations in the *intermedii* again and compare them with Bottrigari's account of the realities of sixteenth-century tuning practices.

Because the *intermedii* of 1519 and 1539 use neither mixed consorts nor multiple foundation instruments, none of the music performed on those occasions would have had any special issues for tuning and intonation. But beginning with the 1548 *intermedii*, there are frequent problems. The first piece on Table 3 should have sounded good, as both the flutes and the spinets were tuned according to mean-tone tuning.

The fifth piece, however, could not have come off as successfully. A five-voice polyphonic texture on a lute consort (reinforced by a bass viol) would sound good by itself, but could not match the pitch of the spinet playing a chordal accompaniment. Again, the fretted instruments were tuned in equal temperament and the keyboard instrument was in mean-tone tuning. The last piece calls for a singer to be accompanied by a consort of viols, a consort of flutes, and two spinets. Presumably, one spinet was associated with each

consort. Most likely, the two consorts played in alternation until the very end of the piece, when the incompatibilities of viol and spinet were compounded by the doubling of the incompatible viols and flutes. Vicentino had not yet published his observation that fretted stringed instruments cannot play in tune with keyboard instruments, but the problem must have been obvious in preparing this piece. If no solution was discovered in rehearsal, it must have been a disappointing finale to anyone in the audience who recognized and appreciated good intonation.

The 1565 *intermedii* opened with an instrumental prologue of two contrasting consorts: one of cornett, recorders, and trombones, and the other of flute and viols. This last consort could not play in tune. However the foundation instruments (four harpsichords and two lutes) were deployed, they would have only added to the faulty intonation, even if the two consorts never played simultaneously. Brown determined that the fourth piece had one group of performers on stage (the singers, the lutes, and one soprano viol) and another off stage (the other soprano viol and the wind instruments). The viol in the off-stage consort could not match the other instruments. Again, the foundation instruments would only add to the problem.

As the remaining *intermedii* became more and more elaborate and more and more adventuresome in combining instruments, the probability of intonation problems multiplied. It is not necessary to add any further explanation of the tables. Some of the music must have been simply intolerable to the trained ear. Of course Bottrigari himself acknowledged that, given enough rehearsal, the intonation problems can be solved and the ensemble can sound glorious. These productions were intended to glorify the splendor and good taste of the host, so it seems reasonable to assume that no effort was spared to make the music sound as good as possible. On the other hand, by the time Bottrigari described the grand concerto in Ferrara, one of the two pieces was older than most of the performers. The music for the *intermedii* was new.

But in any case, when the music of the *intermedii* and other similar pieces were performed by mixed ensembles on more ordinary concerts, the results must have been less than satisfactory. An extraordinary amount of rehearsal would not have been available for an ordinary concert. Then as now, it seems safe to assume that not everyone in the audience recognized or cared about good intonation, but those who did, like Bottrigari, cared very much. As Brown points out, these more ordinary performances were not limited to Florence; similar concerts were held all over northern Italy, including the courts at Mantua and Ferrara.¹⁸ Bottrigari, by the way, was Bolognese, but lived in Ferrara for several years.

Courtly extravaganzas laden with political symbolism, featuring large and diverse instrumental ensembles, continued well into the seventeenth century—at least as late as Cesti's *Il pomo d'oro* (Vienna, 1668)—but they rapidly became something of a backwater in the history of opera. The marriage of Henry IV, king of France, and Maria de' Medici was celebrated in October 1600 in Florence with two theatrical presentations. The larger and more important, so it seemed at the time, was *Il Rapimento di Cefalo*, a production that was claimed to have exceeded any other since the days of the ancient Romans in terms of spectacle. Presumably, it represented the tradition of the Florentine *intermedii*. The other was Jacopo Peri's *Euridice*, one of the very first operas.

The only instruments named in Peri's preface were harpsichord, chitarrone, *lira grande*, and lute. There must have been other instruments; the prologue and finale both have ritornellos that require one melody instrument in treble clef, very likely a viol or violin. One song may have been accompanied by panpipes or two recorders.¹⁹ The opera received mixed reviews.

A somewhat earlier work, *Rappresentazione di Anima et di Corpo* by Emilio Cavaliere, requires a somewhat more elaborate ensemble, but nothing to compare with the Florentine *intermedii*. The preface states that a large quantity of instruments are necessary, but mentions only continuo instruments and the violin by name. A string ensemble and the continuo instruments would be quite sufficient to perform any of this music brilliantly.²⁰

There is no indication that either Peri or Cavaliere avoided wind instruments out of concern for tuning issues. Their music makes its effect by harmonic and melodic expressiveness, not by symbolism or an ostentatious display of wealth. Varied instrumentation was essentially irrelevant to their artistic aims. It is clear, however, that people who objected to the intonation troubles of large, mixed ensembles and who liked the operas would have considered the less extravagant instrumentation an advantage.

Monteverdi, of course, made very imaginative use of wind instruments in *Orfeo* (1607), but he never mixed them with strings in the same piece. Because most of his operas are lost, it is not known how long he continued to use a large, varied instrumentation. Such a holdover from the *intermedii* soon may have sounded dated. At any rate, by 1637, opera had found its permanent home in the public theater, and the orchestra was reduced to a handful of violins and foundation instruments.

It could be pointed out, of course, that 1637 marks the first beginnings of the return to prosperity after the devastating plague of 1630-31. Furthermore, opera was no longer funded by the deep pockets of a court, but by commercial theaters that had significant financial constraints. It is frequently suggested, therefore, that opera did not have a large orchestra because the impresarios could not afford it. In fact, the singers and the stage machinery were extremely expensive, but the audience demanded the best and most spectacular of each. If the audience had wanted a large orchestra, the theaters would have provided one.

It would be absurd to suggest that wind instruments' supposed inability to play in tune with viols without extraordinary rehearsal in 1594, when Bottrigari wrote his treatise, was the sole cause of their not being given much of a chance to play in an ensemble of violins in 1637. After all, the even more incompatible keyboard instruments and lutes still shared the continuo duties. But the multiplicity of tuning systems surely counts as one among several reasons why wind instruments so rarely participated in the operatic orchestra.

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Table 1
1518 performance in honor of the marriage of Lorenzo de' Medici
and Madeleine de la Tour d'Auvergne

1. trumpet, bagpipe and shawms
2. 3 lutes
3. sopranos and 4 violas da gamba
4. "highest pitched quilled keyboard instruments"
5. 4 trombones

Table 2
1539 wedding of Cosimo I and Eleanore of Toledo

1. 24 singers in 8 parts, 4 cornetts, 4 trombones
2. Soprano solo with claviorganum and bass viol
3. 6 singers, 6 crumhorns (or 4 crumhorns and 2 cornetts, depending on which description is the more accurate)
4. 3 singers, 3 flutes, 3 lutes
5. Solo singer accompanying himself on lyra viol
6. 8 singers in 4 parts, singing *a cappella*.
7. Alto voice, 4 trombones
8. 8 singers in 4 parts, violin, pipe and tabor, 2 cornetts, 2 crumhorns, trombone, harp

Table 3
1548 Entry of French king Henry II and his queen into Lyons.

1. Solo singer, 4 flutes, 2 spinets.
2. Solo singer accompanying himself on the *lira da braccio*
3. 4 singers, 4 viols, 4 flutes
4. 4 singers, 3 crumhorns, trombone (doubling the bass)
5. Solo singer, 5 lutes, viol, spinet
6. 5 voices, 2 cornetts, 3 trombones
7. Solo singer accompanying himself on the *lira da braccio*
8. Another solo singer accompanying himself on the *lira da braccio*
9. Solo singer, 4 flutes, 4 viols, 2 spinets

Table 4
1565 Wedding of Francesco de' Medici to Joanna of Austria

1. Mute cornett, transverse flute, 2 recorders, 2 trombones, 4 viols, 4 double harpsichords, 2 lutes.
2. 8 voices, mute cornett, 2 recorders, trombone, 4 viols, 2 harpsichords, lute.
3. 5 voices, 5 flutes, recorder, trombone, 2 viols, 2 harpsichords, lute.
4. 4 voices, mute cornett, flute, recorder, bass trombone, viol, *lirone*, 5 lutes, harpsichord.
5. 8 voices in 6 parts, mute cornett, 5 crumhorns.
6. 6 voices, 3 cornetts, 2 trombones, *dolzaina*, 2 drums.
7. soprano solo, 4 viols, 4 trombones, *lirone*.
8. 10 singers in four parts, 2 mute cornetts, crumhorn, 2 trombones, violin, *dolzaina*, *lira*, *lirone*, soprano lute, tenor lute.
9. 8 voices in four parts, *lira da braccio*, *lirone*.

Table 5
1568 baptism of Leonora de' Medici

1. 6 voices, 5 *dolzaini*, 1 trombone.
2. soprano solo, alto flute, 2 tenor recorders, 4 trombones, 4 bass viols, 3 lutes, 3 harpsichords.
3. 10 voices, without instruments.
4. 4 sopranos, 4 bass viols (playing the lower parts of an 8-part texture).
5. 5 voices, 2 mute cornetts, 2 trombones, bass crumhorn.
6. 3 voices, mute cornett, 2 trombones, 3 viols, *lira da braccio*, lute.
7. 4 voices, 2 recorders, 3 trombones.
8. 7 voices, mute cornett, 3 recorders, 4 trombones, 4 viols, *lira da braccio*, lute.
9. 4 voices, 2 recorders, 3 trombones.
10. 12 voices, 2 cornetts, 2 recorders, transverse flute, 4 trombones, 2 viols, 6 lutes.

Table 6
1589 wedding of Ferdinand I and Christine of Lorraine

1. soprano, bass lute, 2 *chitarroni*.
2. 8 voices, 2 *lire da braccio*, 2 viols, 2 harps, bass lute, *chitarrone*.
3. cornett, transverse flute, 4 trombones, 5 viols, 2 *lire da braccio*, cittern, mandora, psaltery, 6 lutes, 2 harps, *chitarrone*.
4. part 1: child's voice, 2 *lire da braccio*, 2 harps, 2 viols, bass lute, *chitarrone*. part 2: 8 voices accompanied by the ensemble described in no. 3.
5. 15 voices in three choruses, accompanied by all instruments mentioned so far.
6. The entire company again—the first six pieces constitute the first of 6 *intermedii*.
7. violin, lyra viol, 2 *lire da braccio*, bass viol, 2 harps, 2 lutes, *chitarrone*.
8. 3 children's voices, 2 *lire da braccio*, harp.
9. 6 voices, bass lute, bass viol, *chitarrone*.
10. 12 voices, bass lute, bass viol, *chitarrone*.
11. The entire company of the second *intermedio*.
12. 18 voices, viols, flutes, trombones (numbers of instruments unknown).
13. 12 voices, cornett, bass trombone, violin, 2 *lire da braccio*, 2 bass viols, harp, 4 lutes.
14. viols, flutes, trombones (numbers of instruments unknown).
15. 4 voices, harp, *lira da braccio*.
16. The entire company of the third *intermedio*.
17. solo voice, lute, and an ensemble of unrecorded size using bass trombones, violin, *lironi*, bass viols, lutes, double harp, organs with flue pipes. (In the contemporary description, apparently only the violin and harp are given in the singular.)
18. flute, violin, lyra viol, 2 *lire da braccio*, psaltery, 4 lutes, harp, *chitarrone*.
19. 6 voices and the instruments of no. 18.
20. 5 voices, 4 trombones, 4 viols, *lira da braccio*. (The last number in the fourth *intermedio*.)
21. solo voice, lute, *chitarrone*, *lirone*.
22. 5 voices, 2 viols, 3 lutes, harp, *chitarrone*, *lirone*.
23. violin, regal, 2 lutes, bass viol, *chitarrone*.
24. solo voice, 2 echos, *chitarrone*.
25. 7 voices, violin, regal, 2 lutes, bass viol, *chitarrone*. (The last number in the fifth *intermedio*.)

26. 6 voices, violin, 2 *lire da braccio*, bass viol, 4 lutes, 2 *chitarroni*.
 27. 24 voices, 2 cornetts, 4 trombones, violin, 4 viols, cittern, psaltery, mandora, *lirone*, 4 lutes.
 28. solo voice and *chitarrone*.
 29. The entire company—60 voices and the same instruments as nos. 26 and 27.
 30. The entire company.

NOTES

¹These are also available in modern editions: Andrew C. Minor and Bonner Mitchell, ed. *A Renaissance Entertainment: Festivities for the Marriage of Cosimo I, Duke of Florence in 1539* (Columbia, MO: University of Missouri Press, 1968) and D. P. Walker, ed. *Les fêtes du mariage de Ferdinand de Médicis et de Christine de Lorraine, Florence 1589: Musique des Intermèdes de "La Pellegrina"* (Paris: Centre Nationale de la Recherche Scientifique, 1963).

²Howard Mayer Brown, *Sixteenth-Century Instrumentation: The Music for the Florentine Intermedii* (n.p.: American Institute of Musicology, 1973), p. 78.

³*Ibid.*, pp. 85-132. I beg to differ with Brown on one important point. On p. 60, citing Praetorius, he says that all trombones besides the tenor were "unusual, new, or saved for special effects; . . . the quart or quint was unfamiliar to many players, and the bass was newly invented." Praetorius says no such thing, and trombone maker Jorg Neuschel, writing in 1540, refers to the *quart* trombone. (See "Briefe von Jorg Neuschel in Nürnberg, nebst anderen (Im Besitze des kgl. geh. Archivs in Königsberg i/Pr.)," *Monatshefte für Musikgeschichte* 9 (1877): 149-59.) And even if Brown is correct that many players were unfamiliar with other trombones besides the tenor, surely the band in Florence, one of the most sophisticated courts in the world, would include people both knowledgeable and skilled on all useful sizes. While Brown argues that a consort of four trombones probably meant four tenors unless a contemporary description explicitly said otherwise, it seems much more likely that a bass (*quart* or *quint*) trombone routinely played the lowest part. Furthermore, whenever a single trombone played the lowest part in the texture, it was more likely a bass than a tenor.

⁴For a sixteenth-century mathematical demonstration of why just intonation is not a practical tuning system, see Claude V. Palisca, "Scientific Empiricism in Musical Thought", in *Seventeenth Century Science and the Arts*, ed. Hedley Howell Rhys (Princeton, NJ: Princeton University Press, 1961), pp. 104-18.

⁵See J. Murray Barbour, *Tuning and Temperament: A Historical Survey* (East Lansing, Mich.: Michigan State College Press, 1953).

⁶Nicola Vicentino, *L'antica musica ridotta alla moderna prattica* (Rome: Antonio Barre, 1555), trans. by Maria Rika Maniates as *Ancient Music Adapted to Modern Practice* (New Haven, CT: Yale University Press, 1996), p. 443.

⁷Values for Aron's 1/4-comma meantone system are taken from Barbour, *Tuning and Temperament*, p. 26.

⁸Gioseffo Zarlino, *Sopplimenti musicali* (Venice: Senese, 1588), p. 152.

⁹*Ibid.*, p. 216.

¹⁰Ercole Bottrigari, *Il desiderio, overo de' concerti di varii strumenti musicali* (Venice, 1594; 2nd ed. 1599). Eng. trans by Carol MacClintock as *Il desiderio, or, concerning the playing together of various musical instruments* (n.p.: American Institute of Musicology, 1962), p. 13.

¹¹*Ibid.*, p. 16.

¹² Ibid.

¹³ Ibid., p. 17.

¹⁴ Ibid., p. 23.

¹⁵ Ibid., pp. 49-54, 59-60.

¹⁶ *The New Grove Dictionary of Music and Musicians*, 20 vols., ed. Stanley Sadie (London: Macmillan, 1980), s.v. "Bottrigari, Ercole" by Carol MacClintock.

¹⁷ Robert L. Weaver, "The Orchestra in Early Italian Opera," *Journal of the American Musicological Society* 17 (1964): 86-87.

¹⁸ Brown, *Sixteenth-Century Instrumentation*, pp. 81-82.

¹⁹ *The New Grove Dictionary of Opera*, 4 vols., ed. Stanley Sadie (New York: Grove's Dictionaries, 1992), s.v. "Euridice" by Howard Mayer Brown. See also Claude V. Palisca, "The First Performance of *Euridice*" in *Queens College Department of Music Twenty-Fifth Anniversary Festschrift*, ed. Albert Mell (New York: Queens College of the City University of New York, 1964), pp. 1-25.

²⁰ Emilio del Cavaliere, *Rappresentazione di anima, et di corpo* (Rome: Nicolò Muti, 1600; facs. ed. Hants, England: Gregg Press, 1967).