

The Use of Meantone Temperament in the
Performance of Keyboard Music by Johann Jacob Froberger

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ABSTRACT

The music of Johann Jacob Froberger (1616-1667) poses challenges for the performer when selecting an appropriate tuning system. Froberger lived at a time when meantone temperaments were commonly used on keyboard instruments, but many scholars today consider it appropriate to play his music in temperaments that appeared later, because certain notes found in his works do not fit the traditional meantone framework.

In meantone temperaments, only 12 notes are available per octave because some enharmonic notes and intervals are so far from pure that they are unusable. Composers of the sixteenth and seventeenth centuries understood the limitations of prevalent temperaments but some chose to expand those limits either by using notes that lie beyond the normal disposition of meantone, or by making use of the ‘harsh’-sounding intervals.

This study examines the music of Froberger and investigates how best to tune the harpsichord for selected works. The works chosen for the purpose of this study contain notes beyond the 12 that are typically available in meantone temperament. The study suggests effective ways to tune the harpsichord in order to give convincing performances.

The dissertation is divided into three chapters. It contains information on historical temperaments; instruments from the sixteenth and seventeenth centuries particularly those with divided keys and the music written for them; instruments that may have been known to Froberger; internal evidence in Froberger's works that might identify features of the instruments he had in mind; and case studies of Froberger's music discussing intervals and notes in context, and suggestions on tuning and interpretation. This study will be of assistance to performers exploring the music of Froberger, by highlighting issues to consider when choosing a particular way to tune the harpsichord, and how this may affect interpretation and performance.

TABLE OF CONTENTS

	Page
ABSTRACT	ii
TABLE OF CONTENTS	iii
LIST OF FIGURES	vi
LIST OF TABLES	vii
LIST OF EXAMPLES	viii
SOUND EXAMPLES	x
LIST OF SOURCES FOR FROBERGER'S MUSIC	xi
ACKNOWLEDGEMENTS	xii
DECLARATION	xiii
INTRODUCTION	1
Historical Background	2
Aim of the Research	3
Current State of Research	5
Editions and Sources for Froberger's Works	7
Pitch Notation	12
Summary	12
CHAPTER I: Temperament	14
Regular Temperaments	16
1. Meantone Temperaments	16
2. Equal Temperament	19
Irregular Temperaments	21
1. Werckmeister III	21

2. Kirnberger III	22
3. Vallotti ca. 1730, Neidhardt I, and Barnes	23
4. French Tempérament Ordinaire	25
CHAPTER II: Keyboard Instruments in the Sixteenth and Seventeenth Centuries	33
Instruments with More than 12 Notes to the Octave	33
Music for Instruments with More than 12 Notes to the Octave	41
Instruments Froberger May Have Known	49
Johann Mayer: 1619, Stuttgart	49
Giovanni Celestini: 1587, Venice	51
The Compass and Other Features in Froberger's Music	52
Conclusion	58
CHAPTER III: Case studies: Intervals in Context Within the Keyboard Works of Froberger	60
<i>Affligée et Tombeau fait à Paris sur la mort de Monsieur Blanchrocher,</i> FbWV 632a	60
<i>Suite in G minor, Lamentation sur ce, que j'ay été vole. Et se joüe à la discretion, et encore mieux que les soldats m'ont traicté – Courant – Sarabande – Gigue, FbWV614</i>	67
<i>Meditation faite sur ma mort future, la quelle se joüe lentement avec Discretion - Gigue - Courante - Sarabande, FbWV 620</i>	70
<i>Ricercar in F# minor, FbWV 412 / C# minor, FbWV 406</i>	71
Other Ricercars in 'Libro IV' and 'Libro di capricci e ricercate'	76
<i>Suite in E minor, Allemande faite en passant le Rhin dans une barque en grand peril, la quelle se joüe lentement à la discretion - Courante - Sarabande - Gigue, FbWV 627</i>	77

<i>Suite in A minor, FbWV 630, Plaincte faite à Londres pour passer la Melancolie la quelle se joüe lentement et à discretion - Courante - Sarabande - Gigue</i>	82
<i>Lamentation faite sur la tres douloureuse mort de Sa Majeste Imperiale, Ferdinand le Troisiesme, et se joüe lentement avec discretion, FbWV 633</i>	85
Toccatà FbWV 112 in A minor	88
CONCLUSION	91
APPENDIX I: Recital Programme (25th September 2015).....	94
APPENDIX II: DVD Track Listing from the Recital	97
APPENDIX III: Scores of Works Included in the Recital	98
BIBLIOGRAPHY	136

LIST OF FIGURES

Figure		Page
1.	Pitch notation	12
2.	Short-octave keyboard	38
3.	Split-key short-octave keyboard and divided D#/E♭, G#/A♭ keys	38
4.	Suggested retuning for Mayone's <i>Toccata Quarta</i> (1609)	42
5.	Johann Mayer's harpsichord of 1619	50
6.	Viennese short octave	51
7.	Depiction of heaven at the end of <i>Lamento</i> , FbWV 612	56
8.	GG/BB Split-key short octave	57

LIST OF TABLES

Table		Page
1.	List of pure intervals in cents	15
2.	Quality of triads in quarter-comma meantone	17
3.	Quality of triads in sixth-comma meantone	18
4.	Quality of triads in equal temperament	20
5.	Quality of triads in Werckmeister III	22
6.	Quality of triads in Kirnberger III	23
7.	Quality of triads in Vallotti	24
8.	Quality of triads in Neidhardt I	24
9.	Quality of triads in Barnes	25
10.	Detailed analysis of intervals in quarter-comma meantone	28
11.	Detailed analysis of intervals in sixth-comma meantone	29
12.	Detailed analysis of intervals in Kirnberger	30
13.	Detailed analysis of intervals in Werckmeister III	31
14.	Detailed analysis of intervals in Vallotti	32

LIST OF EXAMPLES

Example	Page
1. Philips, <i>Pavana Dolorosa</i> , bars 81-83 from the <i>Fitzwilliam Virginal Book</i> ..	39
2. Bull, <i>Ut re mi fa sol la</i> , bars 10-12	40
3. Mayone, <i>Toccata Quarta</i> (1609), bars 7-10	42
4. Mayone, <i>Toccata Quarta</i> (1609), bars 30-39	43
5. Mayone, <i>Toccata Quinta</i> (1609), bars 8-23	44
6. Frescobaldi, <i>Cento Partite sopra Passacagli</i> , bars 124-126	47
7. Rossi, <i>Toccata Settima</i> , bar 67	48
8. Froberger, FbWV 606, Variation 4 (Libro II and Grimm 1698/99)	53
9. Froberger, Toccata FbWV 101, chord in bar 6	53
10. Froberger, FbWV 613 Sarabande, chord in bar 8	54
11. Froberger, FbWV 611, Courante, bar 6	54
12. Froberger, FbWV 112, bar 9	55
13. Froberger, FbWV 407, bar 46	55
14. Froberger, FbWV 612, <i>Lamento</i> , bar 13	56
15. Froberger, FbWV 620, Gigue, end of bar 5	57
16. Froberger, FbWV 632a, extended trill at bars 18-19	61
17. Froberger, FbWV 632a, <i>Tombeau</i> , bar 5	62
18. Froberger, FbWV 632a, <i>Tombeau</i> , bar 3	63
19. Froberger, FbWV 632a, <i>Tombeau</i> , bar 6-7	64
20. Froberger, FbWV 632a, end of bar 14	64
21. Froberger, FbWV 614, <i>Lamentation</i> , bars 1-5	66
22. Froberger, FbWV 620, <i>Meditation</i> , end of bar 3	71
23. Froberger, FbWV 412, Ricercar, Wobbly title	73

24.	Froberger, Titles of Ricercars FbWV 407-411	73
25.	Froberger, FbWV 627, <i>Allemande faite en passant le Rhin</i> , bar 7	79
26.	Froberger, FbWV 627, <i>Allemande faite en passant le Rhin</i> , bar 5	80
27.	Froberger, FbWV 630, <i>Plaincte faite à Londres</i> , bars 2-3	83
28.	Froberger, FbWV 630, <i>Plaincte faite à Londres</i> , end of bar 4	83
29.	Froberger, FbWV 630, <i>Plaincte faite à Londres</i> , bars 6-7	84
30.	Froberger, FbWV 633, <i>Lamentation</i> , bar 1	86
31.	Froberger, FbWV 633, <i>Lamentation</i> , bars 7-9	88
32.	Froberger, FbWV 633, <i>Lamentation</i> , bar 15	88
33.	Froberger, FbWV 612, <i>Toccata</i> , bars 14-19	90

SOUND EXAMPLES

Track Number	Track Description
Track 1	Wolf in quarter-comma meantone E \flat -G \sharp
Track 2	Chromatic scale in quarter-comma meantone E \flat -G \sharp
Track 3	Wolf in sixth-comma meantone E \flat -G \sharp
Track 4	Chromatic scale in sixth-comma meantone E \flat -G \sharp
Track 5	Bull, <i>Ut re mi fa sol la</i> in quarter-comma meantone E \flat -G \sharp , bars 10-12
Track 6	Bull, <i>Ut re mi fa sol la</i> in simulated 19-divisions meantone, bars 10-12
Track 7	Bull, <i>Ut re mi fa sol la</i> in Kirnberger's temperament, bars 10-12
Track 8	Bull, <i>Ut re mi fa sol la</i> in equal temperament, bars 10-12
Track 9	Froberger, FbWV 632a, poignant d \flat^2 in quarter-comma meantone, bar 5
Track 10	Froberger, <i>Tombeau</i> , FbWV 632a, back-dotted <i>notes inégale</i> quarter-comma meantone, bar 3
Track 11	Froberger, <i>Tombeau</i> , FbWV 632a, strong interrupted cadence in quarter-comma meantone, bar 6
Track 12	Froberger, <i>Tombeau</i> , FbWV 632a, straight rhythms in sixth-comma meantone, bar 3
Track 13	Froberger, <i>Tombeau</i> , FbWV 632a, <i>notes inégale</i> in sixth-comma meantone, bar 3
Track 14	Froberger, <i>Lamentation</i> , FbWV 614, played with no adjustment to A \flat s in quarter-comma meantone, bars 1-5
Track 15	Froberger, <i>Lamentation</i> , FbWV 614, Pure A \flat s, bars 1-5
Track 16	Froberger, <i>Lamentation</i> , FbWV 614, sixth-comma meantone, bars 1-5
Track 17	Froberger, Toccata, FbWV 112, lingering on e \sharp^1 , bars 14-19
Track 18	Froberger, Toccata, FbWV 112, no lingering, bars 14-19

Sound examples are also available at: <https://www.youtube.com/watch?v=RdghWgjeOIk>

LIST OF SOURCES FOR FROBERGER'S MUSIC

Source	Location	Other Information
Libro Secondo (II)	Österreichische Nationalbibliothek, Vienna	Dedicated to Emperor Ferdinand III in 1649 Mus Hs 18706
Libro Quarto (IV)	Österreichische Nationalbibliothek, Vienna	Dedicated to Emperor Ferdinand III in 1656 Mus Hs 18707
Libro di capriccio e ricercate	Österreichische Nationalbibliothek, Vienna	Dedicated to Leopold I c.1658 Mus Hs 16560 ('Libro Terzo III' incorrectly added by a later hand)
SA 4450	Sing-Akademie, Berlin	SA 4450, c. 1662-1667
Bulyowsky 1675	Saxon State and University Library in Dresden	Written by Michael Bulyowsky de Dulic, dated 1675 Mus. 1-T-595
Tappert c. 1670	Biblioteka Jagiellonska in Cracow	Tablature book, c.1660-70 (Source X in DTO)
WMin 743	Minorite Monastery in Vienna	Dated 1708-9 (Source KK in DTO)
Grimm 1698/99	Österreichische Nationalbibliothek, Vienna	Tablature book written by C. Grimm, dated 1698 and 1699 (Source Y in DTO) Mus Hs 16798
Sotheby's	Unknown	Autograph, c.1664-1667 Sold at Sotheby's in London, November 2006 Auction catalogue gives limited information

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DECLARATION

The material presented in this dissertation is the original work of the author. It has not been submitted to be examined for any other qualification, nor has it been published elsewhere.

INTRODUCTION

Musicians today generally agree on using a type of meantone temperament when performing keyboard works from the seventeenth century (Rowland 2001, 39). Meantone temperament, as will be discussed more in detail below, belongs to a group of temperaments classified as regular (or non-circular), and is based on tempering fifths regularly around the circle of fifths. This resulted in some intervals being so far from pure that they were deemed unusable. These intervals were referred to as the 'wolf' because they resembled 'the howling of a wolf' (Oldham and Lindley 2001).

Although Johann Jacob Froberger¹ (1616-1667) lived and worked entirely in the seventeenth century, scholars often state that his works need irregular (or circular) temperaments in which there is no wolf, temperaments which are associated more with the eighteenth century. Mary Cyr, in her book *Performing Baroque Music*, refers to works by Froberger in keys that were then unusual, such as F# minor, B minor and E major, to support her argument (Cyr 1992, 66). Some have suggested that he was an advocate of equal temperament, as he was a pupil of Girolamo Frescobaldi (1583-1643) who is believed to have advocated the use of equal temperament.²

Many scholars consider the use of notes outside the normal disposition of quarter-comma meantone as proof that Froberger used a circular temperament.³ It is true that Froberger seems to explore the limits of meantone temperament in some of his compositions, but when the context in which these notes appear is taken into account, Froberger is not as liberal as he first appears. Indeed, trying to play his pieces in a

¹ Froberger's given names appear in publications in a variety of spellings. According to Rampe, Froberger was baptized as 'Joh. Jacob' although he signed his letters 'Hanß Jacob' (Rampe 2008, XXVI). The spelling 'Johann Jakob' is also frequently used in recent literature.

² Many writers refer to a comment believed to have been made by Giovanni Battista Doni (1595-1647) to support this (Cyr 1992, 66; Norman 1992, 171-2; Pollard 1985, 89).

³ The normal disposition of quarter-comma meantone is E♭ to G#. This will be discussed in more detail in Chapter I.

meantone temperament can reveal another level of understanding of his works, and can provide another dimension to the expressive palette for performers.

Historical Background

Johann Jacob Froberger was born in Stuttgart in May 1616. He was a son of Basilius Froberger (c.1575-1637), a tenor at the Stuttgart court chapel who later became the Kappellmeister in 1621. There were many foreign musicians employed at the Stuttgart court, and he may have been taught by Andrew Borell, an English lutenist, who was known to have taught one of Basilius's children. From 1637, Froberger studied in Rome with Frescobaldi, and later travelled widely across Europe including England. At the end of his life, he stayed with Duchess Sibylla of Württemberg at Héricourt Palace near Montbéliard where he died in May 1667 (Buelow 1985, 154; Rampe 2002, XLVI).

When speaking of his works, Froberger is reported to have asked Duchess Sibylla 'to give nothing to anyone ... since people may not know how to play them, but would only spoil them.' (Kilbuck, 1976:3) He is further reported to have asked her to circulate only the works he authorised. According to Rampe, this information is contained in his will, and works in B minor and E major were not included in volumes compiled during his lifetime (Kilbuck 1976, 3; Rampe 2003, 6-7). Rampe states:

The main reason for Froberger's particular reluctance to provide free access to his works written in keys like B minor, F sharp minor, C minor and E major surely lay in the way mean-tone temperament prevailed from the fifteenth until far into the eighteenth century.... Mean-tone temperament ensures physically almost pure intervals for a central group of favoured keys and makes other keys sound so out of tune that they are practically unusable (Rampe 2003, 8).

Froberger's output is almost entirely for the keyboard. The issue of temperament is particularly relevant when composing for keyboard instruments. The existence of works written in keys that would sound 'out of tune' in meantone and the protection Froberger gave them by trying to prevent people from accessing these works could indicate that he was aware of the problems involved.

Aim of the Research

The aim of this research project is to highlight issues to consider when performing works by Froberger with a particular emphasis on the way the instrument is tuned. It examines selected works taking into account the context in which the notes that lie beyond the normal disposition of quarter-comma meantone appear and suggest ways to adjust the tuning to play his works.

As mentioned earlier, many scholars refer to Froberger as a composer who used circular temperaments. In his article in the *Grove Music Online* on 'Temperaments', Mark Lindley states that Froberger used equal temperament (Lindley 2001). Christopher Stenbridge, in his article 'Music for the Cimbalo Cromatico and Other Split-Keyed Instruments in Seventeenth-Century Italy', also states that the 'liberal use of sharps in Froberger's organ pieces from 1649 onwards would ... suggest tempered thirds' (Stenbridge 1992, 23). More specifically, Froberger uses notes such as $D\flat$, $D\sharp$, $A\flat$, $A\sharp$, $E\sharp$ and $B\sharp$ in his earlier works, notes not normally available in the normal disposition of quarter-comma meantone, and it would be easy to conclude that he intended some sort of a circular temperament for his works. However, when each case is examined separately, it is evident that Froberger was both careful and skilful, and uses these notes effectively with minimum adjustments necessary to the way the instrument is tuned. It

is perhaps the necessity to tune the harpsichord in different ways for various works that made him reluctant to make his works freely available.

A number of Froberger's works bear descriptive titles. Some of them are works written to commemorate the lives of his patrons or friends, while others describe events such as being robbed or someone falling into a river. As it will be revealed, he sometimes uses notes beyond the normal disposition of quarter-comma meantone to create tension and intensity. In these cases, it is perhaps appropriate to leave them as their dissonant sounds would enhance the effect. One such example is in his *Allemande faite en passant le Rhin dans une barque en grand peril*, FbWV 627, in which Froberger portrays a detailed account of someone falling into the Rhine. The work is in E minor, and he appears to use *D#s* at tense moments in the story. This will be discussed in more detail in Chapter III.

At the same time, there is a fine balance between using wolf notes as an expressive device and them becoming a distraction. For example, using a number of wolf notes in close succession would result in disturbing the harmonic structure and could result in weakening the overall shape of the passage. For the same reason, wolf notes do not function well as bass notes either, as the stability of the chords are disturbed. It is always important to examine the context on a case by case basis.

Additionally, performers today sometimes decide on the temperament to use in their performance fairly late in the process of preparation. They are also often chosen merely by examining the notes present, without giving careful thought to the context surrounding them. There is scope for the characteristics of different tunings to stimulate interpretation, and the study of such to be more integrated into the preparation. This can potentially provide more insight into the works.

Current State of Research

Two theses which come close to the current research project are Joseph Victor Pollard's 'Tuning and Temperament in Southern Germany to the End of the Seventeenth Century' (1985) and Edmundo Pacheco Hora's '*As obras de Froberger no contexto do temperamento mesotonico*' (Works of Froberger in the Context of Meantone Tuning) (2004). Hora concludes that Froberger had a circular temperament in mind for at least some of his works. Pollard looks at the primary sources and discusses various temperaments from the period. He also looks at Froberger's music and analyses pitches contained within, in a mathematical way. He concludes that various forms of meantone temperament are the most appropriate for his music, provided that the performer is allowed to apply the 'sideways shift'.⁴ Although a vast amount of information has been included, the discussion of the context in which these notes appear could be taken much further. One particular area missed by the method employed by Pollard is the dissonances created by notes that fall within the 12 notes available in quarter-comma meantone but combined in such a way to create wolf intervals. For example, composers sometimes use *G#* and *C* which are part of the 12 notes available, but combined together, they make an interval of a diminished fourth which would sound like the wolf even though it is in tune as a diminished fourth. Pollard's method does not pick up the use of these intervals, which is one of the devices Froberger uses as part of his harmonic language.

A vast amount of literature exists on the subject of temperament. One important book, though now quite old, is J. Murray Barbour's *Tuning and Temperament: A Historical Survey* (1972). Charles A. Padgham's *The Well-Tempered Organ* (1986) is

⁴ The 'sideways shift' is a term Pollard gave an exercise of moving the wolf fifth about, according to the necessary pitches in each piece. For example, if *D#* is required but no *E♭*, the wolf could be placed between the *D#* and the *B♭*; if *E♭* is needed but not *D#*, the wolf can be placed between *G#* and *E♭*.

often used by harpsichord tuners today as it contains useful information about the main historical temperaments. A more recent publication *Unequal Temperaments: Theory, History and Practice* by Claudio Di Veroli provides a comprehensive guide to performers and scholars alike and is one of the most important reference books on the subject today.

Three articles written by Christopher Stenbridge and Denzil Wraight in the 1990s, 'Music for *Cimbalo Cromatico* and Other Split-Keyed Instruments in Seventeenth Century Italy' (1992), 'The *Cimbalo Cromatico* and Other Italian Keyboard Instruments with Nineteen or More Divisions to the Octave (Surviving Specimens and Documentary Evidence)' (1993), and 'Italian Split-Keyed Instruments with Fewer than Nineteen Divisions to the Octave' (1994) give detailed information about instruments and music for keyboards with more than 12 divisions to the octave. More recently, Ibo Ortgies's article from 2003, 'Subsemitones in Organs Built Between 1468 and 1721' as well as Eleanor Smith's dissertation, 'A Discussion of the Use of Divided-Accidental Keys in Italian Strung-Keyboard Instruments pre-1700' completed in 2008 also deal with the subject, and a comprehensive book by Patricio Barbieri, *Enharmonic Instruments and Music 1470-1900* was published also in 2008. Much of Barbieri's work was originally in Italian, and he quotes from numerous sources of the period. A list of instruments accompanies Ortgies's and Smith's documents, and an up-to-date list compiled by Wraight is also available to download from his website.⁵ In addition, information about instruments with more than 12 notes to the octave can also be found in important books about harpsichords in general. These include *The Harpsichord and Clavichord* (1973) by Raymond Russell, *Makers of the Harpsichord and Clavichord*

⁵ The version currently available (most recently accessed on the 15th April 2015) is a version dated the 24th November 2010. (<http://www.denzilwraight.com/download.htm>)

1440-1840 (1995) by Donald H. Boalch and *A History of the Harpsichord* (2003) by Edward L. Kottick.

Unfortunately, no theoretical work exists by Froberger himself. The literature on Froberger is found in journal articles, a chapter in a book of collected essays, and theses. Avo Somer's dissertation, 'The Keyboard Music of Johann Jakob Froberger' (1962) was the first comprehensive survey of his works written in English, and though now more than 50 years old, remains the most substantial work on Froberger's music to date. It approaches the repertoire from a compositional and historical viewpoint. New sources have been found which have led to the discovery of wrongly attributed works and previously unknown works. Other theses include Howard Schott's dissertation 'A Critical Edition of the Works of J.J. Froberger' (1977), which led to the publication of the complete works of Froberger by Heugel; 'The Toccatas of Johann Jakob Froberger: A Study of Style and Aspects of Organ Performance' by James Walter Kosnik (1979); 'An Analytical Study of Selected Toccatas of Johann Jakob Froberger: Some Possible Insights into Problems of Performance Practice' (1976) by Edith Henry Kilbuck; 'Performance Practice of the Keyboard Music of Johann Jacob Froberger' (1992) by Terence John Norman and a study of the sources for the toccatas by Akira Ishii in his thesis 'The Toccatas and Contrapuntal Keyboard Works of Johann Jacob Froberger: A Study of the Principal Sources' (1999).

Editions and Sources for Froberger's Works

There are numerous sources available for Froberger's works. The most important and authoritative of these are the three autograph volumes held at the Austrian National Library (Österreichische Nationalbibliothek) in Vienna (Mus. Hs. 18706, 18707 and 16560). 'Libro Secondo' (II, 1649) and 'Libro Quarto' (IV, 1656) are dedicated to the

Emperor Ferdinand III, and 'Libro di capricci e ricercati' (c.1658) to his successor, Leopold I.⁶ 'Libro Secondo' and 'Libro Quarto' are considered to be 'among the most handsome copies ever produced by a composer of his own works.' (Hill 1988, vi) Unfortunately, 'Libro Primo' and 'Libro Terzo' have not survived.⁷

All the volumes have been marked with the Latin words 'm pria' (*manu propria*) which indicates that it was written out by the composer.⁸ Robert Hill examines the authenticity of these volumes in the introduction to the facsimile edition published in 1988, and comes to the conclusion that they had been either written out by the composer himself or by a copyist working closely under his supervision (Hill 1988, vi). Other musicians have also recognised the importance of these three volumes. Richard Egarr, in his notes to his recording, states: 'I have used the three autographs alone for those pieces contained therein, as I consider them of absolute value.' (Egarr 1994, 9)

Froberger's works have also been passed down in many other copied sources which vary in importance. Some 60 sources have been used in the preparation of the New Froberger Edition edited by Siegbert Rampe. Several new sources have been discovered in the last 20 years alone, and Volume I, which was originally published in 1993, already had two revisions by 2008.⁹

In 1999, a source that once belonged to the archives of Berlin Sing-Akademie, known by its catalogue number SA 4450, was found in Kiev. It is not in the composer's own hand, and contains toccatas and suites as well as two single-movement works with programmatic titles. Many of the opening movements of the suites also bear descriptive

⁶ For a detailed description of the three volumes, see the Introduction to the facsimile edition by Robert Hill (1988).

⁷ The title page of 'Libro di capricci e ricercati' has 'Libro Terzo' written on it. However, it has been established that this is a late addition and the true 'Libro Terzo' appears to have been lost (Hill 1988, vi).

⁸ The '*manu propria*' marking in itself is not enough to prove it being written out by the composer. In some later collections of his music, for example in the Bauyn manuscript, the copyist did not seem to realise the meaning of the '*manu propria*' marking, and blindly copied it out. However, in the case of the Viennese manuscripts, it has been established that these markings are genuine.

⁹ For detailed information on the sources used in each of the volumes for the New Froberger edition, see the Preface to each volume.

titles. The discovery of this manuscript is significant because it contains some new information which helps to enrich the understanding of his works. For example, the work to which the title *Allemande, faite en passant le Rhin, dans une barque en grand peril* was given has been finally identified as the opening movement of the Suite in E minor, FbWV 627. Scholars previously suspected that the title belonged to the Suite in E♭ major, FbWV 631.¹⁰

SA 4450 also contains a different version of some previously known works. The most notable is the *Tombeau de Monsieur de Blancrocher*, FbWV 632a, in which there is an extended written-out trill towards the end of the work which is absent in the previously-known version.

Peter Wollny, the editor of Barenreiter's facsimile edition of SA 4450, considers this manuscript to be very important:

SA4450 advances to the top of the list of sources for all works not found in Froberger's four [sic] Viennese autographs, even surpassing in accuracy such first-rate sources as the Bulyowsky MS and Ms. XIV 743 from the Minoritenkonvent in Vienna. (Wollny 2006, XIX)¹¹

He also comments that 'its lavish leather binding, the superior quality of its paper, and the meticulous handwriting of its otherwise unknown copyist set it apart from the usually plain and utilitarian manuscripts from that time' (Wollny 2006, XVII). For these reasons this study will focus mainly on works included in the three Viennese autographs and manuscript SA 4450.

Another exciting source which has been discovered recently, is the manuscript which was auctioned at Sotheby's in London in November 2006 but unfortunately

¹⁰ For example in Volume IV.1 of Rampe's edition of Froberger's works (Rampe 2003, 18).

¹¹ For a detailed description of the volumes, see Wollny.

cannot be included in the present study. It contains 20 works in total, 15 of which have been unknown until now.¹² The works have been signed 'm pria' (*manu propria*) and the source is believed to be an autograph, although it is not believed to be either of the missing 'Libro Primo' or 'Libro Terzo' (Maguire 2006, 5). This source is significant because 'none of the pieces in this manuscript exist in autograph elsewhere.' (Maguire 2006, 7). It is also believed that it dates from the last years of the composer's life, and cannot have been compiled before 1662 as there is a *Tombeau* on the death of Leopold Friderich of Württemberg, husband of Duchess Sibylla, who died in 1662.

The previously-known works are six fantasies, six caprices, a suite in F major, a *Meditation* and a *Tombeau* and five other pieces. The current whereabouts of the volume is not publicly known, and Sotheby's is unable to reveal the current or the previous owner(s). In the auction catalogue, parts of the *Meditation* in D major, the end of the *Lamentation* FbWV 633, the beginning of an unknown *Meditation*, and the end of a piece written in open score which appears to end on an E major chord are included. If the manuscript is made accessible, it is expected not only to increase Froberger's publicly-known output by a significant number of pieces but also to provide more reliable readings for the works that are already published.

In terms of modern publications, there are three main editions published over the last 60 years. Guido Adler's *Denkmäler der Tonkunst in Österreich* (DTO) was the first comprehensive edition of Froberger's works and was published in 1959. It contains all of Froberger's works that were known at the time. Later research has revealed that some works were misattributed, repeated, or omitted. The edition by Howard Schott was published in 1977 by Heugel. This was divided into four volumes, Tomes 1 and 2, each

¹² The catalogue claims to have 18 hitherto unknown works, but there appears to be just 15.

containing two volumes. Tome 1 contains the three Austrian autographs and Tome 2 contains the remaining pieces which are passed down only in the copied sources.

Barenreiter's New Froberger Edition edited by Siegbert Rampe, which is yet to be completed, will have seven volumes in total. Volumes I and II contain works included in the three Austrian autographs, and Volumes III, IV and V are divided into two books each and contain works from various copied sources. Volume VI is also divided into two books and contains a modern edition of the SA 4450, and Volume VII will contain two vocal motets, the only non-keyboard works known to have been written by the composer, and a thematic catalogue of all of his works. Rampe's edition adopt a numbering system using FbWV (Froberger-Werke-Verzeichnis) numbers which makes identification of the works clearer.

In addition, there is a facsimile edition of the SA 4450 accompanied by a modern transcription edited by Peter Wollny. The publication of two modern transcriptions of the same manuscript by two different editors from the same publisher seems surprising, and they seem to follow different editorial policies.

While Wollny's edition provides invaluable information with the inclusion of the facsimile of SA 4450, he has modernised the way accidentals are applied in his transcription. Instead of the accidentals being applied to each note as it was the practice at the time of Froberger, they stay effective for the whole bar. He has also added some editorial accidentals without comment, some of which affect the present study. Barline arrangements have also been modernised and so his transcriptions contain many more barlines than the original.

On the other hand, although Rampe's edition is not free from minor errors, he has preserved the old practice of adding accidentals to individual notes, which makes it easier for readers to identify what was contained in the original source. He also

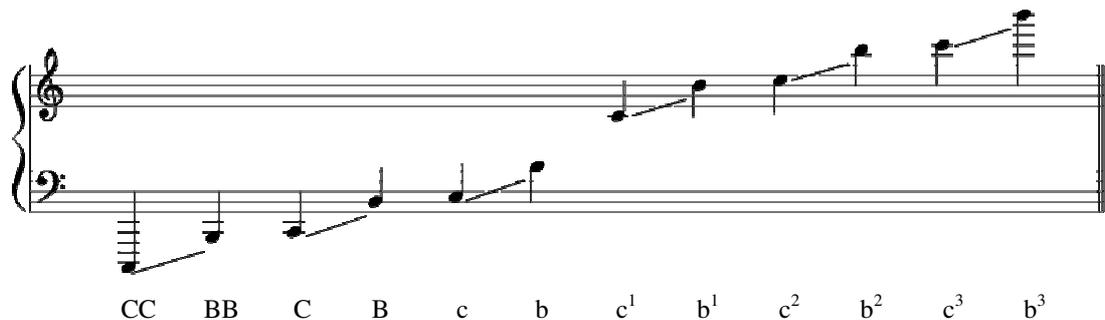
preserves the original barlines. Rampe claims that he had no access to SA 4450 when he was preparing volumes III and IV, hence a separate volume needed to be issued to cover information contained in this source (Rampe 2010, XV).

When references are made to various sources in this study, the same abbreviations as those used in Rampe's New Froberger Edition have been employed. It is beyond the scope of this study to include an examination of all the sources used for the edition. However, the facsimile editions of the Viennese autographs as well as SA 4450 are invaluable.

Pitch Notation

The pitches referred to in this study are based on the Helmholtz notation widely used today. Figure 1 shows a musical representation of the pitches, and how they are referred to in the body of the text. Non-specific pitches are in capital letters italicised.

Figure 1: Pitch notation



Summary

This study is divided into three chapters. Chapter I discusses the main historical temperaments known in the Baroque period, including quarter-comma meantone, sixth-comma meantone as well as selected circular temperaments such as Werckmeister III, Kirnberger III, Vallotti and the French Tempérament Ordinaire. Although the main

focus of this study is on meantone temperaments, discussion about later temperaments are also included so that a greater understanding of the subject of temperaments can help to put earlier temperaments into perspective.

Chapter II discusses instruments from the sixteenth and seventeenth centuries, with particular emphasis on instruments with divided keys. When meantone temperament was prevalent, musicians were restricted to having 12 notes to the octave. They then experimented with providing enharmonic alternatives by dividing certain accidentals. There were also many experiments made with different ways to divide the octave.

Chapter III comprises case studies of Froberger's music, analysing in detail the context in which notes which lie beyond the normal disposition of quarter-comma meantone appear. It takes into account harmonic and rhythmic structures, note values and pitch as well as considering whether extra-musical stimuli affect Froberger's use of notes outside the normal boundaries of meantone tuning.

The objective of the present study is to produce an informative document that performers can consult when preparing to play Froberger's music, especially in terms of the ways to tune the harpsichord. It is hoped that this study will contribute to a deeper understanding of Froberger's musical language, and that present methods of research can be applied to the music of other composers.

CHAPTER I

Temperament

This chapter provides an overview of historical temperaments. It explains why temperaments are necessary and looks at the ways musicians divided the octave in the past. It also discusses the historical background, as well as the physical characteristics and the context in which each temperament was devised.

Until relatively recently when equal temperament became the norm,¹ musicians constantly experimented with different ways to divide the octave, since it is not possible to divide it in such a way that allowed all intervals to be pure. In a circle of fifths starting on *C*, the last note which completes the circle is *B#* and should be an enharmonic of *C* for it to be useful: *C-G-D-A-E-B-F#-C#-G#-D#-A#-E#-B#*. However, if all the fifths are tuned pure, there is a discrepancy between this *B#* and the *C* on which the circle started. This is called the 'Pythagorean comma', and can be calculated as follows:

Since a pure fifth ($3/2$) is 701.96 cents,² it needs to be multiplied by 12 in order to calculate the pitch of the *B#* in cents ($701.96 \times 12 = 8423.52$ cents). Seven octaves (8400 cents) would then need to be taken away from this number in order to work out the discrepancy ($8423.52 - 8400 = 23.52$ cents).

This shows that a scale cannot be produced by using only pure intervals. Additionally, when all fifths are tuned pure, the resulting thirds are 21.53 cents wider than pure. If the

¹ Although the use of equal temperament has been talked about since the sixteenth century, it was not widely used until at least the nineteenth century and seems to have been limited for use on fretted instruments including the lute and the instruments of the viol family (Cyr 1992, 66; Rowland 2001, 40; Pollard 1985, 89). Equal temperament was also disapproved by many musicians in the seventeenth and eighteenth centuries (Cyr 1992, 67).

² Cents are used to measure the size of an interval. A.J. Ellis is credited with devising the idea of cents as a unit for measuring intervals around 1880 (Lindley, Campbell and Greated, 2001). An equal-temperament semitone is 100 cents and therefore an octave is 1200 cents.

circle begins on *C* and each fifth is tuned pure, the resulting third between *C* and *E* is calculated as follows:

There are four fifths between the notes *C* and *E* (*C-G-D-A-E*). Therefore, 701.96 needs to be multiplied by 4 which gives 2807.84 cents ($701.96 \times 4 = 2807.84$ cents), from which two octaves are taken away ($2807.84 - 2400 = 407.84$ cents). Since a pure third is 386.31 cents, this is 21.53 cents wider than pure ($407.84 - 386.31 = 21.53$ cents). This is called the 'syntonic comma'.

The following table gives pure intervals in cents.

Table 1. List of pure intervals in cents

Interval	Number of cents when pure	Ratio
Chromatic/Diatonic semitone	70.67 // 111.73	25/24 // 16/15
Major Tone	203.91	9/8
Minor Third	315.64	6/5
Major Third	386.31	5/4
Fourth	498.04	4/3
Augmented Fourth	590.22	45/32
Fifth	701.96	3/2
Minor Sixth	813.69	8/5
Major Sixth	884.36	5/3
Minor Seventh	996.09	16/9
Major Seventh	1088.27	15/8
Octave	1200	2/1

During the sixteenth, seventeenth and eighteenth centuries, theorists wrote about different ways to tune fixed-pitch keyboard instruments and to distribute the comma around the circle. According to the musical style of each period, musicians had a different set of priorities. During medieval times, music required pure fifths, but this meant that the thirds were not pure, whereas by the Renaissance, they needed more stable and harmonious thirds (Silbiger 2004, 374).

Temperaments can be divided into three categories: those consisting of as many

pure intervals as possible, such as the Pythagorean tuning;³ those in which all the fifths are tempered equally, known as regular (non-circular) temperament; and those in which the fifths are tempered to a varying degree throughout the circle of fifths known as irregular (circular) temperaments.

Regular Temperaments

1. Meantone Temperaments

Meantone temperament is defined as a method of tuning in which a major third is divided into two tones of the same size (Lindley 2001). There are a number of variants including quarter, fifth and sixth-comma meantone. Many scholars credit the Italian theorist Pietro Aaron as the first to describe the quarter-comma meantone in 1523.⁴ In this temperament, all the fifths are tempered by a quarter of the syntonic comma, i.e. 5.38 cents, in order to achieve pure major thirds, which are 21.53 cents too wide when fifths are tuned pure.⁵ As a result, this temperament has many pure major thirds, but the tempering of a quarter of a comma throughout the circle results in over-compensating the comma, leaving one fifth very wide and not useable. This is known as the 'wolf'. All meantone temperaments are characterized by having the wolf making some of the intervals unusable.⁶ There are also two different sizes of the semitone in this temperament, chromatic and diatonic. Track 1 on the accompanying CD demonstrates the wolf interval $E\flat-G\sharp$, and Track 2 is a chromatic scale played in quarter-comma

³ Strictly speaking, these do not classify as 'temperaments', since nothing in them is tempered.

⁴ Writers claim Aaron's description is rather vague. Some writers including Montague believe Zarlino's writing in 1571 to be the first accurate description of quarter-comma meantone. The most detailed description is given by Michael Praetorius (1571-1621) in his *Syntagma Musicum* in 1619 (Cyr 1992, 66; Pollard 1985, 57; Praetorius 1619).

⁵ If one were to achieve a pure third in this set-up, then one would need to distribute 21.53 cents among the four fifths within it. Therefore, if each fifth is tuned 5.38 cents narrow (i.e. $21.53 \div 4$) one can achieve a pure third.

⁶ The wolf fifth is typically between the $G\sharp$ and $E\flat$ and in quarter-comma meantone is calculated as 35.66 cents. It is also possible to shift the location of the wolf to accommodate the needs of a specific piece as would be discussed later in this dissertation.

meantone.

In meantone temperaments, the purity of the intervals in the keys that are usable is equal. Table 2 examines the purity of the triads by showing deviations from the pure intervals in cents. For simplicity, the Pythagorean comma is rounded up to 24 cents and therefore a quarter of a comma is here 6 cents. Numbers along the ‘Tempering of fifths’ row show how much the fifths are tempered for each of the fifths, and the numbers on the lower two rows indicate the deviation from the pure major and minor thirds. Negative numbers indicate that the interval is narrower than pure, and positive numbers wider than pure.

Table 2. Quality of triads in quarter-comma meantone

¼ comma MT	E \flat	B \flat	F	C	G	D	A	E	B	F \sharp	C \sharp	G \sharp
Tempering of 5ths (cents)	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	+36
Tempering of major 3rds (cents)	0	0	0	0	0	0	0	0	41	41	41	41
Tempering of minor 3rds (cents)	-46	-46	-46	-5	-5	-5	-5	-5	-5	-5	-5	-5

As the table indicates, triads in the major keys of *C, G, D, A, E, F, B \flat* and *E \flat* all have a pure major third and the intonation is excellent. On the other hand, the remaining triads on *B, F \sharp , C \sharp* and *G \sharp* all have a third that is too wide and so are not satisfactory to serve as harmonious major chords.

A milder version of the meantone tuning is the sixth-comma meantone in which the fifths are tempered by a sixth of the comma. There seems to be disagreement among writers on which comma this is, however. The problem may stem from theorists of the past. Georg Andreas Sorge (1703-1778) did not distinguish between the syntonic and Pythagorean commas in his writings and some writers today use the sixth of the syntonic comma, while others use the sixth of the Pythagorean comma for this

temperament.⁷ From a practical point of view, the difference is hardly perceptible, and this would not affect the results in the present study. In addition, as the sixth comma meantone does not contain any pure intervals, it is not easy to tune accurately by ear.⁸ For the purpose of this study, therefore, the Pythagorean comma has been used, which agrees with Padgham's publication (1986). Table 3 shows the calculations.

In sixth-comma meantone, the wolf is less pronounced. There are eight good major triads and four unusable ones, although they are not as unpleasant as in quarter-comma meantone. This temperament is sometimes known as Silbermann's temperament after Gottfried Silbermann (1683-1753) who was a German organ builder, and J. S. Bach is known to have played on Silbermann's organs most likely tuned in Silbermann's temperament (Padgham 1986, 58). Track 3 demonstrates the wolf interval $E\flat-G\sharp$ and Track 4 is a chromatic scale played in sixth-comma meantone.

Table 3. Quality of triads in sixth-comma meantone

1/6 comma MT	E \flat	B \flat	F	C	G	D	A	E	B	F \sharp	C \sharp	G \sharp
Tempering of 5ths (cents)	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	+20
Tempering of major 3rds (cents)	6	6	6	6	6	6	6	6	29	29	29	29
Tempering of minor 3rds (cents)	-33	-33	-33	-10	-10	-10	-10	-10	-10	-10	-10	-10

There are other variants of meantone tuning, including 1/3 comma meantone by the Spanish theorist Francisco de Salinas (1513-1590), 2/7 comma meantone by the Italian Gioseffo Zarlino (1517-1590), as well as the fifth comma meantone (Lindley 2001; Padgham 1986, 58; Pollard 1985, 66).

Although not many theorists comment on this, and the only known reference to this practice from the period is mentioned by Giovanni Paolo Cima (1570-1622) in the

⁷ Padgham's description uses the Pythagorean comma (Padgham 1986, 60) while Di Veroli's use the syntonic comma (Di Veroli 2009, 75).

⁸ The author is grateful to Dominic Eckersley for pointing this out.

appendix to his *Ricercari & Canzoni alla francese* published in 1606 (Lindley 2001; Rayner 1969), it can probably be assumed that harpsichordists shifted the wolf as necessary. Pollard also comments:

There can be little doubt that, because of the advantages it offered in extending the note vocabulary flatwards or sharpwards, and the consequences if it were not practised, retuning to accommodate a sideways shift was an accepted expedient for the harpsichord. (Pollard 1985, 126)

As will be shown in Chapter II, this is supported further by the existence of more organs than harpsichords with split keys. Since retuning is much harder on the organ, they needed split keys more than harpsichords to accommodate a wider range of keys. It is assumed that harpsichords were simply retuned as necessary.

2. Equal Temperament

Interestingly, equal temperament also belongs to the category of regular temperaments as the tempering of the fifths around the circle of fifths in this temperament is completely equal. Although the use of equal temperament has been talked about since the sixteenth century, and fretted instruments including the lute and the instruments of the viol family seemed to adopt it fairly early, it was not widely used until at least the nineteenth century (Cyr 1992, 66; Pollard 1985, 89; Rowland 2001, 40). Equal temperament was also disapproved by many musicians throughout history, including Kirnberger and Francois Couperin, (Cyr 1992, 67; Lindley 2001; Kirnberger 1776-1779), but Frescobaldi with whom Froberger spent a period of time studying, is often considered to have been a supporter of equal temperament (Cyr 1992, 66), although Frederick Hammond in his book *Girolamo Frescobaldi* claims that there is no evidence to suggest that Frescobaldi was an advocate of equal temperament (Hammond 1983,

107).⁹

In equal temperament, an octave is divided into twelve equal semitones, and each fifth is tempered by 1/12 of the Pythagorean comma. It is a versatile temperament, and suits today's musical environment since it allows complete freedom in modulation. In this temperament, no interval is pure, but they are consistent, making all of the keys similar. It is, however, not wise to tune harpsichords in equal temperament. Ann Bond in *A Guide to the Harpsichord* explains:

Equal temperament ... does not produce a good sonority on the harpsichord. The rich harmonics of harpsichord sound derive much of their strength from the sympathetic resonance of nearby strings with which they share simple frequency-relationships; if there are no pure intervals, this reinforcement cannot take place. (Bond 2001, 227)

Table 4. Quality of triads in equal temperament

Equal Temp	E \flat	B \flat	F	C	G	D	A	E	B	F \sharp	C \sharp	G \sharp
Tempering of 5ths (cents)	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Tempering of major 3rds (cents)	14	14	14	14	14	14	14	14	14	14	14	14
Tempering of minor 3rds (cents)	-16	-16	-16	-16	-16	-16	-16	-16	-16	-16	-16	-16

Table 4 shows the quality of triads in equal temperament. For the keys of up to two sharps or two flats, equal temperament has, by far, furthest-from-pure intonation out of all the temperaments discussed in this chapter. For major keys with many sharps or flats, such as *F \sharp /G \flat* , *C \sharp /D \flat* and *G \sharp /A \flat* , the intonation is much better, however. Mersenne in 1636 compares equal and meantone temperaments and concludes that 'meantone's strength is the purity of its intervals, whereas equal temperament could provide a much needed standard of pitch.' (Pollard 1985, 141)

⁹ Doni is often cited as having claimed that Frescobaldi was an advocate.

Irregular Temperaments

Irregular temperaments include those suggested by Werckmeister, Kirnberger and Vallotti, all of which are popular temperaments among performers of Baroque music today. Unlike meantone temperaments, these have no unusable key, allowing more freedom in modulation. Since tempering is not consistent throughout the circle, each key has its distinctive characteristics. These temperaments started developing not only because meantone temperaments has unusable keys, but also because there was no distinction in usable triads. Blood comments:

For writers like Werckmeister (1645-1706), Johann George Neidhardt (1685-1759), and Francesco Vallotti (1697-1780), a good temperament was one whose circle of fifths was closed (wolf-free) and thus playable through all the keys, and whose major and minor intervals [thirds and sixths] varied in size systematically: in order to favour the more common scales and triads, the most heavily tempered of these intervals were placed in keys with the greatest number of sharps or flats, and the purest in those with the least. The effect of this irregular construction is quite striking; it enlivens the harmony and emphasizes modulation by contrasting key qualities. (Blood 1979, 491)

The idea of key characteristics originate from the time when circular temperaments became popular, and it was one of the most fascinating and discussed topics.

1. Werckmeister III

Andreas Werckmeister (1645-1706) was a German theorist and composer, as well as organist and organ examiner. He is remembered particularly for his temperament dating from 1691 which is today referred to as Werckmeister III (Padgham 1986, 62). In this

temperament, four of the fifths, namely *C-G*, *G-D*, *D-A* and *B-F#*, are tempered by a quarter of the Pythagorean comma while the remaining fifths are tuned pure. As a result, none of the thirds are pure in this temperament, but the best thirds lie between *C-E* and *F-A*. Since it is an irregular temperament, the quality of intonation varies according to the triad, and it has good intonation in the keys of C and F major, and Pythagorean thirds in the keys of G#, C# and F# major. Table 5 shows the quality of the triads in Werckmeister III.

Table 5. Quality of triads in Werckmeister III

Werckmeister III	E \flat	B \flat	F	C	G	D	A	E	B	F#	C#	G#
Tempering of 5ths (cents)	0	0	0	-6	-6	-6	0	0	-6	0	0	0
Tempering of major 3rds (cents)	16	10	4	4	10	10	16	16	16	22	22	22
Tempering of minor 3rds (cents)	-22	-22	-22	-22	-16	-10	-4	-10	-16	-16	-16	-16

According to Charles Padgham, a surprisingly large number of organs in the UK were tuned in this temperament at the time of the publication of his book, *The Well-Tempered Organ* (1986). In it, he provides a list of organs tuned in unequal temperaments, and Werckmeister III features frequently on this list. Other temperaments that appear on the list include various types of meantone temperaments, with some organs tuned in quarter-comma meantone.

2. Kirnberger III

Johann Philipp Kirnberger (1721-1783) was a pupil of J.S. Bach. For this reason, some considered it possible that one of his temperaments was favoured by Bach, but this idea is no longer popular as J.S. Bach allegedly taught Kirnberger to tune all thirds wider than pure, and none of the Kirnberger temperaments satisfy this criteria (Padgham 1986, 40).

Kirnberger proposed a few temperaments, the third of which was devised in

1779 and is the best-known. Interestingly, all his temperaments result in having the interval *C-E* pure, and in Kirnberger III this results from tempering the fifths within it exactly as in quarter-comma meantone. As a result, the sonorities in the keys with few sharps and flats resemble that in meantone temperament. Kirnberger appears to have had a strong preference for a pure major third which is reflected in his temperaments and also in his disapproval of equal temperament (Cyr 1992, 67).

As a person, he was said to have been ‘emotional and ill-tempered, but dedicated to the highest musical standards.’ He also needed others to present his ideas in a coherent way since ‘although his musical knowledge was wide and profound, it was, according to his contemporaries, disorganised. He found it so difficult to express his ideas in writing that he had to call on others to edit or even rewrite his theoretical works.’ (Serwer 2001)

In this temperament, the fifths *C-G*, *G-D*, *D-A*, *A-E* are tempered exactly as in quarter-comma meantone, each narrowed by a quarter of the syntonic comma. It has very good intonation in keys with few sharps and flats and has wide-ranging key flavours from a pure major third on the C major triad to Pythagorean major thirds on C# and G# major chords. The quality of the triads in Kirnberger III is shown in Table 6.

Table 6. Quality of triads in Kirnberger III

Kirnberger III	E \flat	B \flat	F	C	G	D	A	E	B	F \sharp	C \sharp	G \sharp
Tempering of 5ths (cents)	0	0	0	-5	-5	-5	-5	0	0	-2	0	0
Tempering of major 3rds (cents)	16	11	5	0	5	11	14	20	20	20	22	22
Tempering of minor 3rds (cents)	-20	-22	-22	-22	-22	-22	-11	0	0	-11	-20	-20

3. Vallotti (c. 1730), Neidhardt I, and Barnes

Francesco Antonio Vallotti (1697-1780) was an Italian theorist and composer. This temperament is probably the most popular and widely used of the historical

temperaments today. It is also the only temperament which has a completely symmetrical structure in the quality of the thirds. Major thirds on *F*, *C* and *G* are equally in tune, and *D-F#* is just as in tune as *Bb-D*, *A-C#* as *Eb-G* and so on. This neat design probably also contributed to its becoming the most popular temperament in Baroque performance today. In this temperament, six fifths, namely *F-C*, *C-G*, *G-D*, *D-A*, *A-E* and *E-B*, are tempered by a sixth of the Pythagorean comma while the rest of the fifths are left pure. Table 7 summarises the quality of the triads in Vallotti.

Table 7. Quality of triads in Vallotti

Vallotti	E \flat	B \flat	F	C	G	D	A	E	B	F#	C#	G#
Tempering of 5ths (cents)	0	0	-4	-4	-4	-4	-4	-4	0	0	0	0
Tempering of major 3rds (cents)	14	10	6	6	6	10	14	18	22	22	22	18
Tempering of minor 3rds (cents)	-22	-22	-22	-18	-14	-10	-10	-10	-10	-14	-18	-22

There are a number of variants to this temperament that theorists have suggested, including a temperament suggested by Johann Georg Neidhardt (1685-1739). An exact contemporary of J.S. Bach, Neidhardt's temperament is a step closer to equal temperament and the only temperament other than equal temperament itself to employ the 1/12 comma tempering. This makes the keys with many sharps and flats, in particular F# and C# major triads, better than any other temperaments discussed here apart from equal temperament, although the purity of the keys with fewer sharps and flats is not as good. Table 8 shows the quality of the triads in Neidhardt I.

Table 8. Quality of triads in Neidhardt I

Neidhardt I	E \flat	B \flat	F	C	G	D	A	E	B	F#	C#	G#
Tempering of 5ths (cents)	-2	0	0	-4	-4	-4	-4	-2	-2	0	0	-2
Tempering of major 3rds (cents)	16	14	10	6	8	10	14	18	18	18	18	18
Tempering of minor 3rds (cents)	-20	-18	-18	-20	-18	-14	-10	-10	-12	-14	-18	-20

A temperament proposed by John Barnes (1979) is also worth a mention. In his article, 'Bach's keyboard temperament: Internal evidence from the *Well-Tempered Clavier*', he examines Bach's Well-Tempered Clavier by assessing the occurrence of major thirds and convincingly shows that Bach may have intended it to be played with a temperament similar to Werckmeister III. He also suggests a temperament of his own, which he claims better suits his data from the analysis of the 'internal evidence'. The new temperament looks very much like the one suggested by Vallotti.

The only difference between Barnes's and Vallotti's temperaments is that the fifth *A-E* is tuned pure and instead the fifth *B-F#* is tempered by the sixth of the Pythagorean comma. This is somewhat similar to the arrangement in Werckmeister III and the resulting temperament is somewhat in between Werckmeister and Vallotti. Table 9 shows the quality of the triads in Barnes's temperament.

Table 9. Quality of triads in Barnes

Barnes	E \flat	B \flat	F	C	G	D	A	E	B	F#	C#	G#
Tempering of 5ths (cents)	0	0	-4	-4	-4	-4	-4	0	-4	0	0	0
Tempering of major 3rds (cents)	14	10	6	6	10	10	14	18	18	22	22	18
Tempering of minor 3rds (cents)	-22	-22	-22	-18	-14	-10	-10	-10	-14	-14	-18	-18

4. French Tempérament Ordinaire

Tempérament ordinaire is a term used by theorists in France during the seventeenth and eighteenth centuries to describe a temperament they considered the 'usual' temperament. It is therefore not a term to describe a specific temperament. In the middle of the seventeenth century, Jean Denis described a temperament in his *Traité de l'accord de l'espinette* (1643) which can be interpreted as quarter-comma meantone, although, as the tempering of the fifths is not specified, there are a few other temperaments which also fit the description. Denis's treatise was significant as it was the first French

keyboard treatise to be written by a practitioner specifically on keyboard performance practice. In 1691, Christiaan Huygens, in his 'Lettre touchant le cycle harmonique', described quarter-comma meantone as the norm (Huygens 1691).

During the eighteenth-century, *tempérament ordinaire* referred to circulating temperaments as described by Rameau (1726), d'Alembert (1752), Rousseau (1767) and Mercadier (1776).

The tables on the next few pages have been prepared to show the sizes of each interval in selected temperaments in more details. Each page consists of three tables: the top table shows the size of the intervals in cents in each temperament, with the lower note of the interval in question listed on the left hand side. Each interval is identified at the top as semitone, tone, minor third and so on, and the number directly underneath representing the number of cents in equal temperament of those intervals.

The next row directly beneath that with the *C* in the left column shows the basic structure of the scale in the given temperament. The rest of the figures in the first table are calculated by subtracting figures on the first row so that every interval can be analysed.

The middle table compares the sizes of each interval against that when the interval is pure and lists the difference in each case, i.e. the smaller the value, the closer it is to the pure interval. If the value is 0, the interval is pure. Likewise, the third table compares the sizes of each interval against those in equal temperament.

This chapter provided an overview of the historical temperaments. It looked at meantone temperaments which had been prevalent until the end of the seventeenth century, and discussed the modifications musicians made to them in the eighteenth-century. Irregular temperaments became the norm in the eighteenth century and this is when the idea of key characteristics started. The following chapter discusses how

musicians attempted to solve the problems associated with meantone temperaments with the use of divided accidentals.

Table 10. Detailed analysis of intervals in quarter-comma meantone

Quarter-comma meantone																									
Lower	Semitone	Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve			
Note	100	200		300		400		500		600		700		800		900		1000		1100		1200			
C	C#	76.06	D	193.16	Eb	310.32	E	386.32	F	503.48	F#	579.48	G	696.58	G#	772.64	A	889.74	Bb	1006.90	B	1082.90	C	1200	
C#	D	117.10	Eb	234.26	E	310.26	F	427.42	F#	503.42	G	620.52	G#	696.58	A	813.68	Bb	930.84	B	1006.84	C	1123.94	C#	1200	
D	Eb	117.16	E	193.16	F	310.32	F#	386.32	G	503.42	G#	579.48	A	696.58	Bb	813.74	B	889.74	C	1006.84	C#	1082.90	D	1200	
Eb	E	76.00	F	193.16	F#	269.16	G	386.26	G#	462.32	A	579.42	Bb	696.58	B	772.58	C	889.68	C#	965.74	D	1082.84	Eb	1200	
E	F	117.16	F#	193.16	G	310.26	G#	386.32	A	503.42	Bb	620.58	B	696.58	C	813.68	C#	889.74	D	1006.84	Eb	1124.00	E	1200	
F	F#	76.00	G	193.10	G#	269.16	A	386.26	Bb	503.42	B	579.42	C	696.52	C#	772.58	D	889.68	Eb	1006.84	E	1082.84	F	1200	
F#	G	117.10	G#	193.16	A	310.26	Bb	427.42	B	503.42	C	620.52	C#	696.58	D	813.68	Eb	930.84	E	1006.84	F	1124.00	F#	1200	
G	G#	76.06	A	193.16	Bb	310.32	B	386.32	C	503.42	C#	579.48	D	696.58	Eb	813.74	E	889.74	F	1006.90	F#	1082.90	G	1200	
G#	A	117.10	Bb	234.26	B	310.26	C	427.36	C#	503.42	D	620.52	Eb	737.68	E	813.68	F	930.84	F#	1006.84	G	1123.94	G#	1200	
A	Bb	117.16	B	193.16	C	310.26	C#	386.32	D	503.42	Eb	620.58	E	696.58	F	813.74	F#	889.74	G	1006.84	G#	1082.90	A	1200	
Bb	B	76.00	C	193.10	C#	269.16	D	386.26	Eb	503.42	E	579.42	F	696.58	F#	772.58	G	889.68	G#	965.74	A	1082.84	Bb	1200	
B	C	117.10	C#	193.16	D	310.26	Eb	427.42	E	503.42	F	620.58	F#	696.58	G	813.68	G#	889.74	A	1006.84	Bb	1124.00	B	1200	
Deviation from the pure interval																									
Lower	Semitone	Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve			
C	C#		D	Eb	-5.32	E	0.01	F	5.44	F#		G	-5.38	G#		A	5.38	Bb		B		C			
C#	D		Eb	E	-5.38	F	41.11	F#	5.38	G		G#	-5.38	A		Bb	46.48	B		C		C#			
D	Eb		E	F	-5.32	F#	0.01	G	5.38	G#		A	-5.38	Bb		B	5.38	C		C#		D			
Eb	E		F	F#	-46.48	G	-0.05	G#	-35.72	A		Bb	-5.38	B		C	5.32	C#		D		Eb			
E	F		F#	G	-5.38	G#	0.01	A	5.38	Bb		B	-5.38	C		C#	5.38	D		Eb		E			
F	F#		G	G#	-46.48	A	-0.05	Bb	5.38	B		C	-5.44	C#		D	5.32	Eb		E		F			
F#	G		G#	A	-5.38	Bb	41.11	B	5.38	C		C#	-5.38	D		Eb	46.48	E		F		F#			
G	G#		A	Bb	-5.32	B	0.01	C	5.38	C#		D	-5.38	Eb		E	5.38	F		F#		G			
G#	A		Bb	B	-5.38	C	41.05	C#	5.38	D		Eb	35.72	E		F	46.48	F#		G		G#			
A	Bb		B	C	-5.38	C#	0.01	D	5.38	Eb		E	-5.38	F		F#	5.38	G		G#		A			
Bb	B		C	C#	-46.48	D	-0.05	Eb	5.38	E		F	-5.38	F#		G	5.32	G#		A		Bb			
B	C		C#	D	-5.38	Eb	41.11	E	5.38	F		F#	-5.38	G		G#	5.38	A		Bb		B			
Deviation from Equal Temperament																									
Lower	Semitone	Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve			
C	C#	-23.94	D	-6.84	Eb	10.32	E	-13.68	F	3.48	F#	-20.52	G	-3.42	G#	-27.36	A	-10.26	Bb		6.9	B	-17.1	C	0
C#	D	17.1	Eb	34.26	E	10.26	F	27.42	F#	3.42	G	20.52	G#	-3.42	A	13.68	Bb	30.84	B		6.84	C	23.94	C#	0
D	Eb	17.16	E	-6.84	F	10.32	F#	-13.68	G	3.42	G#	-20.52	A	-3.42	Bb	13.74	B	-10.26	C		6.84	C#	-17.1	D	0
Eb	E	-24	F	-6.84	F#	-30.84	G	-13.74	G#	-37.68	A	-20.58	Bb	-3.42	B	-27.42	C	-10.32	C#		-34.26	D	-17.16	Eb	0
E	F	17.16	F#	-6.84	G	10.26	G#	-13.68	A	3.42	Bb	20.58	B	-3.42	C	-13.68	C#	-10.26	D		6.84	Eb	24	E	0
F	F#	-24	G	-6.9	G#	-30.84	A	-13.74	Bb	3.42	B	-20.58	C	-3.48	C#	-27.42	D	-10.32	Eb		6.84	E	-17.16	F	0
F#	G	17.1	G#	-6.84	A	10.26	Bb	27.42	B	3.42	C	20.52	C#	-3.42	D	13.68	Eb	30.84	E		6.84	F	24	F#	0
G	G#	-23.94	A	-6.84	Bb	10.32	B	-13.68	C	3.42	C#	-20.52	D	-3.42	Eb	13.74	E	-10.26	F		6.9	F#	-17.1	G	0
G#	A	17.1	Bb	34.26	B	10.26	C	27.36	C#	3.42	D	20.52	Eb	37.68	E	13.68	F	30.84	F#		6.84	G	23.94	G#	0
A	Bb	17.16	B	-6.84	C	10.26	C#	-13.68	D	3.42	Eb	20.58	E	-3.42	F	13.74	F#	-10.26	G		6.84	G#	-17.1	A	0
Bb	B	-24	C	-6.9	C#	-30.84	D	-13.74	Eb	3.42	E	-20.58	F	-3.42	F#	-27.42	G	-10.32	G#		-34.26	A	-17.16	Bb	0
B	C	17.1	C#	-6.84	D	10.26	Eb	27.42	E	3.42	F	20.58	F#	-3.42	G	13.68	G#	-10.26	A		6.84	Bb	24	B	0

Table 11. Detailed analysis of intervals in sixth-comma meantone

Sixth-comma Meantone																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
Note	100		200		300		400		500		600		700		800		900		1000		1100		1200	
C	C#	86.35	D	196.10	Eb	305.91	E	392.20	F	502.01	F#	588.30	G	698.05	G#	784.40	A	894.15	Bb	1003.96	B	1090.25	C	1200
C#	D	109.75	Eb	219.56	E	305.85	F	415.66	F#	501.95	G	611.70	G#	698.05	A	807.80	Bb	917.61	B	1003.90	C	1113.65	C#	1200
D	Eb	109.81	E	196.10	F	305.91	F#	392.20	G	501.95	G#	588.30	A	698.05	Bb	807.86	B	894.15	C	1003.90	C#	1090.25	D	1200
Eb	E	86.29	F	196.10	F#	282.39	G	392.14	G#	478.49	A	588.24	Bb	698.05	B	784.34	C	894.09	C#	980.44	D	1090.19	Eb	1200
E	F	109.81	F#	196.10	G	305.85	G#	392.20	A	501.95	Bb	611.76	B	698.05	C	807.80	C#	894.15	D	1003.90	Eb	1113.71	E	1200
F	F#	86.29	G	196.04	G#	282.39	A	392.14	Bb	501.95	B	588.24	C	697.99	C#	784.34	D	894.09	Eb	1003.90	E	1090.19	F	1200
F#	G	109.75	G#	196.10	A	305.85	Bb	415.66	B	501.95	C	611.70	C#	698.05	D	807.80	Eb	917.61	E	1003.90	F	1113.71	F#	1200
G	G#	86.35	A	196.10	Bb	305.91	B	392.20	C	501.95	C#	588.30	D	698.05	Eb	807.86	E	894.15	F	1003.96	F#	1090.25	G	1200
G#	A	109.75	Bb	219.56	B	305.85	C	415.60	C#	501.95	D	611.70	Eb	721.51	E	807.80	F	917.61	F#	1003.90	G	1113.65	G#	1200
A	Bb	109.81	B	196.10	C	305.85	C#	392.20	D	501.95	Eb	611.76	E	698.05	F	807.86	F#	894.15	G	1003.90	G#	1090.25	A	1200
Bb	B	86.29	C	196.04	C#	282.39	D	392.14	Eb	501.95	E	588.24	F	698.05	F#	784.34	G	894.09	G#	980.44	A	1090.19	Bb	1200
B	C	109.75	C#	196.10	D	305.85	Eb	415.66	E	501.95	F	611.76	F#	698.05	G	807.80	G#	894.15	A	1003.90	Bb	1113.71	B	1200
Deviation from the pure interval																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
C	C#		D		Eb	-9.73	E	5.89	F	3.97	F#		G	-3.91	G#		A	9.79	Bb		B		C	
C#	D		Eb		E	-9.79	F	29.35	F#	3.91	G		G#	-3.91	A		Bb	33.25	B		C		C#	
D	Eb		E		F	-9.73	F#	5.89	G	3.91	G#		A	-3.91	Bb		B	9.79	C		C#		D	
Eb	E		F		F#	-33.25	G	5.83	G#	-19.55	A		Bb	-3.91	B		C	9.73	C#		D		Eb	
E	F		F#		G	-9.79	G#	5.89	A	3.91	Bb		B	-3.91	C		C#	9.79	D		Eb		E	
F	F#		G		G#	-33.25	A	5.83	Bb	3.91	B		C	-3.97	C#		D	9.73	Eb		E		F	
F#	G		G#		A	-9.79	Bb	29.35	B	3.91	C		C#	-3.91	D		Eb	33.25	E		F		F#	
G	G#		A		Bb	-9.73	B	5.89	C	3.91	C#		D	-3.91	Eb		E	9.79	F		F#		G	
G#	A		Bb		B	-9.79	C	29.29	C#	3.91	D		Eb	19.55	E		F	33.25	F#		G		G#	
A	Bb		B		C	-9.79	C#	5.89	D	3.91	Eb		E	-3.91	F		F#	9.79	G		G#		A	
Bb	B		C		C#	-33.25	D	5.83	Eb	3.91	E		F	-3.91	F#		G	9.73	G#		A		Bb	
B	C		C#		D	-9.79	Eb	29.35	E	3.91	F		F#	-3.91	G		G#	9.79	A		Bb		B	
Deviation from Equal Temperament																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
C	C#	-13.65	D	-3.9	Eb	5.91	E	-7.8	F	2.01	F#	-11.7	G	-1.95	G#	-15.6	A	-5.85	Bb	3.96	B	-9.75	C	0
C#	D	9.75	Eb	19.56	E	5.85	F	15.66	F#	1.95	G	11.7	G#	-1.95	A	7.8	Bb	17.61	B	3.9	C	13.65	C#	0
D	Eb	9.81	E	-3.9	F	5.91	F#	-7.8	G	1.95	G#	-11.7	A	-1.95	Bb	7.86	B	-5.85	C	3.9	C#	-9.75	D	0
Eb	E	-13.71	F	-3.9	F#	-17.61	G	-7.86	G#	-21.51	A	-11.76	Bb	-1.95	B	-15.66	C	-5.91	C#	-19.56	D	-9.81	Eb	0
E	F	9.81	F#	-3.9	G	5.85	G#	-7.8	A	1.95	Bb	11.76	B	-1.95	C	7.8	C#	-5.85	D	3.9	Eb	13.71	E	0
F	F#	-13.71	G	-3.96	G#	-17.61	A	-7.86	Bb	1.95	B	-11.76	C	-2.01	C#	-15.66	D	-5.91	Eb	3.9	E	-9.81	F	0
F#	G	9.75	G#	-3.9	A	5.85	Bb	15.66	B	1.95	C	11.7	C#	-1.95	D	7.8	Eb	17.61	E	3.9	F	13.71	F#	0
G	G#	-13.65	A	-3.9	Bb	5.91	B	-7.8	C	1.95	C#	-11.7	D	-1.95	Eb	7.86	E	-5.85	F	3.96	F#	-9.75	G	0
G#	A	9.75	Bb	19.56	B	5.85	C	15.6	C#	1.95	D	11.7	Eb	21.51	E	7.8	F	17.61	F#	3.9	G	13.65	G#	0
A	Bb	9.81	B	-3.9	C	5.85	C#	-7.8	D	1.95	Eb	11.76	E	-1.95	F	7.86	F#	-5.85	G	3.9	G#	-9.75	A	0
Bb	B	-13.71	C	-3.96	C#	-17.61	D	-7.86	Eb	1.95	E	-11.76	F	-1.95	F#	-15.66	G	-5.91	G#	-19.56	A	-9.81	Bb	0
B	C	9.75	C#	-3.9	D	5.85	Eb	15.66	E	1.95	F	11.76	F#	-1.95	G	7.8	G#	-5.85	A	3.9	Bb	13.71	B	0

Table 12. Detailed analysis of intervals in Kirnberger

Kirnberger																								
Lower	Semitone	Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve		
Note	100	200		300		400		500		600		700		800		900		1000		1100		1200		
C	C#	90.24	D	193.16	Eb	294.16	E	386.32	F	498.08	F#	590.24	G	696.58	G#	792.20	A	889.74	Bb	996.12	B	1088.28	C	1200
C#	D	102.92	Eb	203.92	E	296.08	F	407.84	F#	500.00	G	606.34	G#	701.96	A	799.50	Bb	905.88	B	998.04	C	1109.76	C#	1200
D	Eb	101.00	E	193.16	F	304.92	F#	397.08	G	503.42	G#	599.04	A	696.58	Bb	802.96	B	895.12	C	1006.84	C#	1097.08	D	1200
Eb	E	92.16	F	203.92	F#	296.08	G	402.42	G#	498.04	A	595.58	Bb	701.96	B	794.12	C	905.84	C#	996.08	D	1099.00	Eb	1200
E	F	111.76	F#	203.92	G	310.26	G#	405.88	A	503.42	Bb	609.80	B	701.96	C	813.68	C#	903.92	D	1006.84	Eb	1107.84	E	1200
F	F#	92.16	G	198.50	G#	294.12	A	391.66	Bb	498.04	B	590.20	C	701.92	C#	792.16	D	895.08	Eb	996.08	E	1088.24	F	1200
F#	G	106.34	G#	201.96	A	299.50	Bb	405.88	B	498.04	C	609.76	C#	700.00	D	802.92	Eb	903.92	E	996.08	F	1107.84	F#	1200
G	G#	95.62	A	193.16	Bb	299.54	B	391.70	C	503.42	C#	593.66	D	696.58	Eb	797.58	E	889.74	F	1001.50	F#	1093.66	G	1200
G#	A	97.54	Bb	203.92	B	296.08	C	407.80	C#	498.04	D	600.96	Eb	701.96	E	794.12	F	905.88	F#	998.04	G	1104.38	G#	1200
A	Bb	106.38	B	198.54	C	310.26	C#	400.50	D	503.42	Eb	604.42	E	696.58	F	808.34	F#	900.50	G	1006.84	G#	1102.46	A	1200
Bb	B	92.16	C	203.88	C#	294.12	D	397.04	Eb	498.04	E	590.20	F	701.96	F#	794.12	G	900.46	G#	996.08	A	1093.62	Bb	1200
B	C	111.72	C#	201.96	D	304.88	Eb	405.88	E	498.04	F	609.80	F#	701.96	G	808.30	G#	903.92	A	1001.46	Bb	1107.84	B	1200
Deviation from the pure interval																								
Lower	Semitone	Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve		
C	C#		D		Eb	-21.48	E	0.01	F	0.04	F#		G	-5.38	G#		A	5.38	Bb		B		C	
C#	D		Eb		E	-19.56	F	21.53	F#	1.96	G		G#	0.00	A		Bb	21.52	B		C		C#	
D	Eb		E		F	-10.72	F#	10.77	G	5.38	G#		A	-5.38	Bb		B	10.76	C		C#		D	
Eb	E		F		F#	-19.56	G	16.11	G#	0.00	A		Bb	0.00	B		C	21.48	C#		D		Eb	
E	F		F#		G	-5.38	G#	19.57	A	5.38	Bb		B	0.00	C		C#	19.56	D		Eb		E	
F	F#		G		G#	-21.52	A	5.35	Bb	0.00	B		C	-0.04	C#		D	10.72	Eb		E		F	
F#	G		G#		A	-16.14	Bb	19.57	B	0.00	C		C#	-1.96	D		Eb	19.56	E		F		F#	
G	G#		A		Bb	-16.10	B	5.39	C	5.38	C#		D	-5.38	Eb		E	5.38	F		F#		G	
G#	A		Bb		B	-19.56	C	21.49	C#	0.00	D		Eb	0.00	E		F	21.52	F#		G		G#	
A	Bb		B		C	-5.38	C#	14.19	D	5.38	Eb		E	-5.38	F		F#	16.14	G		G#		A	
Bb	B		C		C#	-21.52	D	10.73	Eb	0.00	E		F	0.00	F#		G	16.10	G#		A		Bb	
B	C		C#		D	-10.76	Eb	19.57	E	0.00	F		F#	0.00	G		G#	19.56	A		Bb		B	
Deviation from Equal Temperament																								
Lower	Semitone	Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve		
C	C#	-9.76	D	-6.84	Eb	-5.84	E	-13.68	F	-1.92	F#	-9.76	G	-3.42	G#	-7.8	A	-10.26	Bb	-3.88	B	-11.72	C	0
C#	D	2.92	Eb	3.92	E	-3.92	F	7.84	F#	0	G	6.34	G#	1.96	A	-0.5	Bb	5.88	B	-1.96	C	9.76	C#	0
D	Eb	1	E	-6.84	F	4.92	F#	-2.92	G	3.42	G#	-0.96	A	-3.42	Bb	2.96	B	-4.88	C	6.84	C#	-2.92	D	0
Eb	E	-7.84	F	3.92	F#	-3.92	G	2.42	G#	-1.96	A	-4.42	Bb	1.96	B	-5.88	C	5.84	C#	-3.92	D	-1	Eb	0
E	F	11.76	F#	3.92	G	10.26	G#	5.88	A	3.42	Bb	9.8	B	1.96	C	13.68	C#	3.92	D	6.84	Eb	7.84	E	0
F	F#	-7.84	G	-1.5	G#	-5.88	A	-8.34	Bb	-1.96	B	-9.8	C	1.92	C#	-7.84	D	-4.92	Eb	-3.92	E	-11.76	F	0
F#	G	6.34	G#	1.96	A	-0.5	Bb	5.88	B	-1.96	C	9.76	C#	0	D	2.92	Eb	3.92	E	-3.92	F	7.84	F#	0
G	G#	-4.38	A	-6.84	Bb	-0.46	B	-8.3	C	3.42	C#	-6.34	D	-3.42	Eb	-2.42	E	-10.26	F	1.5	F#	-6.34	G	0
G#	A	-2.46	Bb	3.92	B	-3.92	C	7.8	C#	-1.96	D	0.96	Eb	1.96	E	-5.88	F	5.88	F#	-1.96	G	4.38	G#	0
A	Bb	6.38	B	-1.46	C	10.26	C#	0.5	D	3.42	Eb	4.42	E	-3.42	F	8.34	F#	0.5	G	6.84	G#	2.46	A	0
Bb	B	-7.84	C	3.88	C#	-5.88	D	-2.96	Eb	-1.96	E	-9.8	F	1.96	F#	-5.88	G	0.46	G#	-3.92	A	-6.38	Bb	0
B	C	11.72	C#	1.96	D	4.88	Eb	5.88	E	-1.96	F	9.8	F#	1.96	G	8.3	G#	3.92	A	1.46	Bb	7.84	B	0

Table 13. Detailed analysis of intervals in Werckmeister III

Werckmeister III																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
Note	100		200		300		400		500		600		700		800		900		1000		1100		1200	
C	C#	90.24	D	192.18	Eb	294.16	E	390.23	F	498.08	F#	588.28	G	696.09	G#	792.20	A	888.27	Bb	996.12	B	1092.19	C	1200
C#	D	101.94	Eb	203.92	E	299.99	F	407.84	F#	498.04	G	605.85	G#	701.96	A	798.03	Bb	905.88	B	1001.95	C	1109.76	C#	1200
D	Eb	101.98	E	198.05	F	305.90	F#	396.10	G	503.91	G#	600.02	A	696.09	Bb	803.94	B	900.01	C	1007.82	C#	1098.06	D	1200
Eb	E	96.07	F	203.92	F#	294.12	G	401.93	G#	498.04	A	594.11	Bb	701.96	B	798.03	C	905.84	C#	996.08	D	1098.02	Eb	1200
E	F	107.85	F#	198.05	G	305.86	G#	401.97	A	498.04	Bb	605.89	B	701.96	C	809.77	C#	900.01	D	1001.95	Eb	1103.93	E	1200
F	F#	90.20	G	198.01	G#	294.12	A	390.19	Bb	498.04	B	594.11	C	701.92	C#	792.16	D	894.10	Eb	996.08	E	1092.15	F	1200
F#	G	107.81	G#	203.92	A	299.99	Bb	407.84	B	503.91	C	611.72	C#	701.96	D	803.90	Eb	905.88	E	1001.95	F	1109.80	F#	1200
G	G#	96.11	A	192.18	Bb	300.03	B	396.10	C	503.91	C#	594.15	D	696.09	Eb	798.07	E	894.14	F	1001.99	F#	1092.19	G	1200
G#	A	96.07	Bb	203.92	B	299.99	C	407.80	C#	498.04	D	599.98	Eb	701.96	E	798.03	F	905.88	F#	996.08	G	1103.89	G#	1200
A	Bb	107.85	B	203.92	C	311.73	C#	401.97	D	503.91	Eb	605.89	E	701.96	F	809.81	F#	900.01	G	1007.82	G#	1103.93	A	1200
Bb	B	96.07	C	203.88	C#	294.12	D	396.06	Eb	498.04	E	594.11	F	701.96	F#	792.16	G	899.97	G#	996.08	A	1092.15	Bb	1200
B	C	107.81	C#	198.05	D	299.99	Eb	401.97	E	498.04	F	605.89	F#	696.09	G	803.90	G#	900.01	A	996.08	Bb	1103.93	B	1200
Deviation from the pure interval																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
C	C#		D		Eb	-21.48	E	3.92	F	0.04	F#		G	-5.87	G#		A	3.91	Bb		B		C	
C#	D		Eb		E	-15.65	F	21.53	F#	0.00	G		G#	0.00	A		Bb	21.52	B		C		C#	
D	Eb		E		F	-9.74	F#	9.79	G	5.87	G#		A	-5.87	Bb		B	15.65	C		C#		D	
Eb	E		F		F#	-21.52	G	15.62	G#	0.00	A		Bb	0.00	B		C	21.48	C#		D		Eb	
E	F		F#		G	-9.78	G#	15.66	A	0.00	Bb		B	0.00	C		C#	15.65	D		Eb		E	
F	F#		G		G#	-21.52	A	3.88	Bb	0.00	B		C	-0.04	C#		D	9.74	Eb		E		F	
F#	G		G#		A	-15.65	Bb	21.53	B	5.87	C		C#	0.00	D		Eb	21.52	E		F		F#	
G	G#		A		Bb	-15.61	B	9.79	C	5.87	C#		D	-5.87	Eb		E	9.78	F		F#		G	
G#	A		Bb		B	-15.65	C	21.49	C#	0.00	D		Eb	0.00	E		F	21.52	F#		G		G#	
A	Bb		B		C	-3.91	C#	15.66	D	5.87	Eb		E	0.00	F		F#	15.65	G		G#		A	
Bb	B		C		C#	-21.52	D	9.75	Eb	0.00	E		F	0.00	F#		G	15.61	G#		A		Bb	
B	C		C#		D	-15.65	Eb	15.66	E	0.00	F		F#	-5.87	G		G#	15.65	A		Bb		B	
Deviation from Equal Temperament																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
C	C#	-9.76	D	-7.82	Eb	-5.84	E	-9.77	F	-1.92	F#	-11.72	G	-3.91	G#	-7.8	A	-11.73	Bb	-3.88	B	-7.81	C	0
C#	D	1.94	Eb	3.92	E	-0.01	F	7.84	F#	-1.96	G	5.85	G#	1.96	A	-1.97	Bb	5.88	B	1.95	C	9.76	C#	0
D	Eb	1.98	E	-1.95	F	5.9	F#	-3.9	G	3.91	G#	0.02	A	-3.91	Bb	3.94	B	0.01	C	7.82	C#	-1.94	D	0
Eb	E	-3.93	F	3.92	F#	-5.88	G	1.93	G#	-1.96	A	-5.89	Bb	1.96	B	-1.97	C	5.84	C#	-3.92	D	-1.98	Eb	0
E	F	7.85	F#	-1.95	G	5.86	G#	1.97	A	-1.96	Bb	5.89	B	1.96	C	9.77	C#	0.01	D	1.95	Eb	3.93	E	0
F	F#	-9.8	G	-1.99	G#	-5.88	A	-9.81	Bb	-1.96	B	-5.89	C	1.92	C#	-7.84	D	-5.9	Eb	-3.92	E	-7.85	F	0
F#	G	7.81	G#	3.92	A	-0.01	Bb	7.84	B	3.91	C	11.72	C#	1.96	D	3.9	Eb	5.88	E	1.95	F	9.8	F#	0
G	G#	-3.89	A	-7.82	Bb	0.03	B	-3.9	C	3.91	C#	-5.85	D	-3.91	Eb	-1.93	E	-5.86	F	1.99	F#	-7.81	G	0
G#	A	-3.93	Bb	3.92	B	-0.01	C	7.8	C#	-1.96	D	-0.02	Eb	1.96	E	-1.97	F	5.88	F#	-3.92	G	3.89	G#	0
A	Bb	7.85	B	3.92	C	11.73	C#	1.97	D	3.91	Eb	5.89	E	1.96	F	9.81	F#	0.01	G	7.82	G#	3.93	A	0
Bb	B	-3.93	C	3.88	C#	-5.88	D	-3.94	Eb	-1.96	E	-5.89	F	1.96	F#	-7.84	G	-0.03	G#	-3.92	A	-7.85	Bb	0
B	C	7.81	C#	-1.95	D	-0.01	Eb	1.97	E	-1.96	F	5.89	F#	-3.91	G	3.9	G#	0.01	A	-3.92	Bb	3.93	B	0

Table 14. Detailed analysis of intervals in Vallotti

Vallotti																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
Note	100		200		300		400		500		600		700		800		900		1000		1100		1200	
C	C#	94.17	D	196.10	Eb	298.09	E	392.20	F	502.01	F#	592.21	G	698.05	G#	796.13	A	894.15	Bb	1000.05	B	1090.25	C	1200
C#	D	101.93	Eb	203.92	E	298.03	F	407.84	F#	498.04	G	603.88	G#	701.96	A	799.98	Bb	905.88	B	996.08	C	1105.83	C#	1200
D	Eb	101.99	E	196.10	F	305.91	F#	396.11	G	501.95	G#	600.03	A	698.05	Bb	803.95	B	894.15	C	1003.90	C#	1098.07	D	1200
Eb	E	94.11	F	203.92	F#	294.12	G	399.96	G#	498.04	A	596.06	Bb	701.96	B	792.16	C	901.91	C#	996.08	D	1098.01	Eb	1200
E	F	109.81	F#	200.01	G	305.85	G#	403.93	A	501.95	Bb	607.85	B	698.05	C	807.80	C#	901.97	D	1003.90	Eb	1105.89	E	1200
F	F#	90.20	G	196.04	G#	294.12	A	392.14	Bb	498.04	B	588.24	C	697.99	C#	792.16	D	894.09	Eb	996.08	E	1090.19	F	1200
F#	G	105.84	G#	203.92	A	301.94	Bb	407.84	B	498.04	C	607.79	C#	701.96	D	803.89	Eb	905.88	E	999.99	F	1109.80	F#	1200
G	G#	98.08	A	196.10	Bb	302.00	B	392.20	C	501.95	C#	596.12	D	698.05	Eb	800.04	E	894.15	F	1003.96	F#	1094.16	G	1200
G#	A	98.02	Bb	203.92	B	294.12	C	403.87	C#	498.04	D	599.97	Eb	701.96	E	796.07	F	905.88	F#	996.08	G	1101.92	G#	1200
A	Bb	105.90	B	196.10	C	305.85	C#	400.02	D	501.95	Eb	603.94	E	698.05	F	807.86	F#	898.06	G	1003.90	G#	1101.98	A	1200
Bb	B	90.20	C	199.95	C#	294.12	D	396.05	Eb	498.04	E	592.15	F	701.96	F#	792.16	G	898.00	G#	996.08	A	1094.10	Bb	1200
B	C	109.75	C#	203.92	D	305.85	Eb	407.84	E	501.95	F	611.76	F#	701.96	G	807.80	G#	905.88	A	1003.90	Bb	1109.80	B	1200
Deviation from the pure interval																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
C	C#		D		Eb	-17.55	E	5.89	F	3.97	F#		G	-3.91	G#		A	9.79	Bb		B		C	
C#	D		Eb		E	-17.61	F	21.53	F#	0.00	G		G#	0.00	A		Bb	21.52	B		C		C#	
D	Eb		E		F	-9.73	F#	9.80	G	3.91	G#		A	-3.91	Bb		B	9.79	C		C#		D	
Eb	E		F		F#	-21.52	G	13.65	G#	0.00	A		Bb	0.00	B		C	17.55	C#		D		Eb	
E	F		F#		G	-9.79	G#	17.62	A	3.91	Bb		B	-3.91	C		C#	17.61	D		Eb		E	
F	F#		G		G#	-21.52	A	5.83	Bb	0.00	B		C	-3.97	C#		D	9.73	Eb		E		F	
F#	G		G#		A	-13.70	Bb	21.53	B	0.00	C		C#	0.00	D		Eb	21.52	E		F		F#	
G	G#		A		Bb	-13.64	B	5.89	C	3.91	C#		D	-3.91	Eb		E	9.79	F		F#		G	
G#	A		Bb		B	-21.52	C	17.56	C#	0.00	D		Eb	0.00	E		F	21.52	F#		G		G#	
A	Bb		B		C	-9.79	C#	13.71	D	3.91	Eb		E	-3.91	F		F#	13.70	G		G#		A	
Bb	B		C		C#	-21.52	D	9.74	Eb	0.00	E		F	0.00	F#		G	13.64	G#		A		Bb	
B	C		C#		D	-9.79	Eb	21.53	E	3.91	F		F#	0.00	G		G#	21.52	A		Bb		B	
Deviation from Equal Temperament																								
Lower	Semitone		Tone		m3		M3		P4		aug 4/dim 5		P5		aug 5/ m6		M6		m7		M7		8ve	
C	C#	-5.83	D	-3.9	Eb	-1.91	E	-7.8	F	2.01	F#	-7.79	G	-1.95	G#	-3.87	A	-5.85	Bb	0.05	B	-9.75	C	0
C#	D	1.93	Eb	3.92	E	-1.97	F	7.84	F#	-1.96	G	3.88	G#	1.96	A	-0.02	Bb	5.88	B	-3.92	C	5.83	C#	0
D	Eb	1.99	E	-3.9	F	5.91	F#	-3.89	G	1.95	G#	0.03	A	-1.95	Bb	3.95	B	-5.85	C	3.9	C#	-1.93	D	0
Eb	E	-5.89	F	3.92	F#	-5.88	G	-0.04	G#	-1.96	A	-3.94	Bb	1.96	B	-7.84	C	1.91	C#	-3.92	D	-1.99	Eb	0
E	F	9.81	F#	0.01	G	5.85	G#	3.93	A	1.95	Bb	7.85	B	-1.95	C	7.8	C#	1.97	D	3.9	Eb	5.89	E	0
F	F#	-9.8	G	-3.96	G#	-5.88	A	-7.86	Bb	-1.96	B	-11.76	C	-2.01	C#	-7.84	D	-5.91	Eb	-3.92	E	-9.81	F	0
F#	G	5.84	G#	3.92	A	1.94	Bb	7.84	B	-1.96	C	7.79	C#	1.96	D	3.89	Eb	5.88	E	-0.01	F	9.8	F#	0
G	G#	-1.92	A	-3.9	Bb	2	B	-7.8	C	1.95	C#	-3.88	D	-1.95	Eb	0.04	E	-5.85	F	3.96	F#	-5.84	G	0
G#	A	-1.98	Bb	3.92	B	-5.88	C	3.87	C#	-1.96	D	-0.03	Eb	1.96	E	-3.93	F	5.88	F#	-3.92	G	1.92	G#	0
A	Bb	5.9	B	-3.9	C	5.85	C#	0.02	D	1.95	Eb	3.94	E	-1.95	F	7.86	F#	-1.94	G	3.9	G#	1.98	A	0
Bb	B	-9.8	C	-0.05	C#	-5.88	D	-3.95	Eb	-1.96	E	-7.85	F	1.96	F#	-7.84	G	-2	G#	-3.92	A	-5.9	Bb	0
B	C	9.75	C#	3.92	D	5.85	Eb	7.84	E	1.95	F	11.76	F#	1.96	G	7.8	G#	5.88	A	3.9	Bb	9.8	B	0

CHAPTER II

Keyboard Instruments in the Sixteenth and Seventeenth Centuries

This chapter focuses on keyboard instruments, particularly organs and harpsichords, which were in use during the sixteenth and seventeenth centuries. It focuses particularly on instruments with more than 12 notes to the octave, and music that either requires more than 12 notes to the octave, or notes that lie outside the normal disposition of quarter-comma meantone, $E\flat$ to $G\sharp$. Later in the chapter, instruments which Froberger may have known will be discussed. Froberger's works will also be examined for internal evidence in order to identify features on the instruments he may have intended.

Instruments with More than 12 Notes to the Octave

As discussed in the previous chapter, tuning keyboard instruments in quarter-comma meantone $E\flat$ - $G\sharp$ results in some enharmonic notes being omitted from the keyboard. To reiterate, this is because enharmonic notes cannot co-exist in this temperament. For example, the tuner will need to choose between the $E\flat$ or $D\sharp$, as the pitch chosen for $E\flat$ cannot successfully serve as a $D\sharp$ and vice versa. One of the solutions which musicians of the period came up with to make both pitches to be playable was to divide some of the keys into two parts so that the instrument can provide different pitches for enharmonic notes. This resulted in keyboards with more than 12 divisions to the octave.

The earliest known example of such an instrument is recorded in the year 1468 on the organ of Cesena cathedral (Barbieri 2008, 21; Wraight and Stembridge 1994, 169).¹ The provision of extra notes seems more common on the organ than on the

¹ Stembridge points out that according to the way this information was presented, it is likely that the idea of divided accidentals was not new then (Wraight and Stembridge 1994, 169). Ortgies states that split keys were also used in the fifteenth century when Pythagorean tuning was prevalent (Ortgies 2003, 14). Both Pythagorean and meantone tunings have one thing in common – they were both regular temperaments in which there were wolf intervals. The difference between the Pythagorean and meantone

harpsichord since it is easier to make adjustments to the tuning of the harpsichord (Ortgies 2003, 12; Stembridge 1992, 30). Instruments with split-keys were mostly made during the period of 1610 to 1640 in Italy, and extra notes were subsequently removed as circulating (i.e. irregular) temperaments became the norm. Some clavichords were also made with divided accidentals (Stembridge 1992, 7; Russell 1973, 117; Pollard 1985, 95-96).

The most commonly divided keys on instruments with more than 12 notes to the octave were the notes sitting at the edge of meantone temperament, i.e. $E\flat$ and $G\sharp$. When both of them are divided, there are 14-notes to the octave. There were also instruments which had all of the accidentals divided, providing 17 divisions to the octave, although, according to Ortgies, no organs like this are known to have existed (Ortgies 2003, 20). Instruments which also provided $E\sharp$ and $B\sharp$ in addition to all of the divided accidentals resulted in 19 divisions to the octave and were specifically known as the *cimbalo cromatico*, or *clavicymbalum universale* as Praetorius called them (Russell 1973, 96; Stembridge 1992, 8; Pollard 1985, 95; Hubbard 1967, 168; Praetorius 1619).² Although there are a number of harpsichords that shows signs of having been a *cimbalo cromatico*, no instrument has survived in its original form (Stembridge 1992, 5). There are four instruments on a list included in Eleanor Smith's dissertation (Smith 2008) which show evidence of having been a *cimbalo cromatico*. In modern times, Wraight has built one for Stembridge in 1987 who used it for his recording *Consonanze Stravaganti, Neopolitan Music for Organ, Harpsichord and Chromatic Harpsichord* (Stembridge 1997).

tunings, as discussed in the previous chapter, is the importance given to different intervals: Pythagorean tuning gives priority to pure fifths while meantone aims for pure thirds.

² According to Stembridge, Fabio Colonna refers to an instrument with 19 notes to the octave specifically as the *cimbalo cromatico* (Stembridge 1992, 6). Praetorius, in his *Syntagma Musicum*, suggests providing split keys for $E\flat$ and $G\sharp$. He also reports that he has seen a harpsichord in which all the enharmonic notes are provided at Carl Luyton's in Prague made in Vienna around 1590 (Hubbard 1967, 169), and refers to it as the *clavicymbalum universale*.

Scholars generally agree that the *cimbalo cromatico* was originally conceived as an instrument used to accompany singers and other instrumentalists who may have needed the keyboard player to transpose (Stembridge 1992, 6; Ortgies 2003, 12; Kottick 2003, 88; Smith 2008, 53). On instruments tuned in meantone temperament, transposition may result in using notes that are not part of the 12-note octave, making some of the intervals unusable. The *cimbalo cromatico* was able to provide enharmonic alternatives for the keyboard player who needed to transpose into more remote keys.

Possibly the most extreme example of a keyboard instrument with many divisions to the octave was a type of instrument called the *archicembalo* or *arcicembalo*. Invented by Nicola Vicentino (1511-1576), the *arcicembalo* had 31 divisions to the octave but 36 keys arranged on two keyboards.³ There was a renewed interest in the ancient Greek theory of music in the sixteenth century, and Vicentino created the *archicembalo* in order to create a keyboard instrument which could recreate ancient Greek genera, diatonic, chromatic and enharmonic,⁴ to prove a point after he lost a debate. The details of this instrument are described in his publication *L'Antica musica ridotta alla moderna pratica* (1555).⁵

Having so many additional notes to the octave probably made it necessary for players to train specifically to play this type of keyboard. Luzzasco Luzzaschi (c.1545-1607), a composer and organist, was a player who was known to have excelled at

³ No *archicembalo* by Vicentino survives but a modern reconstruction was made by Marco Tiella in 1974 (Barbieri 2008, 310). There seems to be some misleading information and confusion with regards Vicentino's instruments. Rudd and Davies comment on 31 divisions but do not mention 36 keys (Rudd 2004, 243; Davies), and Meeùs incorrectly states that there were '35 keys in the octave' (Meeùs). For Vito de Trasuntinis's instrument, Russell (1973) and Meffen (1973) state that there were 32 keys to the octave, perhaps including the note on which the octave started.

⁴ For more details on the ancient Greek theory, see Michopoulou (2006, 157-158).

⁵ For more information on Vicentino's *archicembalo*, see 'The Archicembalo of Nicola Vicentino' (Tiella 1975), 'The Archicembalo of Nicola Vicentino' (Brink 1966), 'Vicentino and the Greek Genera' (Kaufmann 1963), 'More on the Tuning of the *Archicembalo*' (Kaufmann 1970) and *Enharmonic Instruments and Music 1470-1900* (Barbieri 2008, 308-324).

playing the *archicembalo* (Strainchamps). He was Girolamo Frescobaldi's teacher,⁶ who was in turn Froberger's teacher. Frescobaldi himself was also 'reputed to be the only player in Rome capable of manipulating a similar instrument' (Hammond 1983, 106). Frescobaldi was also teacher of Francesco Nigetti (1603-1681) who later spent many years designing instruments with more than 12 divisions to the octave, using designs similar to Vicentino's instruments. Frescobaldi had taught Nigetti while he was in Florence between 1628 and 1634, before he taught Froberger from 1637.

In 1606, Vito de Trasuntinis made an instrument called the *clavemusicum omnitonum* which is considered to have been based on Vicentino's descriptions of the *archicembalo*.⁷ It had 31 divisions to the octave and therefore was perhaps similar to Vicentino's *arciorgano* (*Descrizione dell'arciorgano*, 1561) (Ripin). It is now kept in *Museo internazionale e biblioteca della musica di Bologna* but is not in playing condition. A modern, working copy of this instrument made in 1985 exists and is now at the Germanisches Nationalmuseum in Nuremberg (Kaufmann and Kendrick, 57; Stembridge 1993).

Many other musicians have also proposed instruments of different designs in the sixteenth and seventeenth centuries. These include designs by Francisco de Salinas (1577), Fabio Colonna (1618), Marin Mersenne (1636-7), Giovanni Battista Doni (1635-40), Galeazzo Sabbatini (c.1650, quoted by Kircher), and Athanasius Kircher (1650) (Meeùs). In particular, Athanasius Kircher's (1602-1680) *Musurgia universalis* (1650) has information on instruments with 12, 16, 18, 26 and 31 divisions to the octave with illustrations (Pollard 1985, 96).⁸

⁶ Frescobaldi mentions him in his publications of 1624 and 1630.

⁷ Trasuntinis's surname is sometimes spelt Trasuntini or Trasuntino (Wraight).

⁸ Kircher's *Musurgia universalis* also happens to include Froberger's *Fantasia* which is the only work by him that was published during Froberger's lifetime. According to a letter cited by Rampe, Froberger stayed with Kircher in Rome until mid-1649, the year before the publication of Kircher's important work.

As mentioned earlier, the most common notes to be divided on instruments with split-keys are $E\flat/D\sharp$ and $G\sharp/A\flat$ (Stembridge 1992, 6). It appears that on Italian instruments, particularly organs, the $A\flat$ was the first to be split. This enables all of the notes of the hexachord to have a major and a minor third (Ortgies 2003, 20).⁹ The hexachord was used by many composers from the fifteenth to the seventeenth centuries as a basis for compositions (Hirshberg), and it would therefore be an obvious choice for instruments to have this note split. Stembridge states: 'From the surviving instruments and the documentary evidence it is clear that the most important pair of split keys was $g\sharp$ and $a\flat$. Every single Italian organ, harpsichord, or virginal for which there is conclusive evidence of the existence of specific split keys had $g\sharp$ s and $a\flat$ s.' (Wraight and Stembridge 1994, 169)

On the other hand, $D\sharp$ appears to have been important in the music of the Low Countries. Pollard cites Praetorius, stating that it 'seems safe to assume from his writings that the first raised note to be split was $D\sharp/E\flat$ '. Praetorius's illustration shows a keyboard with split $D\sharp/E\flat$ keys. (Pollard 1985, 94) Stembridge also comments that Frescobaldi wrote some $D\sharp$ s 'after spending a year in the Low Countries, where keyboard music of the period frequently used $D\sharp$.' (Stembridge 1992, 21). Frescobaldi made his only trip outside Italy in 1607. Ortgies comments that the 'practice varied...and it became more and more common that the first added note was $d\sharp$, followed by $a\flat$.' (Ortgies 2003, 20) Furthermore, Denzil Wraight comments on Praetorius's illustration and states that 'this type of keyboard is not known among Italian instruments' since Italian instruments usually had more than one note per octave divided.

The split-key was also used for another purpose. During the sixteenth and seventeenth centuries, the most common compass for plucked keyboard instruments was

⁹ See also Barbieri (2008, 45) for a further discussions on why the $A\flat$ was important for organists.

C/E-c³ (O'Brien 1990, 28; Kottick 2003, 155; Burnett 2004, 215). The lowest note indicated with a forward slash signifies that an arrangement known as the short octave was in use. In this arrangement, the lowest note which appears to be E is tuned to C, and notes that appear to be F# and G# are tuned to D and E respectively, as shown in Figure 2. F# and G# were not often needed in this register in the music of this period, so instrument makers made alternate use of these keys. However, as time went on, F# and G# started appearing in the repertoire. The instruments needed to be modified. D and E were each divided so that one half of the key served as D the other half F#, and the same went for E and G# as shown in Figure 3. The keyboard is now equipped with all of the chromatic notes down to C, but without makers having to increase the width of the instrument. This was known as the split-key short octave, or the broken octave.

Figure 2. Short-octave keyboard

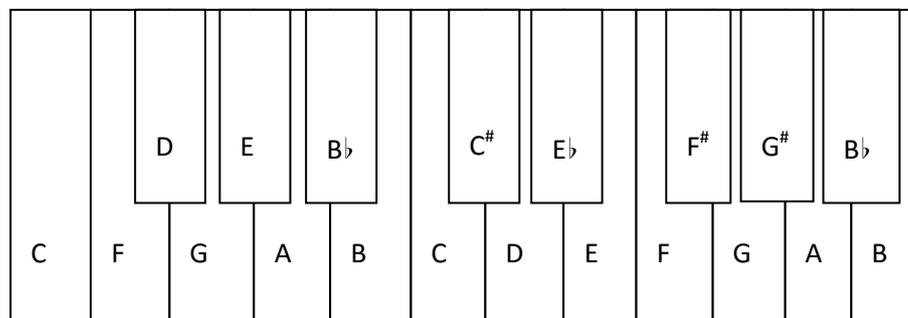
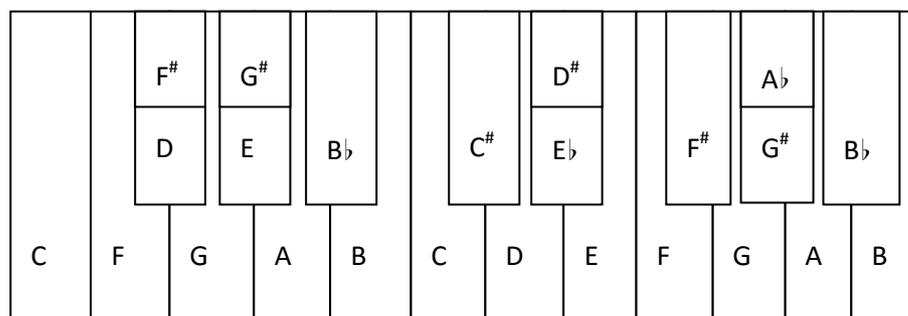
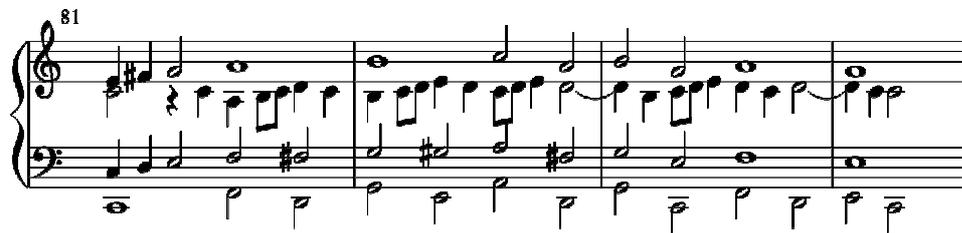


Figure 3. Split-key short-octave keyboard and divided D#/E_b, G#/A_b keys



The unique arrangement of the keys offered by this device has inspired some composers to write music specific to this type of keyboard. For example, Peter Philip's *Pavana Dolorosa* (LXXX from the Fitzwilliam Virginal Book) has alternating octaves and 10ths at bars 81-83 (and elsewhere) as shown in Example 1. On a short-octave keyboard, the player merely needs to play what appears to be parallel octaves on the keyboard to execute this passage.

Example 1. Philips, *Pavana Dolorosa*, bars 81-83 from the *Fitzwilliam Virginal Book*



Since this work also requires the G# which does not exist on a normal short-octave keyboard, Philips must have had an instrument with split-key short octave in mind when he wrote this work. Interestingly, Wraight comments that when split keys are provided at the low end of the keyboard to facilitate the split-key short octave, the instrument is more likely than not also to have split keys on the accidentals higher up the register to cater for enharmonic notes (Wraight 2010, 6).

The Fitzwilliam Virginal Book also contains one of the earliest examples of enharmonic modulation, in John Bull's *Ut re mi fa sol la*. In this piece, Bull modulates from the sharp side to the flat side by using $d\flat^1$ rather than $c\sharp^1$ for an A major chord in bar 11 (marked with an * in Example 2), travels through flat keys and through to C major and gradually back through to the sharp side. Works like this are rare in this period, and scholars suggest using some sort of equal temperament, or at least a circular temperament for this work (Meeùs; Maitland and Squire 1899, 183; Meffen 1973, 108). This work uses 17 different pitches, and can possibly be played on a *cimbalo cromatico*

or a *clavicymbalum universale* both of which has 19 notes to the octave, although Meeùs states that it would 'sound awkward at the point where there is an enharmonic modulation with a A major triad including a $D\flat$ instead of a $C\sharp$.'

Example 2. Bull, *Ut re mi fa sol la*, bars 10-12



Robert Hill has recently published a recording of this work online (April 20, 2015) in what he calls 'simulated 19-division meantone tuning' (Hill 2015). Since Bull does not mix his sharps and flats, Hill tuned his instrument so that all of the sharps are pure, and then retuned it so that all of the flats are pure. He then spliced his recordings together to create the 'simulated 19-division meantone tuning'.¹⁰ The sound examples on the CD include bars 10 to 12 of this work played firstly in normal disposition of quarter-comma meantone (track 5), then 'simulated 19-division meantone tuning' (track 6), Kirnberger III (track 7) and equal temperament (track 8). Using the normal disposition of quarter-comma meantone is obviously not successful; 19-division meantone tuning brings a grammatically-correct performance, but the passage is admittedly not entirely convincing either. In Kirnberger III and equal temperament, the enharmonic change is more successful, although the resonance of Kirnberger III seems more appealing than rather dull-sounding equal temperament.

It appears that musicians at the time were interested in the issues associated with using quarter-comma meantone, and actively experimented with creating instruments equipped with divided keys. Since many instruments, especially organs, had the

¹⁰ The current author is grateful to Robert Hill for sharing his method of creating the 'simulated 19-division meantone tuning' (Personal correspondence).

mechanisms subsequently removed when the prevalent tuning system moved to circular temperaments with no wolf intervals (Rowland 2001, 40), instruments have not survived to speak for themselves. Wraight further comments that 'the data available suggests that the manufacture of virginals and harpsichords with split sharps formed a significant part of the instrument makers' output in the first half of the 17th century.' (Wraight 2010, 7) The following section discusses other music which contains notes beyond the 12 available in the normal disposition of quarter-comma meantone.

Music for Instruments with More than 12 Notes to the Octave

Around the time instruments with more than 12 notes to the octave were being made, some composers wrote pieces specifically for them. In his article from 1992, Stembridge discusses some of this music specifically written for the *cimbalo cromatico*. These include works by Ascanio Mayone (c.1565-1627), Giovanni Maria Trabaci (c.1575-1647) and Gioanpietro del Buono (d.1657).

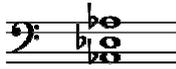
His research reveals that, although composers sometimes specify the *cimbalo cromatico* in the title, they also design their works in such a way as not to exclude those who did not have access to such an instrument. Perhaps in an attempt not to restrict circulation of their works, or even to maximise on profit,¹¹ they carefully structure their works so that they can still be played successfully on a standard keyboard.

Mayone's *Toccata Quarta per il Cimbalo Cromatico* from *Secondo Libro Diversi Capricci per Sonare* published in Naples in 1609 is the earliest work to specify the *cimbalo cromatico*. It makes use of A \flat , d \flat , a \flat , d \flat^1 , and a \flat^1 but does not make use of G#s and C#s in the same register. This means that, although it appears to use notes that are not normally available, there are ways to play this piece without the extra notes, by

¹¹ Stembridge comments that all compositions that are known to have been written specifically for the *cimbalo cromatico* are surprisingly from published sources (Stembridge 1992, 10).

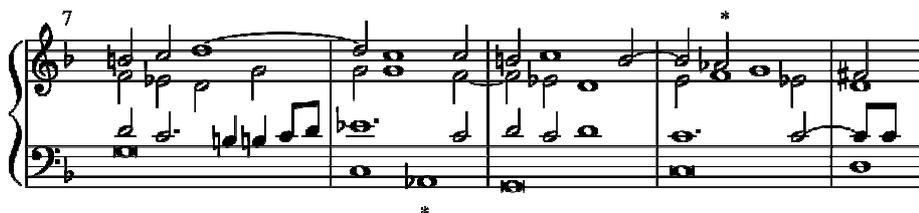
retuning these notes in these specific registers. A further investigation reveals that if three out of five of these pitches ($A\flat$, $d\flat$ and $a\flat$) are retuned (see Figure 4), it would be possible to give a successful performance on a normal keyboard.

Figure 4. Suggested retuning for Mayone's *Toccata Quarta* (1609)



Playing this on the harpsichord reveals that the impure enharmonic notes are most noticeable as the root of the chords. For example, it is crucial that $A\flat$ in bar 8 is in tune, but $a\flat^1$ in bar 10 is acceptable as $g\sharp^1$ because of its passing nature, the descending line, and also because the progression moves towards the 7th chord on D (i.e. an imperfect cadence) at the start of bar 11. The low pitch of the $A\flat$ which is tuned as $G\sharp$ would only add to intensify this cadence. Bars 7-10 of this work are shown in Example 3.

Example 3. Mayone, *Toccata Quarta* (1609), bars 7-10



Similarly, in bars 31 to 37, while it is crucial to have the $d\flat$ in bar 35 and $A\flat$ in bar 37 in tune as the root of these chords, the $d\flat^1$ in bar 33 tuned as $c\sharp^1$ would add more tension to the passage and may even add a welcome 'spice' to the music. It is interesting that both the $a\flat^1$ in bar 10 as well as $d\flat^1$ in bar 33 are part of a descending line, and the lower pitch which would result from using $g\sharp^1$ and $c\sharp^1$ makes the passage perhaps a little more quirky but not unpleasant. It is also interesting to note that notes that lie

outside the normal disposition of the meantone temperament appear in only 8 out of 46 bars, and in only 2 passages (bars 8-10 and bars 31-37). Example 4 shows bars 30-39.

Example 4. Mayone, *Toccata Quarta* (1609), bars 30-39



During the sixteenth to eighteenth centuries, the study of rhetoric was an important topic for musicians as well as orators, and many theorists and writers, including Kircher (1650), commented on the subject. Rhetoric is the art of persuasion, and was applied to composition as well as the delivery of a musical performance or a speech. There were five components to rhetoric: *inventio*, *dispositio*, *elocutio*, *memoria* and *pronunciatio*, of which the process of composition corresponds to *dispositio*. *Dispositio* was broken down into *exordium* (introduction), *narratio* (overview), *propositio* (main presentation of the contents), *confirmatio* (confirmation of the argument), *confutatio* (refutation) and *peroratio* (conclusion) (Bartel 1997, 68, 81). Interestingly, as later analysis will also reveal, notes that fall outside the 12 notes of the quarter-comma meantone often appear in a section that corresponds to *confutatio*.

In the case of *Toccata Quarta*, the concluding section starts in bar 39 with completely new figuration. This is shortly after the last appearance of $A\flat$ in the bass in bar 37 at the end of the section quoted above, where several $A\flat$ s and $D\flat$ s appear in succession. The concluding section stays entirely within the normal disposition of quarter-comma meantone, following the effective rhetorical structure.

In *Toccata Quinta per il Cimbalo Cromatico*, on the other hand, Mayone seems to make more use of the notes available only on the *cimbalo cromatico*. All of the

sharps including, $E^\#$ and $B^\#$, are present, but no flats are to be found. $D^\#$ s and $A^\#$ s appear only in one register as $d^\#1$ and $a^\#1$, so retuning of these notes can be carried out easily. This leaves $e^\#1$ and $b^\#1$, which again only appear in one register. Interestingly, they always resolve upwards as leading notes (bars 9, 12, 13 and 20), and using notes tuned as f^1 (natural) and c^2 (natural) would be still be acceptable provided that all the other sharps are in tune, since the function of the leading note is to 'lead' towards the note on which it resolves and the high pitch of the leading note would only enhance this function.

Example 5. Mayone, *Toccata Quinta* (1609), bars 8-23

Stembridge makes two suggestions for the performance of this piece. First, he suggests using a harpsichord with two split keys for E^\flat and $G^\#$ and transposing the work up a minor third. While this exercise reveals that the work is not as adventurous as it first appears and would solve all the problems, this solution seems unlikely. If this is

what Mayone intended, he could have written the work in the transposed key, particularly as it was published.

The other solution he suggests, when attempting to play this work on a standard 12-note keyboard, is to omit the section that involves these notes all together. The section in which all of these pitches appear is confined to the passage from bars 8 to 23. There is conveniently an E major chord at either end of this section, at bars 8 and 23, and Stembridge makes a cut between these two places. He has recorded this piece with the abridged section as well as the full work on his recording (Deutsche harmonia mundi 05472 77247 2) (Stembridge 1992, 12).

The practice of omitting a section within a work is not unknown in this period, as Frescobaldi and other composers of the period mentioned. Performers were allowed to exercise more liberty to pick and choose the sections they want to include in a performance. Frescobaldi stated in the preface to his 1616 book of toccatas that he would be happy for performers to apply this more relaxed attitude, and that his toccatas have been written in such a way to accommodate this.

Another work of importance for the *cimbalo cromatico* is by Trabaci. Published in 1615, *Toccata Terza, & Ricercar sopra il Cimbalo Cromatico* specifies the use of *cimbalo cromatico* in its title, but as Trabaci himself admits, goes beyond the notes available on the instrument by using an f## which does not exist on a *cimbalo cromatico*. Trabaci then suggests that the player plays f# instead when this note is not available. Stembridge also comments that Praetorius is also in support of this practice and suggests playing the nearest alternative, or to leave the note out, or to insert an ornament to obscure the note (Stembridge 1992, 26; Praetorius 1619).

Stembridge then discovers that transposing the piece down by a whole tone makes the work fit on the *cimbalo cromatico* and makes it much easier to play. He

suspects that this piece was conceived at this pitch, and later transposed, perhaps in order to impress his audience. A further analysis reveals that, at this transposed pitch, the only note outside the 12 notes of the normal disposition of quarter-comma meantone that Trabaci uses freely is the $D\#$. Again, these notes most frequently appear in the middle of the piece, and in the last section the only note which goes beyond the normal 12-note meantone is $a\flat^1$ which is used as part of a descending chromatic scale. Again, this works seems to respect the rhetorical structure.¹²

Although Frescobaldi, Froberger's teacher, does not specify the *cimbalo cromatico* in any of his works, he wrote some pieces which overstep the limits of meantone temperament. His association with instruments with split-keys may be deduced from inventories of his patrons, as detailed in Frederick Hammond's book *Girolamo Frescobaldi* (1983, 105-108). As mentioned earlier, Frescobaldi was a pupil of Luzzaschi who was known to have been an accomplished player of the *archicembalo*. Frescobaldi published *Cento Partite sopra Passacagli* in 1637, which had a section containing notes that go beyond the normal disposition of quarter-comma meantone. It might also be worth noting that 1637 was the year Froberger arrived in Rome to study with Frescobaldi.

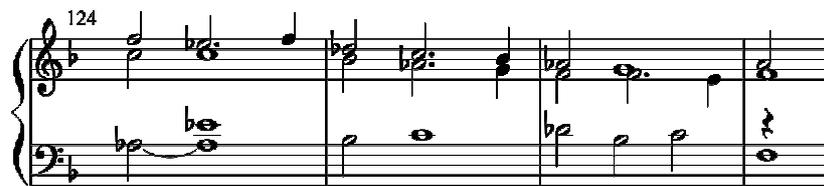
An investigation of this work reveals that Frescobaldi's *Cento Partite sopra Passacagli* (1637) needs 15 pitches in total. In addition to the 12 pitches available in meantone temperament, the work also uses $D\flat$, $A\flat$ and $D\#$. For the first third of this work, Frescobaldi's music remains conservative and does not venture outside the 12 notes available. In bar 110, the first $A\flat$ appears, and next 20 bars contain several $A\flat$ s and $D\flat$ s, in particular from bars 124 to 126 (as shown in Example 6). Except for a few further appearances of the $A\flat$ s and $D\flat$ s, Frescobaldi returns to being conservative in the

¹² For further information on music that contains more than 12 notes to the octave and/or notes that lie beyond the normal disposition of quarter-comma meantone, see Stembridge (1992).

last section. $A\flat$ s in bars 162 and 165 are either part of a chromatic line or its duration is very brief, and several $D\sharp$ s towards the end all appear as the leading note to E . Because of its leading nature, using the pitch of $E\flat$ for these $D\sharp$ s sounds acceptable. For the $A\flat$ s, retuning is not a feasible option, because 8 out of 13 $A\flat$ s are $a\flat^1$, which is the exact pitch of the $G\sharp$ in the final chord of the work.

If this work to be played on a harpsichord with two split-keys for $G\sharp/A\flat$ and $E\flat/D\sharp$, then this just leaves the $D\flat$ s in bars 125 and 126 to be accounted for. Provided that $A\flat$ s in this section are in tune, the lower pitch of the $D\flat$ would probably add intensity to this cadence without disturbing the flow of the music, particularly as Frescobaldi strictly stays within the simple tonality of F major for the following phrase.

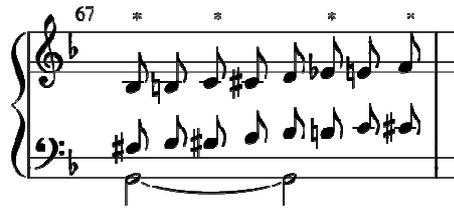
Example 6. Frescobaldi, *Cento Partite sopra Passacagli*, bars 124-126



Of course, as in the case discussed above, it is possible to omit this section altogether. As the *Cento* is made up of many small sections, this is certainly a possible solution. In fact, the passage from bar 111 to 131 is marked '*Altro Tono*'. If the *Altro Tono* section is omitted, the work is still left with several $A\flat$ s and all of the $D\sharp$ s towards the end, but they are less concentrated and the biggest of the problems, namely bars 124-126, can be avoided. For today's performers, it is possible to use a double-manual instrument and tune the upper manual differently to cater for this section. It is also interesting to note that the '*Altro Tono*' section is buried right in the middle of a very long work, and if it were to be played with some out-of-tune notes, then there is enough time for the listeners to 'recover' aurally before the end of the work.

The music of another pupil of Frescobaldi, Michelangelo Rossi (1602-1656) is also worth a mention. John Butt states that Froberger's toccatas resemble Rossi's toccatas even more than Frescobaldi's (Butt 2004, 184). Rossi liked using chromatic passages, but instead of using notes that go beyond the limit meantone temperament, he created chromaticisms with what was available to him. For example in *Toccata Settima*, Rossi stays within the normal disposition of quarter-comma meantone but successfully manages to create a passage that sounds as if he has overstepped the bounds of meantone temperament. He manages to do this by using a combination of diminished fourths, augmented fifths and augmented sixth as well as a linear chromatic line which is jagged in quarter-comma meantone. Bars 67 is quoted below to illustrate this.

Example 7. Rossi, *Toccata Settima*, bar 67



Composers at the time used chromaticisms and notes outside the quarter-comma meantone in various ways in to enhance their compositions. Some of them specified the *cimbalo cromatico* and yet wrote in such a way to allow the performance of their works with minimum adjustments to the normal keyboard. Others used what was available to make their works sound more dissonant without overstepping the limits of meantone temperament.

The next section discusses some of the surviving instruments which Froberger may have known.

Instruments Froberger may have known

Although no concrete information is available on the instruments Froberger played, it is possible to identify instruments he may have come across in his employment and on his travels.

Johann Mayer: 1619, Stuttgart

Froberger was born in Stuttgart in 1616, where his father Basilius worked as a tenor at the court from 1599. Basilius later became the Kapellmeister there in 1621. Johann Mayer (1576-1626) worked as a court organ builder and also made harpsichords as part of his job until his death in 1626. It is not known if a harpsichord made by Mayer in 1619 was known to the young Froberger, but it is certainly a possibility.

Since not many German harpsichords survive from before 1700 (Pollard 1985, 100), perhaps because of the Thirty Years War (1618-1648), Mayer's harpsichord is one of relatively few examples. Now kept in Salzburg, it has two 8' registers and 3 rows of jacks. Its most interesting feature is a compass which apparently runs from BB \flat to c³, although BB and C# are left out (Boalch 1995, 503). Curiously, the lowest note which appears to be BB \flat is in fact slightly shorter than the other accidentals, and this could perhaps have been some sort of a short octave.

A few of today's makers have copied this instrument. Nikolaus Damms is one of them, and he said that he treated the BB \flat key as a short-octave device (personal correspondence), and Martin Puehringer who has studied the instrument also considers it can be a note that was 'probably tuned to whatever was necessary.' (personal correspondence) This seems the most logical solution.¹³

In terms of Froberger's music, the BB \flat key on the Mayer harpsichord could perhaps be tuned to AA. Although it is unlikely he composed works to fit the compass

¹³ The author is grateful to both Nikolaus Damms and Martin Puehringer for taking their time to answer her enquiries.

of the harpsichord he knew in his formative years, most of Froberger's music does not require C# or BB but does require E♭ and AA. This fits the Mayer instrument perfectly if the shorter BB♭ was tuned to AA. The protruding BB♭ can be seen in the picture in Figure 5 below.

Figure 5. Johann Mayer's harpsichord of 1619



There were other interesting arrangements of the short octave. Richard Maunder in his book, *Keyboard Instruments in Eighteenth-Century Vienna*, discusses a keyboard with a special short-octave he refers to as the Viennese short octave (1998, 35-36). In this arrangement, the lowest note is made to look like the end-block and tuned to FF. The next note is divided not in two but in three, and provides GG, AA and BB♭. The note after that is where the normal C/E key is on a standard short-octave keyboard, but is divided into two and provides BB and C. Mayer's BB♭ key could therefore be a simplified or early version of this complicated short-octave arrangement.

¹⁴ Photograph kindly supplied by Nikolaus Damms.

Figure 6. Viennese short octave

	BB _♭			F [#]	G [#]	
	AA	BB		D	E	B _♭
FF	GG	C	F	G	A	B

Giovanni Celestini: 1587, Venice

Another instrument of interest is a virginal of 1587 by Giovanni Celestini (*fl.*1587-1610). It is now kept at the Museum für Kunst und Gewerbe in Hamburg, and there is a theory that this instrument belonged to the Habsburg court because of the double-crested eagle on the instrument (Hora 2004, 177). Several instruments by Celestini survive, of which two are virginals at the Hamburg Museum. 1587 is the earliest dated and has the compass of C/E-f³.

Celestini was a celebrated maker of virginals and harpsichords, and particularly famous for Wolfgang Amadeus Mozart being seated at one of his harpsichords in the 1770 painting by Saverio dalla Rosa (1745-1821). The painting has much detail and the date of 1583 can be read on the inscriptions of the harpsichord. No surviving harpsichord corresponds to this date, however, so the harpsichord seems to have been lost. The painting once belonged to Alfred Cortot (Beurmann 2012, 39).

Rampe lists two organs in Volume I of his *New Froberger* edition as instruments that Froberger may have known. One is an organ from Brescia dated 1581 which he 'may have played on his trip to Italy', and the other an organ by Hans Wökherl made in 1642 which he 'may have played during the instrument's official inauguration.'

(Froberger 2008, XL). The Wökherl organ, although not actually at the court, had the compass of C/E-c³ and split keys for g[#]/a^b, e^b¹/d[#]¹, and g[#]¹/a^b¹. Rampe further states, 'In view of Austria's close political ties with Italy and Spain, in addition to the Germanies and the Low Countries, stringed keyboard instruments from these southerly regions were probably known at the Habsburg court.' (Froberger 2008, XL)

The Compass and Other Features in Froberger's music

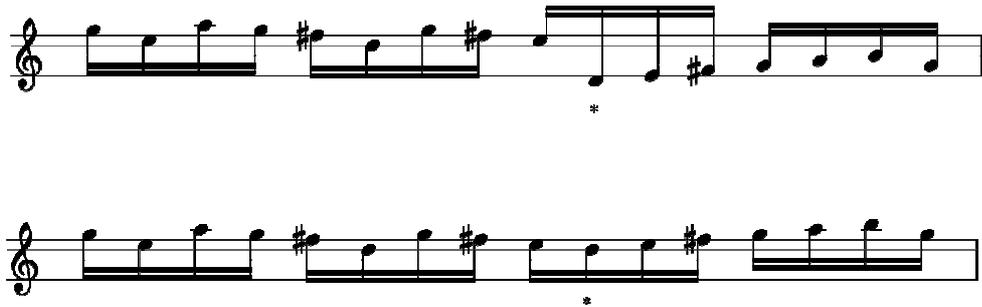
One way to find out more about his instruments is by examining Froberger's music, which may provide internal evidence of the instruments for which it was intended. Froberger's works can be classified into two groups, autograph scores and music that has been handed down in copied sources. A comparison between the most important sources for Froberger's music, namely 'Libro II' (1649), 'Libro IV' (1656), 'Libro di capricci, e ricercate' (c. 1658) held in the Austrian National Library, as well as the manuscript SA4450 in the Berlin Sing-Akademie, and the same works contained in other copied sources reveal some interesting facts.

All of the works in 'Libro II' (1649) fit within the compass of C/E-a² which was a common compass for keyboard instruments in this period, along with C/E-c³ (O'Brien 1990, 28). In the first bar¹⁵ of the fourth variation in Partita VI 'auff Die Maÿerin', FbWV 606, Froberger stays within the C/E-a² compass in 'Libro II', while the same work in a copied source of Grimm 1698/99, goes up to b². Grimm 1698/99 is a tablature source. While it is easy to make a mistake in tablature which could result in notes being displaced by an octave, this discrepancy may indicate that Froberger had an instrument with fewer notes when preparing 'Libro II', but had wanted to go up to b² if the

¹⁵ When there is a discrepancy in the numbering of bars between sources or editions, the bar number corresponds with the autograph source, in this case 'Libro II' from 1649.

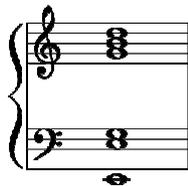
instrument allowed it. Example 8 shows a passage from Variation 4 of Partita VI 'auff Die Maÿerin', FbWV 606 where a discrepancy between the sources can be found.

Example 8. Froberger, FbWV 606, Variation 4 (Libro II and Grimm 1698/99)



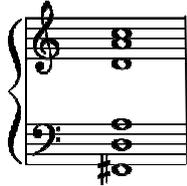
A number of his works indicate that they were written for an instrument with the short-octave. For example, in Toccata FbWV 101 from 'Libro II', there are chords with a 10th in the left hand which are much easier to play on a short-octave keyboard. This particular work happens to have both F# and G#, which do not exist if the instrument is equipped with the normal short-octave keyboard, and therefore it is possible that this work was intended for an instrument with the split-key short octave. Example 9 shows the chord containing a 10th.

Example 9. Froberger, Toccata FbWV 101, Chord in bar 6



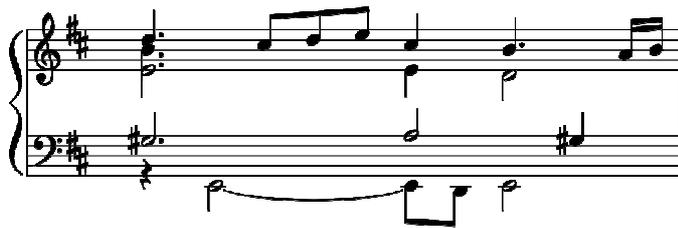
It is also possible, however, that Froberger simply had a rather large hand span and could comfortably reach a 10th. In FbWV 613, he writes a 10th which would not be made easier with the use of the short octave. (Example 10)

Example 10. Froberger, FbWV 613 Sarabande, Chord in bar 8



However, even if Froberger did have a large hand span, he could hardly have expected players to manage this passage below (Example 11):

Example 11. Froberger, FbWV 611, Courante, bar 6



This work seems to make use of F# and G# quite freely, and it is reasonable to think that the instrument intended for this work must have had a split-key short octave. Wraight interestingly states that when a split-key short octave is used, the instrument was, more often than not, provided with split-key enharmonic alternatives as well (Wraight 2010, 6). This work also has a number of *D*#s and *A*#s, and it would be convenient if there were split-keys for enharmonic alternatives in the higher registers.

There is other evidence that Froberger's keyboard did not extend lower than C with no E \flat or C# when he was preparing 'Libro II'. In Toccata FbWV 112, the passage at bar 9 has an extended descending scale followed by a large leap just as it reaches the E \flat (Example 12). On a short-octave keyboard, the E \flat does not exist and it would make

sense for the passage to make a large leap up to the $e\flat$. This work also makes use of the $G\sharp$, again suggesting a split-key short octave.

Example 12. Froberger, FbWV 112, bar 9



Another example is also found at bar 46 in Ricercar FbWV 407, this time apparently avoiding $C\sharp$:

Example 13. Froberger, FbWV 407, bar 46



In 'Libro IV' (1656) and 'Libro di capricci, e ricercate' (c. 1658), he also stays within the $C-a^2$ compass, except for the suites, where three out of six suites go beyond a^2 but not beyond c^3 . In the *Lamento* FbWV 612, it is crucial that the keyboard extends to c^3 , as there is a C major scale that extends up to c^3 right at the end of the work to symbolise the soul of the deceased Ferdinand IV ascending to heaven (Example 14). There is even a picture of what must be a depiction of heaven after the scale in the autograph score of 'Libro IV' (Figure 7).

Example 14. Froberger, FbWV 612, *Lamento*, bar 13

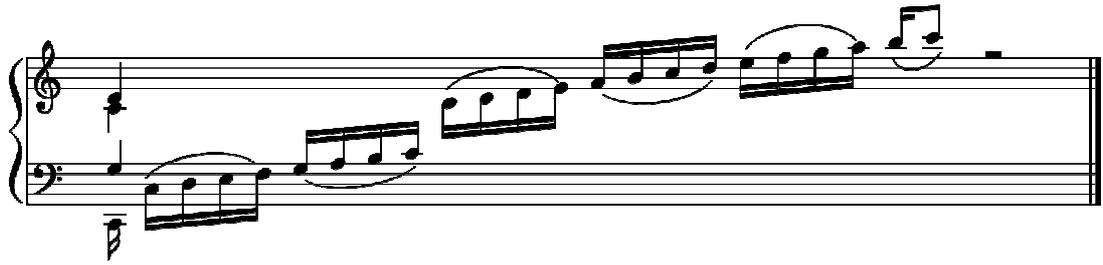


Figure 7. Depiction of heaven at the end of *Lamento*, FbWV 612

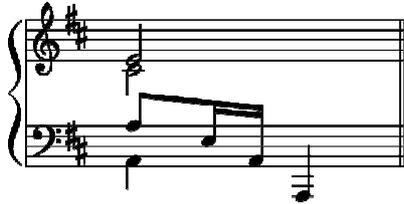


At the lower end of the keyboard, the lowest note he ever wrote was AA, but BB is never found among his works. While he seems to write F# and G# quite freely, E \flat is rare. It only appears in a few works including Partite FbWV 614, 617, 618, and 619.

The only AA he writes in the Austrian autograph sources (i.e. 'Libro II', 'Libro IV', 'Libro di capricci, e ricercate') is the AA in the Sarabande of Partite FbWV 608. In it, AA is a reiteration of A and could easily be replaced by A if AA is absent from the keyboard. In fact, this is exactly how it is notated in SA4450, and one wonders if the AA in 'Libro IV' is a slip of the pen; perhaps Froberger forgot to transpose it up an octave when preparing this volume. Curiously, the rest of that manuscript contains AA, for example in *Tombeau* FbWV 632a, *Meditation* FbWV 620 and *Lamentation* FbWV 633. In addition, the role of AA is sometimes a little more than an octave reiteration as

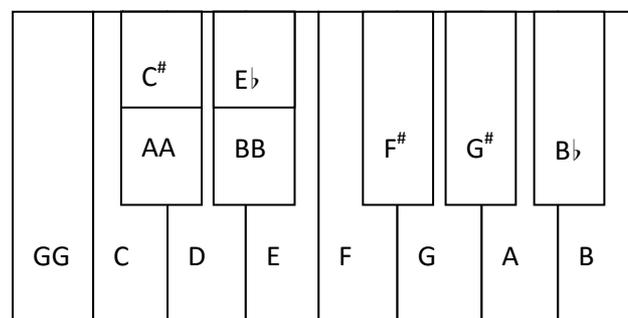
in the Gigue of FbWV 620 where replacing it with A would not be an option (Example 15):

Example 15. Froberger, FbWV 620, Gigue, End of bar 5



In the Tombeau FbWV 632a, Froberger writes $BB\flat$ which is not found anywhere else in his works. *Tombeau* is known to have been written in Paris after the death of his friend and colleague Monsieur Blanchrocher in the winter of 1652. The typical compass of French harpsichords in the middle of the seventeenth century was $GG/BB-c^3$. As on Italian instruments, French harpsichords of this period were also often equipped with the split-key short octave (Kottick 2003, 167). As can be seen in the diagram below (Figure 8), $BB\flat$ exists only if the keyboard chromatically extends down to GG without the short-octave, unless Froberger expected BB key to be tuned to $BB\flat$ for this work as BB was not needed.

Figure 8. GG/BB Split-key short octave



Conclusion

Many experiments with regard to accommodating the wolf were made to make meantone temperament work on keyboard instruments during the sixteenth and seventeenth centuries. Split-keys were invented and used to provide alternatives for enharmonic notes, particularly $E\flat/D\sharp$ and $G\sharp/A\flat$. Instruments equipped with 19 divisions to the octave providing all of the enharmonic options, and instruments with up to 31 divisions to the octave were also invented and developed by various musicians.

Split-key devices were also used to accommodate the split-key short-octave mechanisms. The compass of instruments from the sixteenth and seventeenth centuries used the short octave in which the accidentals in the lowest register were replaced by more useful pitches. This had some economical advantages particularly on the organ as organ pipes in the low register were expensive to make. Later, these accidentals were added again by the use of split-keys which enabled the instrument to have all of the notes without having to increase the width of the instrument. This also made it possible to play more sonorous chords without the hand stretching more than an octave.

Music of the period also made use of notes beyond the 12 notes available in quarter-comma meantone. At the same time, composers also seem to make them playable on standard keyboards by sometimes only using enharmonic notes in different registers, or by using wolf notes only confined to a section, or used them in such a way that added intensity to the passage. Works that clearly overstep the limits of meantone temperament were also discovered to have been conceived at a pitch which perhaps made the work simpler, and transposed later to make it look more impressive. Composers also seem to have been relaxed about performers omitting sections and/or making small changes to their compositions.

A number of instruments which might have been known to Froberger were then discussed. These included Johann Mayer's 1619 harpsichord, Giovanni Celestini's 1587 virginal, an organ from Brescia made in 1581 and an organ in Vienna by Hans Wökherl made in 1642. The organ by Wökherl was equipped with some split keys for enharmonic options.

Froberger's music was then discussed in terms of the compass used in his works. Notes which overstep the limits of meantone temperament will be discussed along with the discussion of context in which they appear in the next chapter. Froberger was a pupil of Frescobaldi who was a pupil of Luzzasco Luzzaschi who was famous for being an accomplished player of the *archicembalo*. Among other musicians who had influence on Frescobaldi as a composer include Vicentino who invented the *archicembalo*, and Mayone and Trabaci who wrote for the *cimbalo cromatico* (Jackson 1971). These musicians experimented with the limits of meantone temperament, and through Frescobaldi's influence it must have passed down to Froberger.

CHAPTER III

Case studies: Intervals in Context Within the Keyboard Works of Froberger

It will be seen in some of the case studies below that Froberger's works were revised throughout his lifetime. There are sometimes up to ten versions of the same work available in different sources. This indicates that he was very creative and always brimming with ideas. Rampe states:

Undoubtedly inspired by the composer's own performance of the compositions, the changes always demonstrate improvisatory qualities and involve not only details like ornamentation and part-writing, but also the addition of voices and new cadential or closing sections. They all provide impressive evidence of a phenomenon that is known to have applied to many other keyboard works ranging through the sixteenth to early twentieth centuries. They were never performed twice in exactly the same way; changes were always made in the course of performance in order to captivate audiences afresh. (Rampe 2003, 9)

To incorporate details about the changes in his works would be a study in itself. However, any significant changes or those that affect the current study have been commented on throughout this chapter.

Affligée et Tombeau fait à Paris sur la mort de Monsieur Blanchrocher, FbWV 632a

Suggested retuning: None

The *Tombeau* was inspired by the death of his friend and colleague, the French lutenist Charles Fleury, Sieur de Blanchrocher who died after falling down the stairs while Froberger was visiting Paris in 1652-3. It is known that Blanchrocher died in November

1652 (Rampe 2003, XXXIX) and this piece was probably written in Paris between November 1652 and March 1653. Blanchrocher's death also inspired other composers to write similar works (Asperen 2001, 12), most notably Louis Couperin (c.1626-1661).

The *Tombeau* survives in two sources, SA 4450 and WMin 743. It is in C minor although only one flat appears in the key signature in SA 4450.¹ In WMin 743, there are two flats in the key signature, and this has a dramatic effect on the ominous descending scale at the end, as the extra flat in the key signature makes it minor. There is another significant difference between the two sources at the end of this work, where an extended written-out trill is found in SA 4450 but not in WMin 743. Example 16 shows the added extended trill and the scale in C major.

Example 16. Froberger, FbWV 632a, Extended Trill at bars 18-19

The image displays a musical score for Example 16, Froberger, FbWV 632a, Extended Trill at bars 18-19. The score is presented in two systems. The first system shows bars 18 and 19, with a trill in the right hand. The second system shows the continuation of the trill and a descending scale in the right hand, ending with the text 'Requiescat in Pace'.

The work uses no $A\flat$, which belongs to the key of C minor, but its enharmonic $G\sharp$ is used three times. Interestingly, this fits the normal disposition of quarter-comma meantone $E\flat$ - $G\sharp$.

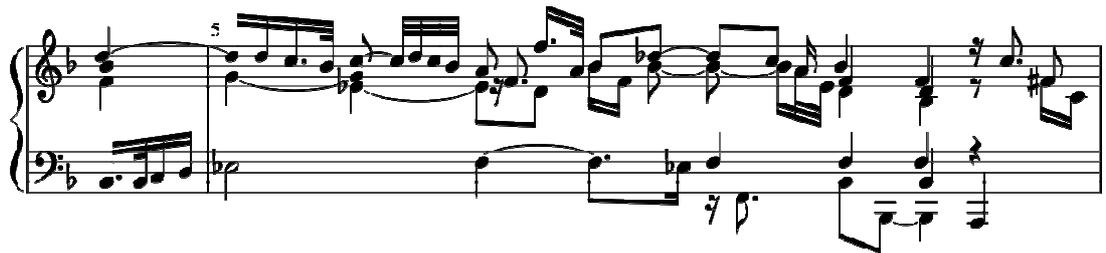
Outside the notes available in this disposition of quarter-comma meantone, a $D\flat$ ($d\flat^2$) is used. Its enharmonic, $c\sharp^2$ is used several times, so it would not be an option

¹ Before the eighteenth century, works were often notated with fewer flats and sharps than in today's notation (Chew and Rastall 2001).

to retune $d\flat^2$ pure. $D\flat$ is not one of the notes commonly divided on harpsichords with split accidentals.

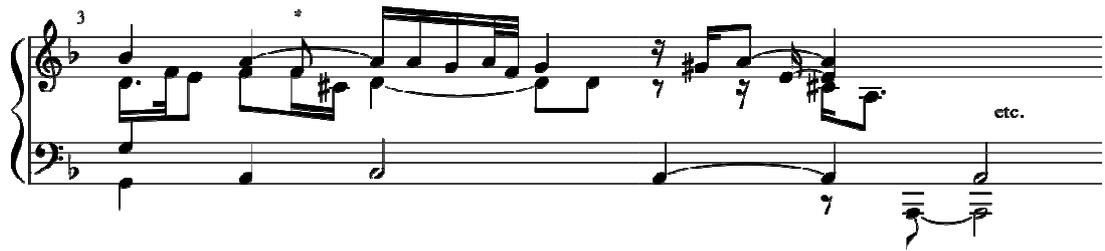
The $d\flat^2$ appears against $b\flat^1$ in bar 5, a minor third away. It sounds low because it is tuned as $c\sharp^2$ and the interval $b\flat^1-d\flat^2(c\sharp^2)$ is 46.48 cents narrower than a pure minor third. The $d\flat^2$ is exposed in the top voice and its low pitch enhances the sorrowful subject. In performance, the minor third containing $d\flat^2$ could be slightly delayed and the following $e\flat$ in the left hand delayed also, so that the poignant character of this interval can be highlighted. Track 9 on the accompanying CD demonstrates bar 5, here recorded with a spontaneous passing note to enhance the effect.

Example 17. Froberger, FbWV 632a, *Tombeau*, bar 5



The *Tombeau* also makes use of a few diminished fourths using notes that are within the normal disposition of quarter-comma meantone. In bar 3, $c\sharp^1$ appears against f^1 , creating an interval of a diminished fourth. In equal temperament, this interval is enharmonically equivalent to a major third, an already wide interval. In quarter-comma meantone, this interval is 41.11 cents wider than a pure major third which is also 27.42 cents wider than a major third in equal temperament. Since the limit of deviation from the pure interval the ear can tolerate is around the maximum of 20 cents for a third, this interval will sound especially dissonant. Example 18 shows the passage at bar 3 with an asterisk (*) over the diminished fourth.

Example 18. Froberger, FbWV 632a, *Tombeau*, bar 3



Froberger notates this interval in such a way that indicates that he wanted these notes to be overlapped. A harmonic diminished fourth is more striking than a melodic diminished fourth where the two notes do not overlap. Perhaps in an attempt to express the pain of losing a friend, he chose to use this interval in this way, although he makes it less conspicuous by making the notes of the outer voices hold over, which somewhat disguises the effect (See Example 18 above). In performing this work, it is possible to highlight the expressive nature of this interval to express Froberger's devastation at his friend's death by perhaps applying a back-dotted version of *notes inégale* to these notes in order to increase the time f^1 and $c\#^1$ overlap, as heard on Track 10 of the accompanying CD.

In bar 6, the same gesture returns. Here, Froberger harmonises both f^1 and $c\#^1$: f^1 is now part of a D minor chord, and $c\#^1$ which follows is part of an A major chord. The dissonant quality of the diminished fourth is no longer heard. Instead, the climax of this passage has now shifted to the seventh chord on $B\flat$ which follows, resulting in a strong interrupted cadence where Froberger lets the $B\flat$ and a clash on the seventh crotchet beat of the bar (Track 11, Example 19). The passage in bar 3 was also followed by $B\flat$ in the bass, but the note that creates the seventh, namely the A, appeared in the treble register, creating an interval of a fourteenth which sounds less dissonant than a seventh.

Example 19. Froberger, FbWV 632a, *Tombeau*, bars 6-7

Diminished 4th now harmonised

In the second half of this work, Froberger uses more diminished fourths, this time between *B*-natural and *E* \flat in two different registers. Two of them are harmonic, and the other two are melodic intervals. These intervals again help to convey melancholy and could be emphasised by lingering, placing or playing them deliberately.

Example 20. Froberger, FbWV 632a, End of bar 14

If sixth-comma meantone were to be used to play this work, then all of the above-mentioned intervals would be less pronounced. The interval *C* \sharp -*F* is 29.35 cents wider than a pure major third and 15.66 cents wider than a major third in equal temperament. The interval *B* \flat -*D* \flat , is 32.71 cents narrower than a pure minor third, therefore these intervals would be less colourful. In bar 3, performers may choose to give priority to maintaining the momentum of the rising bass line, focusing instead on the 7th chord on *B* \flat that follows. It is possible to hide the diminished fourth further by

playing the notated rhythm (instead of applying the back-dotted version of *notes inégale* as suggested earlier), as heard in Track 12, or by applying *notes inégale* as heard in Track 13.

It has been claimed that Froberger was one of the first composers to write programmatic music for the keyboard based on specific events he personally experienced (Asperen 2001, 6). His music is narrative, and the *Tombeau* seems to contain a musical representation of the fall that caused Blancherocher's death, with fast runs and a sudden leap to a very low note at the start of the second half. The G pedal towards the end is possibly a portrayal of the church bells from his funeral procession (Rampe 2003, XXXIX), and the ominous descending scale at the end representing the soul of the deceased giving up the body. A cross and the words '*Requiescat in pace*' (Rest in peace) appear at the end in the score.

Given the extra-musical inspiration of this work, and the way in which Froberger seems to have used the limits of meantone temperament for colour, it may be concluded that playing this piece in quarter-comma meantone $E\flat-G\sharp$ is effective. The performer has Froberger's consent to play with rhythmic freedom as Froberger indicates this *Tombeau* 'to be played very slowly and freely', allowing the performers either to highlight or smooth out dissonances which are made more or less intense by their choice of temperament.²

² It might be interesting to draw a quick comparison to Louis Couperin's equivalent work. Couperin puts his *Tombeau* in the key of F major and the general mood of the work is less somber than that of Froberger's. It has less rhythmic variety, and Couperin's aim appears to be to express resignation and a feeling of loss through the use of pure harmonies and longer rhythmic note-values. It is worthy of note, however, that in bars 31 and 52 of this work, Couperin uses $A\flat$ s which would sound very low if the harpsichord is tuned in quarter-comma meantone $E\flat-G\sharp$, and would create a similar effect to the $D\flat$ in bar 5 of Froberger's *Tombeau* as discussed here. Also in bar 46, Couperin uses a diminished fourth, which also features in Froberger's work.

Example 21. Froberger, FbWV 614, *Lamentation*, bars 1-5

The image displays a musical score for Example 21, Froberger, FbWV 614, *Lamentation*, bars 1-5. The score is written for piano and consists of five systems of music, each with a treble and bass staff. The key signature is G minor (one flat) and the time signature is 3/4. The first system (bar 1) features a complex texture with sixteenth-note runs in the right hand and a steady bass line. The second system (bar 2) continues the melodic development in the right hand. The third system (bar 3) shows a change in the bass line. The fourth system (bar 4) includes a fingering instruction '7-6' in the bass staff. The fifth system (bar 5) concludes the passage with a final cadence. The notation includes various rhythmic values, accidentals, and phrasing slurs.

Suite in G minor, *Lamentation sur ce, que j'ay été vole. Et se jouë à la discretion, et encore mieux que les soldats m'ont traicté* – Courant – Sarabande – Gigue,

FbWV 614

Suggested retuning:



The *Lamentation* in G minor FbWV 614 was also inspired by an extra-musical event. The French title translates as: 'Lamentation on me being robbed, to be played at pleasure and better than the soldiers who mistreated me.' The incident described in the French title is believed to have happened on his travels between Brussels and Leuven (Rampe 2002, LXXX).

This work is in G minor although only one flat appears in the key signature. One of the first aspects that draws attention when studying this work is its use of A \flat s. Froberger uses several A \flat s throughout the work and they appear at harmonically crucial moments when a well tuned chord is required. For example, a perfect cadence appears in bar 3 in the key of A \flat (see Example 21), where A \flat needs to be stable as the root of the 'tonic' chord. In bar 4, a 7-6 suspension happens over the A \flat which is held for four crotchet beats which then makes an effective chromatic shift to A-natural in the bass. In order for this passage to be successful and for the A \flat s to provide harmonic stability, the wolf A \flat is not acceptable.

Blandine Verlet chose to play this work in the normal disposition of quarter-comma meantone on her recording from 1989. This is recreated by the present author on Track 14 on the accompanying CD. As can be heard, using the normal disposition of quarter-comma meantone interrupts the flow of the music to the extent that harmonic

progression is no longer functional. As the music of the Baroque period is built upon strong harmonic foundation, wolf notes in the bass do not work well. There are also several $A\flat$ s scattered throughout two long bars in the first half of the work, as well as a few more $D\flat$ s and $A\flat$ s in the second half, and together, they appear frequently enough to disorientate the listeners.

Possibilities for practical adjustments include tuning both of the $A\flat$ s which appear at two different pitches pure since their enharmonic notes are absent in this work. Track 15 on the accompanying CD demonstrates the first half of this work recorded with pure $A\flat$ s.

Some may argue that the incident of Froberger being robbed affected him so much that he may have wanted the $A\flat$ s to sound 'out of tune'. Since Froberger is known to use wolf notes for his extra-musical portrayals, this argument is at first plausible. However, it is difficult to imagine a seventeenth-century composer making this a priority over the overall structure of the work. Harmonic progressions provide the foundation for music at this time and it seems unlikely that wolf notes would be used for expressive colouring at the expense of the structure.

If a performer wishes to retain the effect of using some wolf notes without disturbing the music, it is possible to retune just $A\flat$ at that pitch as there is no $G\sharp$, but not $a\flat^1$ or either of the $D\flat$ s. This would help to retain some of the tension built by the use of the wolf notes while still be able to maintain the harmonic structure. In bar 9 of this movement, Froberger uses a number of $a\flat^1$ s and $d\flat$ in quick succession. The instability of these notes within the temperament will momentarily disorientate the listener. It is interestingly followed by a passage in F major which would sound serene and pure, perhaps in an attempt to make the passage regain harmonic stability.

There is also $d\flat^2$ in the second half of bar 7. While the enharmonic of this note is absent, it would be appropriate to leave this note tuned as $c\sharp^2$. Exactly in the way this note provided a poignant moment in the *Tombeau* investigated earlier, this would provide a suitably poignant sound.

It is also possible to play this work in sixth-comma meantone, which provides a milder version of the wolf. The wolf interval still has a deviation of 19.55 cents, but compared with 35.72 cents in quarter-comma meantone, it is significantly closer to pure. This solution may also provide another reasonable compromise as it could be argued that the $A\flat$ tuned as $G\sharp$ is used for extra colour. Track 16 demonstrates this.

From an interpretative point of view, these options in tuning may provide inspiration for completely different approaches. When the $A\flat$ s are tuned pure, the performer may choose to confidently enjoy the bass notes $e\flat - E\flat - A\flat$ in bar 3. Placing and lingering on the $A\flat$ allows time not only to register the pure sound of the $A\flat$ but also allows the listeners time to enjoy the $A\flat$ major chord before the f^1 is introduced to make the chord a $6/5$ chord (see Example 21). The $A\flat$ appears in the bass again a bar later. This can also be prepared by carefully placing the preceding $B\flat$ in such a way to make the $A\flat$ seem important over which there is a 7-6 suspension.

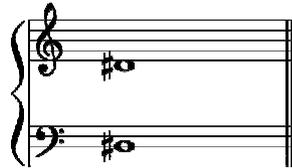
When using sixth-comma meantone, a performer may be inspired to do exactly the opposite. The previous phrase can finish on the $e\flat$ in the middle of bar 3, giving a new impulse on the sixth crotchet beat (the low $E\flat$), from which the $A\flat$ can bounce off as a note en route to $B\flat$ on the downbeat of bar 4. The C minor chord on the third crotchet beat of bar 4, which was a low point in the previously discussed interpretation can now become more important, from which the bass notes can relax into the $A\flat$ in the middle of bar 4 so as not to draw the listeners' attention to these succession of unstable $A\flat$ s.

Meditation faite sur ma mort future, la quelle se joüe lentement avec Discretion

(Meditation about my future death, to be played slowly and with discretion) -

Gigue - Courante - Sarabande, FbWV 620 - included in the recital

Suggested retuning:

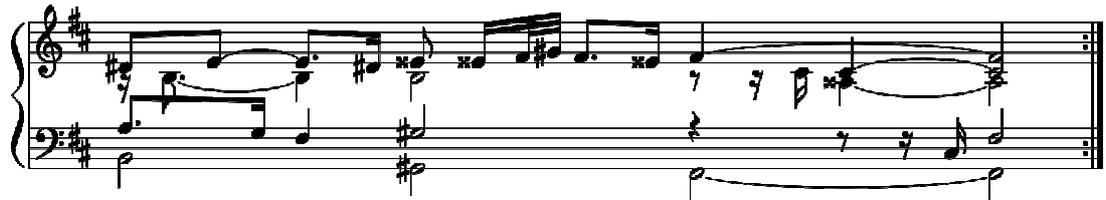


The unusual subject of this piece is Froberger's own future death. Whereas the deaths of others seem to inspire the composer to use flats and minor keys, he chooses to use a major key for a work about his own. The work is in D major, and the notes beyond the normal disposition of quarter-comma meantone include *D#s*, *A#s* and *E#s*. As with other works which have programmatic titles for the first movement followed by dances, he is most adventurous in the opening movement. Notes beyond the normal disposition of quarter-comma meantone are rarely used in the remaining movements. In fact, the Gigue is entirely free of any of the notes listed above, and the Courante and Sarabande have just one *D#* each.

Interestingly, Froberger uses a different sign for *A#s* and *E#s*. They are marked with a 'x' rather than a '#'. It is perhaps because the *D#s* were likely to be split but *A#s* and *E#s* were not, or simply that he expected *D#s* to be tuned pure, but *A#s* and *E#s* were to be left as the pitches for their enharmonic notes. The *E#* near the end of the first half would certainly make more of an impact if the *D#s* preceding it are pure. Example 22 shows this passage. Rhetorically, this is the perfect place to have these wolf notes as discussed in the previous chapter. Froberger cleverly follows this passage with an *F#* minor chord at the beginning of the second half. This immediately takes the edge off the

sound of the 'sour' F# major chord which concludes the first half of this work, and enhances the mellowness of the F# minor chord, therefore perhaps portraying the sorrow of his own mortality.

Example 22. Froberger, FbWV 620, *Meditation*, End of bar 3



In practical terms, $d\#$ and $d\#^1$ could quickly be tuned pure for the performance of this work since there are no $E\flat$ s. $d\#^2$, which only appears once in the Courante, could be left tuned as an $E\flat$ as it appears at the top of the chord and it leads upwards. As this is the leading note, the higher pitch of this note would be welcome as it would enhance its leading-note character. It is also known that Sotheby's manuscript includes this work. In fact, there are some sections of it reproduced in the auction catalogue, but the photograph unfortunately falls short of the section with the $A\#$ s and $E\#$ s. More discoveries may be made if this source eventually becomes accessible. Chapter 5 on the accompanying DVD from the recital demonstrates the points made above.

Ricercar in F# minor, FbWV 412 - included in the recital
Ricercar in C# minor, FbWV 406

Suggested retuning: None

The Ricercar in F# minor FbWV 412 was included in 'Libro Quarto', a volume compiled for Emperor Ferdinand III of Habsburg in 1656. This work, together with the Ricercar in C# minor FbWV 406 from 'Libro di capricci e ricercate' presented to Emperor Leopold I around 1658, are perhaps the most intriguing works by Froberger.

The Ricercar in F# minor ends with a *Tierce de Picardie*, so the final chord of the work is an F# major chord consisting of F#, A# and C#. In fact, each of the three sections in this work ends on an F# major chord. When a harpsichord is tuned in quarter-comma meantone, the major third between F# and A# (B \flat) would be 41.11 cents wider than pure and therefore unusable, particularly as the final chord of a work.

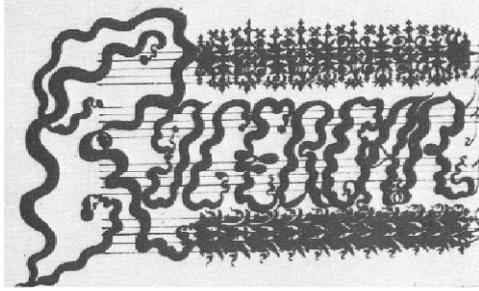
In an attempt to understand his compositional concept behind the Ricercar in F# minor, it would be helpful to determine whether it requires a circular temperament or if it is still rooted within the limits of meantone temperament but made to appear that it requires a circular temperament by his choice of key as Trabaci appears to have done in his work for the *cimbalo cromatico* as discussed in the previous chapter. For the purpose of this investigation, it was temporarily transposed to D minor and the notes were analysed.

In D minor, this work sits within the normal disposition of quarter-comma meantone E \flat -G# except for one A \flat which appears in the penultimate bar as part of a passing chromatic gesture. Using one note outside a particular disposition of meantone is not unusual for Froberger and can hardly be considered as overstepping the limits of meantone temperament, particularly in its role as a passing note. This proves that, in theory, this work can be performed in quarter-comma meantone if the wolf were placed between the B# and G and the harpsichord tuned with the disposition of G-D-A-E-B-F#-C#-G#-D#-A#-E#-B# with no flats at all, and not even a C-natural. However, it is highly unlikely that Froberger expected the harpsichord to be tuned in such a way, and it is indeed puzzling to see this work included in a volume presented to the Emperor.

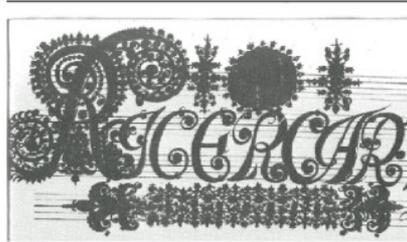
My attention was then drawn by Richard Egarr to the dramatically wobbly writing of the title 'Ricercar' in the autograph (see Example 23). Since no other Ricercar has its title written in this bizarre manner (see Example 24 for titles belonging to the

other ricercars of the set), he considered that this work was intended to be played in the normal disposition of quarter-comma meantone and the F# major chord was supposed to sound 'harsh'.

Example 23: Froberger, FbWV 412, Ricercar, Wobbly title



Example 24: Froberger, Titles of Ricercars FbWV 407-411



Under further analysis, it was found that the notes that overstep the limits of meantone temperament are mostly confined to the end of each of the three sections where there is a cadence in F# major. The first two of these cadences are both followed by an F# minor chord, a technique seen in the *Meditation* analysed above where he gives the listener the mellow sound of a minor chord on the same key note after the 'harsh' sound of the major chord containing the wolf major 3rd. At the end of the work, Froberger uses the E# at the last possible moment to establish a perfect cadence in F# major. A performance of this work in the normal disposition of quarter-comma meantone E \flat -G# is included as Chapter 6 on the accompanying DVD of the recital.

This ricercar is therefore not as adventurous as it first appears. It is perfectly possible to perform this work in the normal disposition of quarter-comma meantone, particularly if the audience is informed about the appearance of the title in the autograph. For those performers who would not like an unstable chord for the end of the piece, it is possible to tune the harpsichord in quarter-comma meantone from F to A#, with no flats, F-C-G-D-A-E-B-F#-C#-G#-D#-A#. This still sounds quite extraordinary as this will still leave E# and B# which are part of the dominant, and the dominant of dominant as wolf notes, but makes the F# major chord stable. Both the E# and the B# only appear at cadences as leading notes, and as such, they can be left high and still function as leading notes, as has been seen in other examples above.

If sixth-comma meantone E \flat -G# is used, then the interval between F# to A# is still nearly 30 cents too wide but the effect is less shocking. If the wolf were shifted in the manner described above, then similar solutions are possible and result in a disposition with no flats.

It is of course possible to play this piece in a later temperament with no wolf. After all, this work, and the Ricercar in C# minor discussed below, are probably works

which prompted writers to conclude that Froberger's music requires a circular temperament, particularly because both were included in volumes presented to the respective Emperors.

For this investigation, a selection of later historical temperaments was chosen. Historical temperaments by Kirnberger, Werckmeister and Vallotti represent the temperaments that were used after musicians moved away from meantone temperaments before they considered equal temperament to be the norm. In this investigation, intervals *F#* to *A#* and *C#* to *E#* were analysed.

Kirnberger III seems to have a slightly better *F#* major chord than the other two temperaments. It is a useful temperament when meantone temperaments prove difficult. As discussed in Chapter I, the first part of the circle of fifths is identical to quarter-comma meantone. It resembles meantone in the keys with fewer flats or sharps, but has the flexibility of a circular temperament with no wolf. In this temperament, *F#* to *A#* is 19.57 cents, and *C#* to *E#* is 21.53 cents wider than pure.

In both Werckmeister and Vallotti's temperaments, *F#* to *A#* and *C#* to *E#* are 21.53 cents wider than pure and so fractionally worse than Kirnberger's temperament. Since the historical temperaments of the Baroque period were designed to maintain pure intervals in keys with fewer sharps and flats, none of the historical temperaments has very good intonation on *F#* to *A#* or *C#* to *E#*. The only solution that improves these intervals is to use equal temperament. Both of these intervals are the same as all the other major thirds, and are just 13.69 cents wider than pure. It still seems more convincing to show the listeners Froberger's dramatically wobbly title and to enjoy the effects of the wolf intervals.

Ricercar in *C#* minor is similar to the work in *F#* minor. Again, the notes which overstep the limits of meantone temperament mostly appear at cadences. Transposing it

reveals the same result as the Ricercar in F# minor,³ and although there is no wobbly-looking title for this work, none of the ricercars in this set has an ornate title at all. Therefore, it could probably have the same solution as the Ricercar in F# minor.

In Chapter II, harpsichords with split keys were discussed. It is known that these harpsichords existed in places that Froberger visited and so he may have come across them on his travels (Rampe 1995, XXX). Playing these ricercars on instruments with split keys, perhaps even a *cimbalo cromatico*, would solve many of the problems of intonation with much more ease.

Other Ricercars in 'Libro IV' and 'Libro di capricci e ricercate'

There are ten other ricercars that were included in 'Libro IV' and 'Libro di capricci e ricercate', FbWV 407-411 and FbWV 401-405. It is interesting to note that they are mostly in keys with just one sharp or flat making them far easier to perform in the normal disposition of quarter-comma meantone than the two discussed above. In 'Libro Quarto', there are two in D minor, and one in each of G minor, E minor and G major, and only the ricercar in E minor FbWV 409 makes use of a note outside the normal disposition of quarter-comma meantone $E\flat-G\sharp$, namely the $D\sharp$ which is part of the dominant chord in the key of E minor. All occurrence of the $D\sharp$ are in fact within the context of the dominant chord, and since there is no $E\flat$ in this work, it is perfectly possible to tune the $D\sharp$ s pure.

In 'Libro di capricci e ricercate', there are two ricercars in C major, one in G major, one in F major and one in G minor of which only the ricercar in F, FbWV 403, contains a note which lies outside the normal disposition of meantone temperament, $E\flat$ -

³ Pollard (1985, 140) in his thesis states that if the Ricercar in C# minor was transposed up a semitone to D minor it would fit the normal disposition of quarter-comma meantone. He also implies that if the F# minor ricercar was transposed down a tone to E minor, this would fit the normal meantone disposition. However, both are incorrect. C# minor ricercar would need to be transposed down a major third to A minor to fit the normal disposition of quarter-comma meantone.

G#. However, this note, *D♭*, only appears briefly within the context of a perfect cadence to mark the end of a section. While it is possible to retune this *D♭* in order for it to be pure as there is no *C#*, it is hardly worth the trouble. Froberger could easily have written a *D*-natural in its place, and it would have made perfect musical sense. Instead, he chose to flatten the *D* to *D♭*, and the low pitch of the *D♭* (tuned as a *C#* in quarter-comma meantone) may enhance the effect Froberger may have been seeking.

Pollard uses this very example and states that this *D♭* is 'in a position where it is not easy to disguise; it is meant to be heard, savoured and perhaps even lingered over, but in quarter comma meantone temperament the 'tone' *E♭-C#* is distressingly wide (234c).' However, this bar acts as the coda to the previous section and the main cadential point of arrival has already occurred at the start of bar 59. Furthermore, the *E♭* in the bass provides a more prominent harmonic surprise, and the *D♭* which occurs right at the end of the bar appears within this context, contributing merely to add extra 'spice' to this already colourful passage.

Suite in E minor, *Allemande faite en passant le Rhin dans une barque en grand peril, la quelle se joïe lentement â la discretion* (Allemande made crossing the Rhine in a boat in great danger, played slowly with discretion) - Courante - Sarabande - Gigue, FbWV 627 - included in the recital

Suggested Tuning for the Allemande:



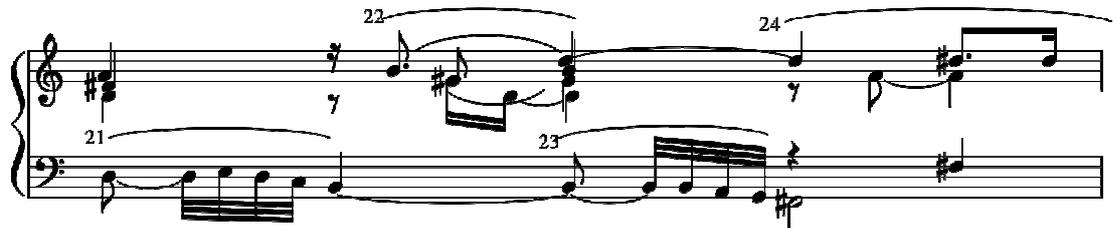
Suggested Tuning for the other dances:



Before SA 4450 was discovered, this work was known in two sources, Tappert (*c.* 1670) and Bulyowsky (1675). However, the opening Allemande was only known as the 'Waterfall' and it was not until SA 4450 was discovered that the full title became known. In fact, the title had been reported by Mattheson (Wollny 2006, XVIII), and there had been much speculation by scholars as to which work the title referred.

This piece is also unique in that it includes a detailed description of the events portrayed, which is written out in SA 4450. In fact, the descriptions are so detailed that each passage is marked with a number which corresponds with the number indicated in the descriptions (Nos. 1-26). It is a musical representation of Monsieur Mitternacht's ordeal of falling into the Rhine at St. Goar. Monsieur Mitternacht, major-domo to Count von Thurn, was travelling on the Rhine with his master, two other men and the composer when the incident happened. They had gone out for the evening until the small hours on the 24th June. On their return, Monsieur Mitternacht fell into the Rhine, and the piece portrays a detailed account of his rescue (Wollny 2006, XX-XXI). Froberger musically depicts each part of the incident in detail. For example, the passage at events Nos. 21 to 23 are shown in Example 25. No.21 represents the current that Monsieur Mitternacht is drawn under, he is almost losing hope on the diminished chord at No.22, then he is drawn deeper into the currents at No.23. Eventually, he is rescued and all is well.

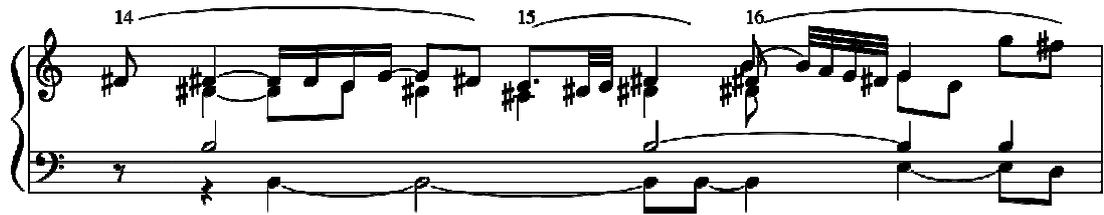
Example 25: Froberger, FbWV 627, *Allemande faite en passant le Rhin*, bar 7



The opening Allemande makes use of a number of $D\#$ s, but as there is no $E\flat$ found in this movement, or in fact in any of the dances that follow, it is possible to tune $D\#$ s pure. $D\#$, as mentioned in the previous chapter, is also one of the more common notes to be split on harpsichords with split-keys, so no retuning would be necessary if it is played on such an instrument.

On closer examination, however, it is evident that whenever something more dramatic happens, Froberger uses $D\#$ s, for example at no. 8 when Monsieur Mitternacht 'begins to sigh'. $d\#^1$ appears quite exposed at the top of the chord, and it might be quite appropriate for it to remain a pure $E\flat$. Similarly, there are several $D\#$ s in bar 5 (shown in Example 26 below), when Mr Mitternacht gets caught in the water swirl and struggles (Nos. 14-16). It is then reported that he comes back up to the surface, which is what the large upward leap at the end of the bar is probably portraying. Again, these $D\#$ s could be left tuned as $E\flat$ s in order to add intensity to this passage. The appearance of the $D\#$ s in bar 5 (i.e. Nos. 14-16) are concentrated: there is a $D\#$ on every crotchet beat, and they disappear after the large upward leap. On the other hand, perhaps the $d\#$ in bar 2 still needs to be tuned pure, as the bass notes need to be more stable. In performance, it might be appropriate to linger on the $D\#$ s that are not pure to enhance the intensity of the events being portrayed.

Example 26: Froberger, FbWV 627, *Allemande faite en passant le Rhin*, bar 5



It is also interesting to note that when *Monsieur Mitternacht* is 'momentarily resting' at No.13, the *D#* from the B major chord is omitted. In Bulyowsky 1675, which does not include detailed descriptions, the chord was filled out with $d\#^1$ and $f\#^1$. This also supports the view that it would be appropriate to leave $d\#^1$ tuned as $e\flat^1$ in this movement.

The remaining movements contain some *A#*s which were absent from the opening movement.⁴ This is unusual, since as previously stated, Froberger tended to use more 'remote' pitches in the opening movement, which also most frequently bears a programmatic title. Again, *A#*s are marked with a 'x' rather than a '#', and perhaps imply that pure *D#*s were to be used but *A#*s could be left tuned as *B*'s. All of the *A#*s appear either in one of the inner voices disguising the high pitch of those notes, or so written that they call for a trill, again disguising its pitch. If the harpsichord is equipped with some split-sharps, pure *D#*s could easily be used in these movements. The availability of pure *D#*s would be convenient as the A section in all three of these movements conclude on the dominant chord, B major, which contains the *D#*.

The B section opens with an interesting passage. In SA 4450, the B sections of the Courant and Sarabande have a B major chord with a *D#*. This suggests that the *D#*s do indeed need to be tuned pure. The end of the A section is often where notes outside

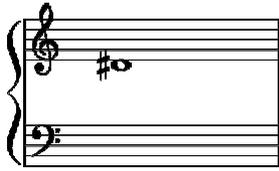
⁴ In sources Tappert c. 1670 and Bulyowsky 1675, $a\#^1$ is used towards the end of the A section of the opening movement. In the modern transcription of SA 4450, Wollny seems to respect this and inserts editorial $g\#^1$ and $a\#^1$ without commenting. These are absent from the facsimile of SA 4450.

the normal disposition of quarter-comma meantone are found. In the *Meditation* FbWV 620, discussed earlier, the chord found at the end of the A section contained an A# marked with an 'x' (possibly tuned as a pure B \flat). Froberger followed this with a minor chord on the same bass note at the start of the B section, and it was commented that this minor chord functioned to mellow the effect of the F# major chord containing a high A#. In a similar manner, perhaps Froberger had a version for the dances of FbWV 627 in which minor chord on B was to be played at the start of the B section, perhaps for when harpsichords with split-sharps were unavailable. It is perhaps, then, advisable to play a minor chord at the start of the B section in the dances, whenever pure D#s are not available for this work.

Instruments with two registers could provide another solution. The opening movement could be played on one set of 8' register tuned with pure e \flat ¹ and pure d#, and the rest of the movements on the other set of 8' register tuned with pure d# and d#¹. When this solution is applied, both the end of the A section as well as the beginning of the B section in all of the remaining dances could be played with a B major chord containing a pure D#. A performance from the recital (Chapter 4 of the accompanying DVD) is played with the pure e \flat ¹ and pure d# for the first movement, and d#¹ retuned for the remaining dances.

Suite in A minor, FbWV 630, *Plaincte faite à Londres pour passer la Melancolie la quelle se joüe lentement et à discretion* - Courante - Sarabande - Gigue - included in the recital

Suggested retuning



This work also has a brief description of the event portrayed. The descriptions are in Latin in the source WMin 743, and in German in SA 4450, but they convey the same story. Froberger was robbed twice on his way to England, once between Paris and Calais, and then again between Calais and Dover. He arrived in London with no money and was reduced to operating organ bellows, but as he was preoccupied with melancholy thoughts, he was not concentrating on this menial task. He was eventually thrown out on to the street, and he wrote this work.

The work contains a few *D*#s in the middle of the movement, as well as a few more in the Courante and Gigue that follow (there are no *D*#s found in the Sarabande), otherwise there are no other notes that lie outside the normal disposition of quarter-comma meantone. There are no *E*♭s, so *D*#s, particularly *d*#¹, could easily be tuned pure.

Froberger's use of diminished fourths is interesting in the opening movement. Diminished fourths are an enharmonic equivalent of a major third but they would be wolf intervals in quarter-comma meantone and sound 'out of tune' even though they are in tune as a diminished fourth. Froberger seems to use this interval effectively in order to express his 'melancholy' without using notes that lie outside the normal disposition of quarter-comma meantone, just as Rossi did in the example cited in the previous chapter.

The first diminished fourth appears in bar 3 between $c\#^2$ and f^2 . This occurs at a moment of repose after a long ascending scale and some demisemiquaver movement, and it is followed by descending scales in small note values, as shown in Example 27. It would be appropriate, perhaps, to pull up slightly into the diminished fourth to prepare for the dissonance and linger on it for as long as the music permits in order to enhance the effect.

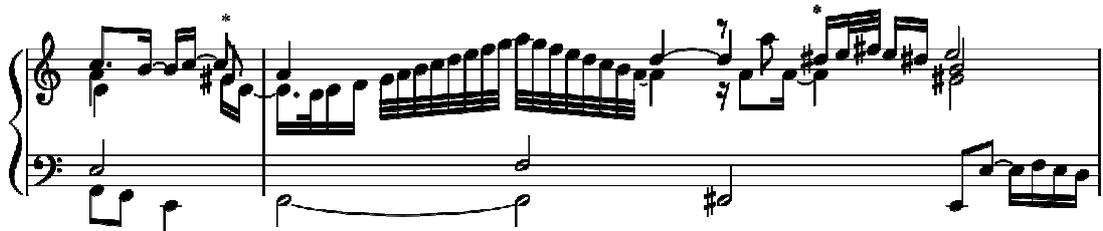
Example 27. Froberger, FbWV 630, *Plaincte faite à Londres*, bars 2-3

At the end of bar 4, another diminished fourth is used where a pair of lombard rhythms appear. Again, it would be appropriate to linger on the diminished fourth between $g\#^1$ and c^2 marked with an asterisk (*) in Example 28 below. The $d\#^1$ which appears at the start of bar 5 should probably sound pure so as not to take away the listener's attention from the aforementioned expressive diminished fourth.

Example 28. Froberger, FbWV 630, *Plaincte faite à Londres*, End of bar 4

The diminished fourth at the end of bar 6 could also be lingered upon (marked with an * in Example 29). This time it could be used to build up tension leading into the scale flourish which follows at the beginning of bar 7 as shown in Example 29. There are a couple of $d\sharp^2$ s towards the end of bar 7 but these could perhaps be left as pure $e\flat^2$ s as the higher pitch of these notes seem quite appropriate at this climactic moment, and these are unlikely to cause any disruption to the general flow of the music. All of the points made here are demonstrated in the performance in the recital (Chapter 3 of the accompanying DVD).

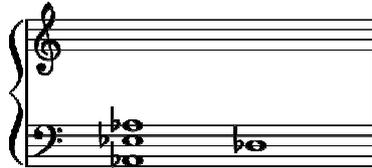
Example 29. Froberger, FbWV 630, *Plaincte faite à Londres*, bar 6-7



The two $d\sharp^2$ s in the Courante are both in the inner voice, they both resolve to e^2 and one of them exactly at the point where a cadential trill would be appropriate, making the pitch of the $d\sharp^2$ less obvious. There are three $d\sharp^1$ in the Gigue, two of which are very brief, and the other one as part of a $6\sharp-4\sharp-2$ chord on A. The pitch of the $D\sharp$ in a $6-4-2$ chord is not so noticeable because the clash between A and b is more of an impact than the high pitch of $d\sharp^1$.

Lamentation faite sur la tres douloureuse mort de Sa Majeste Imperiale, Ferdinand le Troisiesme, et se jouie lentement avec discretion (made on the very painful death of His Imperial Majesty, Ferdinand III, and is played slowly with discretion), FbWV 633 - included in the recital

Suggested retuning:



the ascent and $D\flat$ on the descent. In SA4450, however, the chord on $B\flat$ is always minor as shown in Example 30. These notes are significant, since both $A\flat$ and $D\flat$ are beyond the normal disposition of quarter-comma meantone.

Example 30. Froberger, FbWV 633, *Lamentation*, bar 1

This work is listed as a *Tombeau* rather than a *Lamentation* in Sotheby's auction catalogue. Maguire, the author of the catalogue, comments that 'important A-flats and D-flats are missing in other sources' for the opening of this work (Maguire 2006, 7). This implies that both of these chords are notated as minor in the Sotheby.

The catalogue contains pictures of some of the pieces. Unfortunately, the beginning of the *Lamentation* is not one of them, but the end bars are included on page 5. While no discrepancy is evident with regards to the pitches, a couple of ties which had previously been absent but added by editors including Rampe are now confirmed to be original.

On harpsichords tuned in the normal disposition of quarter-comma meantone, it might be appropriate to start both chords as major, just as in WMin 743, to establish the chords without wolf notes, before introducing $A\flat$ and $D\flat$. It is even possible that the

scribe of the WMin 743 decided wolf notes at the outset of the work as inappropriate and altered them.

The work contains several other $A\flat$ s and $D\flat$ s scattered throughout. In bar 9, which is at the end of the second part of this three-part work, there is an $A\flat$ major chord which contains $A\flat$, $a\flat$ and $a\flat^1$. These $A\flat$ s all need to be useable. Since there are no $G\sharp$ s used, it would be possible to retune all of the $A\flat$ s at these three pitches. $A\flat$ is also one of the two common keys to be split on harpsichords with split-keys, so if this work is played on such a keyboard, pure $A\flat$ s would be available.

In addition, some $D\flat$ s appear as the bass note. Interestingly, while there are more higher $A\flat$ s in the work than lower $A\flat$ s (15 $a\flat^1$ s, nine $a\flat$ s, and five $A\flat$ s), $D\flat$ s follow the opposite pattern and there are more lower $D\flat$ s found. In particular, there are eight $d\flat$ s found as opposed to just four $d\flat^2$ s. Given the fact that wolf notes do not function well as the bass notes, it would be a good idea to retune $d\flat$ pure as there is no $c\sharp$ found at this pitch. Its more frequent use compared with the $d\flat^2$ also seems to support this idea.

The $d\flat^1$ is the only pitch for which its enharmonic note, $c\sharp^1$ is used, and the passage in bar 8, for example, would not work with the $D\flat$ tuned as a $C\sharp$. On closer examination, however, the passage from the upbeat to bar 7 to the $A\flat$ major chord at the start of bar 9 can be treated as a separate section, and if a double-manual instrument was available, it would be possible to tune the upper manual so that all of the $A\flat$ s and $D\flat$ s contained in this section can be played as pure intervals. Example 31 shows this passage, and a performance in the recital (Chapter 7 of the accompanying DVD) demonstrates this on a single-manual harpsichord with the help from an assistant.

Example 31. Froberger, FbWV 633, *Lamentation*, bars 7-9

If the suggested tuning is adopted, there remains just enough wolf notes to colour the work without them becoming a distraction. The $d\flat^1$ near the beginning of bar 15 is particularly poignant as the arrival point after a rapid ascending scale as shown in Example 32. It is then resolved upwards onto a *D*-natural before the work comes to a conclusion on an arpeggiated and pure-sounding F major chord (Example 32).

Example 32. Froberger, FbWV 633, *Lamentation*, bar 15

Tocatta FbWV 112 in A minor - included in the recital

Suggested retuning: None

This toccata is from 'Libro Quarto' and contains the sharpest note among the toccatas in this volume, namely *E#*. Hora analysed this work in his dissertation, and considered it one of the deciding factors for his conclusion that Froberger used a circular

temperament (Hora 2004, 143-145). On closer examination, however, it is evident that this work can be played successfully in quarter-comma meantone.

The $E\#$ in question ($e\#^1$) appears in bar 16. Its enharmonic, f^1 , is used freely throughout the work, so tuning the $e\#^1$ pure is not an option. However, a further investigation reveals that the section from bars 14 to 19 (shown in Example 33) which contains $e\#^1$ is completely free from its enharmonic f^1 . Considering the freedom with which Froberger uses f^1 in other parts of this toccata, this is intriguing. As there is a break in the music at the start and end of this section, it is possible to play this section on a different set of strings, if the instrument is equipped with more than one set of strings, and tune $e\#^1$ pure.

If retuning is not an option, either because the performer wants to use both sets of strings coupled together, as is often done for performances of the toccatas, or a second set of strings is not available, there can be two different ways to play this passage. It is possible to either highlight or hide $e\#^1$. If the performer chooses to highlight it, then it is possible to linger on it, and it could be followed by a gradual *rit.* into the 7th chord on c, which occurs on the third crotchet beat of bar 17. Track 17 on the CD demonstrates this option.

If the performer chooses to hide $e\#^1$, then the *rit.* could happen slightly later at the start of bar 17, and the pitch of the $e\#^1$ is hardly noticed, as demonstrated on Track 18 on the accompanying CD. The pitch of the $e\#^1$ on this track is further disguised by the addition of a trill in the right hand.

Froberger also uses a few diminished fourths in this work. As discussed above, these create wolf-sounds. In particular, the wolf-sounding diminished fourths in bars 2 and 13 are expressive and help to add colour. A performance from the recital included on the accompanying DVD (Chapter 2) demonstrates this. As with some other works

analysed above, the last section of this work is also free from any notes which lie beyond the normal disposition of quarter-comma meantone and the writing displays dazzling virtuosity.

Example 33. Froberger, FbWV 112, Toccata, bars 14-19

The musical score for Example 33, Froberger's Toccata in F major (FbWV 112), bars 14-19, is presented in four systems. Each system consists of a grand staff with a treble clef on the upper staff and a bass clef on the lower staff. The key signature is one flat (B-flat major/D minor), and the time signature is 3/4. The first system (bars 14-15) shows a complex texture with sixteenth-note runs in the right hand and a more rhythmic bass line. The second system (bars 16-17) continues the intricate patterns, with a fermata over a chord in the right hand at the end of bar 16. The third system (bars 17-18) features a dense, rapid sixteenth-note passage in the right hand. The fourth system (bar 19) concludes with a final chord and a few notes in the bass line.

CONCLUSION

This study examined the works of Froberger, focusing on notes that fall outside of the normal disposition of quarter-comma meantone, and passages which use wolf intervals. It was found that Froberger's harmonic language was still firmly rooted in quarter-comma meantone and he overstepped its limits in a reserved way. When he did, he did so with intention, often to portray extra-musical events.

Chapter I examined historical temperaments that were known in the sixteenth to the eighteenth centuries. It discussed why temperaments are necessary, and how musicians of the past found solutions. Historical temperaments are divided into three groups, those consisting mostly of pure intervals with no tempering such as the Pythagorean tuning, regular temperaments such as the various forms of meantone temperament, and irregular temperaments which are sometimes called circular temperaments because they had no unusable intervals. Sizes of intervals varied according to where the notes lie in the circle, and the idea of key characteristics developed. Historical background and characteristics of each temperament were discussed.

Chapter II looked at instruments from the sixteenth and seventeenth centuries and the ways musicians tried to make keyboard instruments work in terms of enharmonic notes in meantone temperaments. It discussed firstly instruments with a different number of notes per octave: some instruments had just a few extra notes per octave; *cimbalo cromatico* had all of the enharmonic notes resulting in 19 notes to the octave; and Vicentino's *archicembalo* which is believed to have had 31 divisions and 36 keys to the octave. It was found that the instruments with many split keys were experimental in nature, and did not become common. Instruments with enharmonic

notes were probably made initially out of necessity as accompanists were asked to transpose for singers and instrumentalists. It was also found that the most common notes to be split on instruments with divided accidentals were $E\flat/D\sharp$ and $G\sharp/A\flat$. Many of these instruments had the mechanism removed later when the prevalent temperaments changed to irregular (circular) temperaments, and few instruments from the period survive with the mechanisms intact.

The chapter also looked at music written for such instruments. While composers experimented with notes outside of the normal disposition of quarter-comma meantone, it was found that they also tried to make their works playable on a standard keyboard. These notes were sometimes used leading up to a cadence, or at the cadences themselves to increase the intensity of the passage, sometimes only used in one section of the work usually somewhere in the middle, and in other cases, buried in the middle voice and so less conspicuous. It was also mentioned that Froberger's teacher, Frescobaldi may have been a competent player of instruments with many divided keys. His teacher, Luzzaschi was known to have been an accomplished player of the *archicembalo*.

Instruments which may have been known to Froberger were then discussed, although little firm evidence is available. Specifications of the instruments were mentioned, and his music was surveyed to establish some of the features of them that Froberger was acquainted with.

Chapter III covered case studies of Froberger's works. It was found that many of the techniques discussed in Chapter II were used by Froberger. This included only introducing wolf notes at rhetorically appropriate moments, or confined to one section, or leading up to cadences. He wrote many works with descriptive titles, and it was found that he used wolf notes to create tension in programmatic writing. At the same

time, it is clear that his compositional foundation was firmly rooted in meantone temperament. Even for his most adventurous works that have survived, namely his two *ricercars* in F# minor and C# minor, his use of the wolf notes were mostly confined to cadential points perhaps with the exception of *D#s* which were found to be prevalent in the music of the low countries, as discussed in Chapter II.

In addition, Froberger sometimes used wolf notes at the end of a section, creating a striking effect, but then followed it with a minor version of the same chord. He uses this technique several times in his works, balancing out the tension created by the wolf notes in a section with pure, inoffensive harmonies.

Although there were cases in which Froberger used several wolf notes in succession, interrupting the harmonic progression and general line of the music, solutions were always found by modifying quarter-comma meantone. At least with regard to his surviving works, there is no evidence to suggest that his preferred temperament was a type of circular one.

This study highlighted issues for choosing the way to tune the harpsichord for performance of the music of Froberger. The method presented in this study could also be applied to other music of the period and beyond, and could provide more insight into the works and how the chosen temperament could affect interpretation and performance.

Appendix I:

Recital Programme

Friday 25th September 2015

The Use of Meantone Temperament in the
Performance of Keyboard Music by Johann Jacob Froberger

11.30am, Friday 25th September, 2015

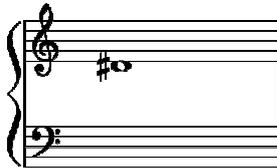
Recital Programme

1. Toccata in A minor, FbWV 112

No notes retuned.

2. Suite in A minor, *Plainte faite à Londres pour passer la Melancolie la quelle se joüe lentement et à discretion* - Courante - Sarabande - Gigue, FbWV 630

Note retuned:

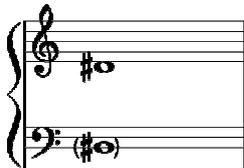


3. Suite in E minor, *Allemande faite en passant le Rhin dans une barque en grand peril, la quelle se joüe lentement à la discretion* - Courante - Sarabande - Gigue, FbWV 627

Note retuned for the Allemande:



Notes retuned for the other dances:



4. Suite in D major, *Meditation faite sur ma mort future, la quelle se joüe lentement avec Discretion* - Gigue - Courante - Sarabande, FbWV 620

Notes retuned:



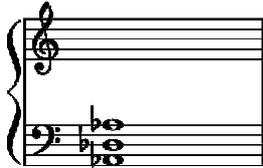
*** Tuning break (5-10 mins) ***

5. Ricercar in F# minor, FbWV 412

No notes retuned.

6. *Lamentation faite sur la tres douloureuse mort de Sa Majeste Imperiale, Ferdinand le Troisiesme, et se joüe lentement avec discretion*, FbWV 633

Notes retuned:



Further two notes retuned on front 8' only:



7. Suite in C major, *Lamentation faite sur la tres douloureuse Mort de sa Majeste, Ferdinand le Quatriesme - Gigue - Courante - Sarabande*, FbWV 612

No notes retuned.

Depiction of heaven:



Harpsichord built by Andrew Wooderson (2011) modelled on a seventeenth-century anonymous Italian instrument.

Appendix II:

DVD Track Listing from the Recital

- Chapter 1. Introduction
- Chapter 2. Toccata FbWV 112
- Chapter 3. Suite in A minor FbWV 630
- Chapter 4. Suite in E minor FbWV 627
- Chapter 5. Suite in D major FbWV 620
- Chapter 6. Ricercar in F# minor FbWV 412
- Chapter 7. Lamentation FbWV 633
- Chapter 8. Suite in C major FbWV 612

DVD is also available at:

<https://www.youtube.com/watch?v=RJZMM7Z21mk>

Appendix III:

Scores of works included in the recital

Tocatta in A minor, FbWV 112

22

The image shows a page of handwritten musical notation for the Tocatta in A minor, BWV 112. The page is numbered '22' in the top left corner. On the left side, there is a large, highly decorative initial letter 'L' that spans across the first staff. The 'L' is filled with intricate patterns, including stars, sunbursts, and floral motifs. To the right of the 'L', the musical notation begins on the first staff. The notation is written in a clear, elegant hand, featuring various note values, rests, and ornaments. The second and third staves continue the musical piece, showing a mix of rhythmic patterns and melodic lines. The overall appearance is that of a historical manuscript page.

The image shows a page of handwritten musical notation, oriented vertically. The page number '100' is located in the top right corner. The musical score is written on three systems of staves. Each system consists of a treble clef staff on top and a bass clef staff on the bottom. The notation is dense and includes various musical symbols such as notes, rests, accidentals, and dynamic markings. The handwriting is in black ink on a light-colored paper. The first system has a treble clef staff with a key signature of one sharp (F#) and a common time signature (C). The second system has a treble clef staff with a key signature of one sharp (F#) and a common time signature (C). The third system has a treble clef staff with a key signature of one sharp (F#) and a common time signature (C). The notation is dense and includes various musical symbols such as notes, rests, accidentals, and dynamic markings.

The image shows a page of handwritten musical notation, numbered 23 in the top left corner. The page contains three systems of musical staves. Each system consists of two staves: the upper staff is in treble clef and the lower staff is in bass clef. The notation is dense and complex, featuring many beamed notes, slurs, and dynamic markings. The first system has a treble staff with a series of beamed notes and a bass staff with a few notes and rests. The second system has a treble staff with a series of beamed notes and a bass staff with a few notes and rests. The third system has a treble staff with a series of beamed notes and a bass staff with a few notes and rests. The handwriting is in black ink on a light-colored paper.

A page of handwritten musical notation on three staves. The notation is written in black ink on aged paper. The top staff begins with a treble clef and a key signature of one sharp (F#). The middle staff begins with a bass clef and a key signature of one sharp (F#). The bottom staff begins with a treble clef and a key signature of one sharp (F#). The music consists of various note values, including quarter, eighth, and sixteenth notes, as well as rests and accidentals. The handwriting is fluid and characteristic of a composer's sketch or a personal manuscript.

24

A handwritten musical score consisting of three staves. The notation is dense and includes various musical symbols such as notes, rests, and dynamic markings. The first staff begins with a treble clef and a key signature of one sharp (F#). The second staff features a treble clef and a key signature of one sharp, with a 'p' marking. The third staff starts with a treble clef and a key signature of one sharp, and includes a 'p' marking. The handwriting is fluid and characteristic of a composer's sketch.

A page of handwritten musical notation on three staves. The notation is written in black ink on a light-colored paper. Each staff begins with a treble clef and a key signature of one sharp (F#). The music consists of a series of notes and rests, with some notes beamed together. The first staff contains approximately 12 measures of music. The second staff contains approximately 12 measures of music. The third staff contains approximately 12 measures of music. The handwriting is clear and legible.

25

The image shows three staves of handwritten musical notation. The notation is dense and appears to be a complex piece of music, possibly for a string instrument or a voice with piano accompaniment. The first staff contains a series of notes and rests, with some accidentals. The second staff continues the notation, showing more complex rhythmic patterns and some slurs. The third staff concludes the piece with a final note and a double bar line. The handwriting is fluid and characteristic of a composer's sketch or a working draft.

38

Courante

Sarabande

39

40

Cigue

Handwritten musical score for a piece titled "Cigue". The score is written on seven systems of two staves each. The first system is labeled "Cigue". The notation includes treble and bass clefs, a key signature of one sharp (F#), and a common time signature (C). The music features a variety of note values, including eighth and sixteenth notes, and rests. The final system ends with a double bar line and a flourish. Below the seventh system are three empty staves.

34

Courante

Sarabande: *r.* $\text{C} \frac{3}{4}$

35

36

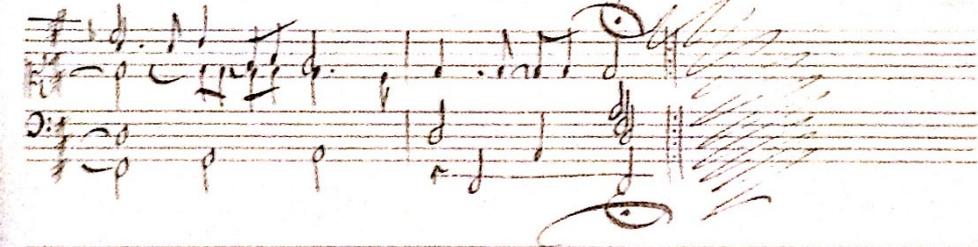
Gigue. C^6
C₇

64

Sigue

Primo Direzione

Corrente



66

Sarabande

Ricercar in F# minor, FbWV 412

This image shows a page of handwritten musical notation for a Ricercar in F# minor, BWV 412. The score is written on ten staves. The first five staves are dominated by a large, intricate, and highly decorative initial letter 'R' that fills most of the page's width. The notation is in a historical style, with notes and clefs written in black ink. The piece begins with a treble clef and a key signature of one sharp (F#). The notation includes various note values, rests, and bar lines, characteristic of Baroque lute or keyboard music. The decorative initial 'R' is the central focus, with its vertical stem extending down the first staff and its horizontal top extending across the first five staves.

54

The image shows a handwritten musical score on page 54, which is numbered 120 in the top right corner. The score is organized into two systems, each consisting of four staves. The notation is handwritten and includes various musical symbols such as notes, rests, and accidentals.

The first system (top) consists of four staves. The top staff begins with a treble clef and contains several notes, including a whole note with a sharp sign. The second staff starts with a bass clef and contains notes with stems pointing upwards. The third and fourth staves continue the musical notation with various note values and accidentals.

The second system (bottom) also consists of four staves. The top staff begins with a treble clef and contains notes with stems pointing upwards. The second staff starts with a bass clef and contains notes with stems pointing downwards. The third and fourth staves continue the musical notation with various note values and accidentals.

The image displays a handwritten musical score on ten staves, organized into two systems of five staves each. The notation is dense and includes various musical symbols:

- Staff 1 (top left):** Features a series of notes with stems, some marked with an 'X' above them. There are also some isolated notes and rests.
- Staff 2 (second from top left):** Contains notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 3 (third from top left):** Shows notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 4 (fourth from top left):** Contains notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 5 (bottom left):** Features notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 6 (top right):** Contains notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 7 (second from top right):** Shows notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 8 (third from top right):** Contains notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 9 (fourth from top right):** Features notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.
- Staff 10 (bottom right):** Contains notes with stems, some with 'X' marks, and a few notes with a 'y' or similar character above them.

The notation is highly stylized and appears to be a form of shorthand or a specific dialect of musical notation. The use of 'X' and 'y' marks above notes is a notable feature. The staves are connected by a single vertical line on the left and right sides.

Handwritten musical notation on four staves. The first staff contains a sequence of notes with accidentals. The second staff has notes with stems. The third staff has notes with stems and accidentals. The fourth staff is mostly empty with a few notes.

Handwritten musical notation on four staves. The first staff contains notes with stems and accidentals. The second staff has notes with stems and accidentals. The third staff has notes with stems and accidentals. The fourth staff has notes with stems and accidentals.

The image shows a page of handwritten musical notation, oriented vertically. It contains two systems of music, each consisting of four staves. The notation is written in black ink on a white background. The first system (top) begins with a treble clef and a key signature of one sharp (F#). The notation includes various note values, rests, and dynamic markings such as 'p' (piano) and 'f' (forte). The second system (bottom) also begins with a treble clef and a key signature of one sharp. The notation continues with similar note values and rests. The handwriting is clear and legible, typical of a composer's manuscript.

28

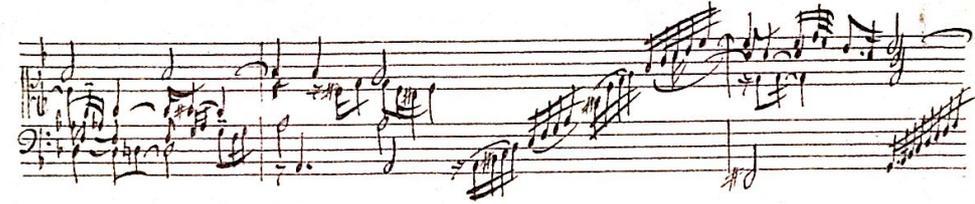
The image displays a handwritten musical score on ten staves, organized into two systems of five staves each. The notation is dense and includes various note values, rests, and clefs. The first system (top) begins with a treble clef on the first staff, followed by four staves of music. The second system (bottom) also begins with a treble clef on the first staff, followed by four staves of music. The handwriting is clear and consistent throughout the piece.

This image shows a page of handwritten musical notation on ten staves. The notation is a mix of standard musical symbols and highly decorative, calligraphic flourishes. The first four staves on the left contain more traditional notation, including notes, stems, and clefs. The fifth staff begins with a large, ornate flourish that resembles a stylized 'X' or a similar symbol. The remaining staves continue with a combination of standard notation and these decorative elements. The handwriting is fluid and expressive, characteristic of a composer's sketch or a personal manuscript. The page is numbered '125' in the top right corner.

*Lamentation faite sur la tres douloureuse mort de Sa Majeste
Imperiale, Ferdinand le Troisiesme, FbWV 633*

Handwritten musical score for a lamentation. The title is written in French: "Lamentation faite sur la tres douloureuse mort de Sa Majeste Imperiale, Ferdinand le Troisiesme, FbWV 633". The score is written on a page numbered 67 in the top right corner. The music is written in a single system with a treble clef and a common time signature (C). The notation includes various rhythmic values, accidentals, and dynamic markings. The score is divided into four systems of music, each consisting of a single staff. The first system includes the title and the beginning of the piece. The second system starts with a bracketed number [19]. The third and fourth systems continue the musical notation. Below the fourth system, there are four empty staves, suggesting the end of the piece or a continuation on another page.

68



Suite in C major, FbWV 612

Seppia
Soprano la cetera per ditta della
FERDINANDO
IV. Re de Romanis

The image shows a page of handwritten musical notation for the Suite in C major, BWV 612. The page is oriented vertically but contains musical staves that are rotated 90 degrees clockwise. On the left side of the page, there is a decorative woodcut illustration of a man and a woman. The man is seated and playing a lute, while the woman stands beside him. The illustration is framed by ornate scrollwork and floral patterns. To the right of the illustration, the title and composer information are written in a mix of bold, decorative fonts and cursive script. The musical notation itself consists of several staves, each with a clef and various notes, rests, and ornaments. The handwriting is clear and consistent throughout the score.

113

A handwritten musical score consisting of ten staves. The notation is dense and includes various note values, rests, and dynamic markings. The score is written in black ink on aged paper. At the top of the page, there is a decorative illustration of a large, billowing cloud formation with radiating lines, possibly representing a storm or a dramatic scene. The number '113' is written in the upper left corner of the page.

A page of handwritten musical notation on aged paper. The score is written on five staves. The first staff is partially obscured by a large, intricate, dark floral or scrollwork ornament. The notation includes various note values, rests, and clefs. The handwriting is in a historical style, likely from the 18th or 19th century. The paper shows signs of age, including some staining and discoloration.

114

This page contains a handwritten musical score, numbered 114 in the top left corner. The score is organized into three systems, each consisting of two staves. The first system features a treble clef on the upper staff and a bass clef on the lower staff, with various musical notations including notes, rests, and dynamic markings such as *forte*. The second system continues the notation with similar clefs and includes a *rit.* (ritardando) marking. The third system also uses treble and bass clefs and contains dense musical notation. The handwriting is fluid and characteristic of a composer's draft. At the bottom of the page, there are four empty musical staves.

The image displays a page of handwritten musical notation. The title "XOQUINI" is written in a large, decorative, gothic-style font, embellished with intricate floral and scrollwork patterns. Below the title, the musical score is written on several staves. The notation includes various note values, rests, and dynamic markings such as "p" (piano) and "f" (forte). The score is organized into systems, with some staves containing multiple lines of music. The handwriting is clear and consistent throughout the piece.

115

A handwritten musical score consisting of five staves. The notation is dense and includes various musical symbols such as notes, rests, and clefs. The first staff begins with a treble clef and a key signature of one sharp (F#). The notation is written in a cursive, handwritten style. The score appears to be a single melodic line or a simple harmonic setting. The paper shows signs of age, with some staining and a slightly uneven texture.

This image shows a page of handwritten musical notation. The page is oriented vertically but contains musical staves that are rotated 90 degrees clockwise. On the left side of the page, there are several staves of music. The top staff is partially obscured by a decorative floral wreath. Below it, a large, ornate, calligraphic title or heading is written across the staves, featuring intricate scrollwork and floral motifs. To the right of this title, there are several more staves of music, each with a clef and various musical notes and rests. The handwriting is in black ink on a light-colored paper. The overall appearance is that of a historical or early manuscript page.

116

This page contains a handwritten musical score. The notation is spread across several staves. The right side of the page is dominated by a highly decorative and dense section of music, characterized by intricate, swirling lines and complex rhythmic patterns. The left side of the page shows more standard musical notation, including notes, rests, and stems, with some decorative flourishes. The page number '116' is written in the top left corner.

BIBLIOGRAPHY

General

- Aldwell, E., and C. Schachter. *Harmony and Voice Leading*. Second Edition. Fort Worth: Harcourt Brace Jovanovich Inc, 1989.
- Annibaldi, Claudio. 1995. 'Froberger in Rome: From Frescobaldi's Craftsmanship to Kircher's Compositional Secrets'. *Current Musicology* 58 (1995): 5-27.
- Apel, Willi. 'Germany'. In *The History of Keyboard Music to 1700*. Bloomington: Indiana University Press, 1972.
- Asperen, Bob van. Liner notes to *Johann Jacob Froberger: Le passage du Rhin*. Aeolus, AE-10024, 2001, CD.
- _____. 'A New Froberger Manuscript'. *Journal of Seventeenth-Century Music* 13.1 (2008).
- Barbieri, Patricio. *Enharmonic Instruments and Music 1470-1900*. Latina, Italy: Levante, 2008.
- Barnes, John. 'Bach's Keyboard Temperament: Internal evidence from the *Well Tempered Clavier*'. *Early Music* Vol. 7.2 (1979): 236-249.
- Bartel, Dietrich. *Musica Poetica: Musical-Rhetorical Figures in German Baroque Music*. Lincoln and London: University of Nebraska Press, 1997.
- Beebe, Carey. 'Technical Library'. <http://www.hpschd.nu/tech/>. Accessed 23 November 2012.
- Beurmann, Andreas. *Harpsichords and More: Harpsichords, Spinets, Clavichords, Virginals*. Georg Olms Verlag, 2012.
- _____. 'Ein weiterer "Cellestini" in Hamburg Ein Beitrag zur Geschichte der Tasteninstrumente'. In *Musikkulturgeschichte. Festschrift für Constantin Floros zum 60. Geburtstag*, edited by P. Petersen. Wiesbaden: Breitkopf & Härtel, 1990.
- Blood, William. "'Well-Tempering" the Clavier: Five Methods'. *Early Music* 7.4 (1979): 491-495.
- Boalch, Donald H. *Makers of the Harpsichord and Clavichord 1440-1840*. Oxford: Clarendon Press, 1995.
- Bond, Ann. *A Guide to the Harpsichord*. Original edition, 1997. Portland, Oregon: Amadeus Press, 2001.
- Brink, Paul. 'The Archicembalo of Nicola Vicentino, Music', (PhD thesis, The Ohio State University), 1966.

- Buelow, Goerge J. 'Johann Jacob Froberger'. In *The New Grove North European Baroque Masters*, edited by S. Sadie. London: Macmillan, 1985.
- Bukofzer, Manfred. *Music in the Baroque Era: Monteverdi to Bach*. New York: W. W. Norton, 1947.
- Burnett, Richard. *Company of Pianos*. Goudhurst: Finchcocks Press, 2004.
- Butt, John. 'Germany and the Netherlands'. In *Keyboard Music Before 1700*, edited by A. Silbiger. London: Routledge, 2004.
- Caldwell, John. *English Keyboard Music Before the Nineteenth Century*. Oxford: Basil Blackwell, 1973.
- Carapezza, Paolo Emilio, and Giuseppe Collisani. 'Del Buono, Gioanpietro'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 30 May 2015.
- Chew, Geoffrey, and Richard Rastall. 'Notation III, 4. Mensural notation from 1500'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 19 April 2015.
- Collins, Paul. *The Stylus Phantasticus and Free Keyboard Music of the North German Baroque*. Aldershot: Ashgate, 2005.
- Couch, Leon W. 'Review of The Stylus Phantasticus and Free Keyboard Music of the North German Baroque'. *Notes* 63.2 (2006): 342-345.
- Cyr, Mary. *Performing Baroque Music*. Aldershot: Ashgate. Original edition, 1992.
- Davies, Hugh. 'Microtonal instruments'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 13 May 2015.
- Di Veroli, Claudio. *Unequal Temperaments: Theory, History and Practice*. Bray, Ireland, 2009.
- Duffin, Ross W. *How Equal Temperament Ruined Harmony (and Why You Should Care)*. London and New York: W. W. Norton, 2007.
- Egarr, Richard. *Johann Jakob Froberger: The Complete Keyboard Works in Four Volumes*. Globe, 1994, CD.
- Ferguson, Howard. *Keyboard Interpretation*. Oxford: Oxford University Press, 1975.
- Hammond, Frederick. *Girolamo Frescobaldi*. Cambridge, Massachusetts: Harvard University Press, 1983.
- _____. Frescobaldi, Girolamo. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 23 November 2012.

- Hill, Robert. 'John Bull Chromatic Fantasia on Ut Re Mi Fa Sol La'. YouTube recording, <https://www.youtube.com/watch?v=hpDkbRpxwKw>. Accessed 6 May 2015.
- Hirshberg, Jehoash. 'Hexachord'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 9 September 2014.
- Hora, Edmundo Pacheco. 2004. 'As obras de Froberger no contexto do temperamento mesotônico', (PhD thesis, Universidade Estadual de Campinas), 2004.
- Hubbard, Frank. *Three Centuries of Harpsichord Making*. Second Printing. Original edition, 1965. Cambridge, Massachusetts: Harvard University Press, 1967.
- Hunt, Edgar. 'Tuning and Temperament'. *The English Harpsichord Magazine*. 7 (1976).
- Institute of Physics, and Charles Arthur Padgham. *Subjective limitations on physical measurements*. London: Chapman and Hall, 1965.
- Ishii, Akira. 'The Toccatas and Contrapuntal Keyboard Works of Johann Jacob Froberger: A study of the Principal Sources', (PhD thesis, Duke University), 1999.
- Jackson, Roland. 'Mayone, Ascanio'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 30 May 2015.
- _____. 'Trabaci, Giovanni Maria'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 30 May 2015.
- _____. 'On Frescobaldi's Chromaticism and Its Background'. *The Musical Quarterly* 57.2 (1971): 255-269.
- Jones, Philip P. 'Bach, and Werckmeister'. *Early Music* Vol. 8 No. 4 (1980): 511-513.
- Jones, Timothy Rhys. 'Rhetoric'. In *The Oxford Companion to Music. Oxford Music Online*. Oxford University Press, accessed 30 May 2015.
- Jorgensen, Owen. *Tuning the Historical Temperaments by Ear*. Marquette: The Northern Michigan University Press, 1977.
- Karp, Theodore. *Dictionary of Music*. Evanston: Northwestern University Press, 1973.
- Kaufmann, Henry W. 'Vicentino and the Greek Genera'. *Journal of the American Musicological Society* 16.3 (1963): 325-346.
- _____. 'More on Tuning of the Archicembalo'. *Journal of the American Musicological Society* 23.1 (1970): 84-94.
- Kaufmann, Henry W., and Robert L. Kendrick. 'Vicentino, Nicola'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 19 April 2015.

- Kilbuck, Edith Henry. 'An Analytical Study of Selected Toccatas of Johann Jakob Froberger: Some Possible Insights into Problems of Performance Practice', (PhD thesis, University of Oregon), 1976.
- Kosnik, James Walter. 'The Toccatas of Johann Jakob Froberger: A Study of Style and Aspects of Organ Performance', (PhD thesis, University of Rochester), 1979.
- Koster, John. *Keyboard Musical Instruments in the Museum of Fine Arts, Boston* Boston: Museum of Fine Arts, 1994.
- Kottick, Edward L. *A History of the Harpsichord*. Bloomington & Indianapolis: Indiana University Press, 2003.
- Lehman, Bradley. 'Bach's extraordinary temperament: our Rosetta Stone - 1'. *Early Music* 33.1 (2005): 3-23.
- _____. 'Bach's extraordinary temperament: our Rosetta Stone - 2'. *Early Music* 33.2 (2005): 211-226.
- Leonhardt, Gustav. 'Johann Jakob Froberger and his Music'. *L'Organo* (6), 1968.
- Lewis, Pierre. 'Understanding Temperaments'.
<http://pages.globetrotter.net/roule/temper.htm>. Accessed 19 April 2010.
- Lindley, Mark. 'Mean-tone'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 20 February 2012.
- _____. 'Instructions for the clavier diversely tempered'. *Early Music* 5.1 (1977): 18-23.
- _____. *Lutes, Viols & Temperaments*. Cambridge: Cambridge University Press, 1984.
- _____. 'Temperaments'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 20 February 2012.
- Lockwood, Lewis , and Giulio Ongaro. 'Willaert, Adrian 1. Early career and Ferrarese service'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 19 April 2015.
- Maguire, Simon. *Johann Jacob Froberger: A Hitherto Unrecorded Autograph Manuscript*. London: Sotheby's, 2006.
- Maitland, J.A. Fuller , and W. Barclay Squire. *The Fitzwilliam Virginal Book*. Edited by B. Winogron. Originally published 1899. Revised Dover Edition. London: Dover, 1980.
- Maunder, Richard. *Keyboard Instruments in Eighteenth-Century Vienna*. Oxford: Clarendon Press, 1998.

- Meeùs, Nicolas. 'Enharmonic Keyboard'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 18 February 2015.
- Meffen, John. 'The temperament of keyboard instruments in England during the late sixteenth and early seventeenth centuries', (Masters thesis Durham University), 1973.
- _____. 'The Temperament of Keyboard Instruments in England from the Virginalists to the Middle of the Nineteenth Century', (PhD thesis, University of Leeds), 1977.
- Michopoulou, Aikaterini. 'Contrapuntal and Keyboard Idioms in the Artificio Collection (1641) of Giovanni Pietro Del Buono', (PhD thesis, University of York), 2006.
- Montague, Jeremy. 'Temperament'. In *The Oxford Companion to Music*, edited by A. Latham. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 29 August 2009.
- Moroney, Davitt. 'The performance of unmeasured harpsichord preludes'. *Early Music* 4.2 (1976): 143-151.
- _____. 'Keyboard'. In *A Performer's Guide to Music of the Baroque Period*, edited by A. Burton. London: The Associated Board of the Royal Schools of Music, 2002.
- Murray Barbour, J. 'Bach and the Art of Temperament'. *The Musical Quarterly* 33.1 (1947): 64-89.
- _____. *Tuning and Temperament: A Historical Survey*. New York: Da Capo Press, 1972.
- Newcomb, Anthony. 'Review: Girolamo Frescobaldi by Frederick Hammond'. *Renaissance Quarterly* 37 (Autumn 1984): 475-479.
- _____. 'Frescobaldi's Toccatas and their Stylistic Ancestry'. *Proceedings of the Royal Musical Association* 111 (1985): 28-44.
- Norman, Terence John. 'Performance Practice of the Keyboard Music of Johann Jacob Froberger', (PhD thesis, Monash University, Melbourne), 1992.
- O'Brien, Grant. *Ruckers: A harpsichord and virginal building tradition*. Cambridge: Cambridge University Press, 1990.
- Oldham, Guy, and Mark Lindley. 'Wolf'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 30 May 2015.
- Ortgies, Ibo. 'Subsemitones in Organs Built between 1468 and 1721: Introduction and Commentary with an Annotated Catalog'. *Goart Research Reports* 3 (2003): 11-74.

- Padgham, Charles A. *The well-tempered organ*. Oxford: Positif, 1986.
- Pollard, Joseph Victor. 'Tuning and Temperament in Southern Germany to the End of the Seventeenth Century', (PhD thesis, University of Leeds), 1985.
- Rasch, Rudolf. 'Johann Jacob Froberger's travels 1649-1653'. In *The Keyboard in Baroque Europe*, edited by C. Hogwood. Cambridge: Cambridge University Press, 2003.
- Rampe, Siegbert. 'Preface' In *Volume I: Keyboard and Organ Works from Autograph Sources, Libro Secondo (1649)*. 2002. Third Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2008.
- _____. 'Preface' In *Volume II: Keyboard and Organ Works from Autograph Sources, Libro Quarto (1656) Libro di capricci, e ricercate (ca. 1658)*. 1995. Second Revised Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2008.
- _____. 'Preface' In *Volume III.1: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 1a*. 2002. Second Revised Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2005.
- _____. 'Preface' In *Volume III.2: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 1b*. 2002. Second Revised Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2005.
- _____. 'Preface' In *Volume IV.1: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 2*. New Edition of the Complete Works. Kassel: Barenreiter, 2003.
- _____. 'Preface' In *Volume IV.2: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 3*. New Edition of the Complete Works. Kassel: Barenreiter, 2003.
- _____. 'Preface' In *Volume V.1: Keyboard and Organ Works from Copied Sources Toccatas*. New Edition of the Complete Works. Kassel: Barenreiter, 2011.
- _____. 'Preface' In *Volume V.1: Keyboard and Organ Works from Copied Sources Polyphonic Works*. New Edition of the Complete Works. Kassel: Barenreiter, 2014.
- _____. 'Preface' In *Volume VI.1: Keyboard and Organ Works from Copied Sources New Sources, New Readings, New Works, Part 1*. New Edition of the Complete Works. Kassel: Barenreiter, 2010.
- _____. 'Preface' In *Volume VI.2: Keyboard and Organ Works from Copied Sources New Sources, New Readings, New Works, Part 2*. New Edition of the Complete Works. Kassel: Barenreiter, 2010.

- _____. *Johann Jacob Froberger: The Unknown Works Vol. 1*. MDG 341 1186-2, 2003, CD.
- _____. *Johann Jacob Froberger: The Unknown Works Vol. 2*. MDG 341 1195-2, 2004, CD.
- Rayner, Clare G. 'The Enigmatic Cima: Meantone Tuning and Transpositions'. *Galpin Society* 22 (1969): 23-34.
- Ripin, Edwin M. 'Arcicembalo [archicembalo]'. In *Grove Music Online*. Oxford Music Online. Oxford University Press, accessed 19 April 2015.
- Roberts, Tim. 'Froberger's secret art'. *Early Music* (May 2005): 340-343.
- Rowland, David. *Early Keyboard Instruments: A Practical Guide*. Cambridge: Cambridge University Press, 2001.
- Rudd, Robert. 'Chapter Five: Italy'. In *Keyboard Music Before 1700*, edited by A. Silbiger. New York and London: Routledge, 2004.
- Russell, Raymond. *The Harpsichord and Clavichord: An Introductory Study*. Second Revised Edition. ed. London: Faber, 1973.
- Sadie, Julie Anne. *Companion to Baroque Music*. Oxford: Oxford University Press, 2002.
- Sadie, Stanley. *Early Keyboard Instruments*. Edited by S. Sadie, *The New Grove Musical Instruments Series*. London: Macmillan Press, 1989.
- Scholes, Percy A. *The Oxford Companion to Music*. edited by J. O. Ward. Oxford: Oxford University Press, 1991.
- Schott, Howard. *Playing the Harpsichord*. Newton Abbot: Dover, 1971.
- _____. 'A Critical Edition of the Works of J.J. Froberger', (PhD thesis, University of Oxford), 1977.
- Schulenberg, David. 'Recent Editions and Recordings of Froberger and Other Seventeenth-Century Composers'. *Journal of Seventeenth-Century Music* (2012), <http://www.sscm-jscm.org/jscm/v13/no1/schulenberg.html>.
- Serwer, Howard. 'Kirnberger, Johann Philipp'. In *Grove Music Online*. Oxford Music Online. Oxford University Press, accessed 16 February 2012.
- Sharp, G. B. 'J. J. Froberger: 1614-1667 a link between the Renaissance and the Baroque'. *The Musical Times* CVIII (1967): 1093-1097.
- Silbiger, Alexander. 'Tracing the Contents of Froberger's Lost Autographs'. *Current Musicology* 54 (1993): 5-23.

- _____. *Keyboard Music Before 1700*. New York and London: Routledge, 2004.
- _____. 'Performance Practice'. In *Keyboard Music Before 1700*, edited by A. Silbiger. London: Routledge, 2004.
- Smith, Eleanor. 'A Discussion of the Use of Divided-Accidental keys in Italian Strung-Keyboard Instruments pre.1700', (Masters thesis, Edinburgh University), 2008.
- Somer, Avo. 'The Keyboard Music of Johann Jakob Froberger', (PhD thesis, University of Michigan), 1962.
- Stembridge, Christopher. *Ascanio Mayone: Primo e Secondo Libro di Diversi Capricci: Deutsche harmonia mundi, 05472 77247 2*, 1992, CD.
- _____. 'Music for the Cimbalo Cromatico and Other Split-Keyed Instruments in Seventeenth-Century Italy'. *Performance Practice Review* 5.1 (1992): 5-43.
- _____. 'The Cimbalo Cromatico and Other Italian Keyboard Instruments with Nineteen or More Divisions to the Octave (Surviving Specimens and Documentary Evidence)'. *Performance Practice Review* 6.1 (1993.): 33-59.
- _____. *Consonanze Stravaganti*. Ars Musici, 1997, CD.
- Strainchamps, Edmond. 'Luzzaschi, Luzzasco'. In *Grove Music Online*. Oxford Music Online. Oxford University Press, accessed 19 April 2015.
- _____. 'Nigetti, Francesco'. In *Grove Music Online*. Oxford Music Online. Oxford University Press, accessed 19 April 2015.
- Tarling, Judy. *The Weapons of Rhetoric*. St Albans: Corda Music Publications, 2005.
- Taruskin, Richard. *Music in the Seventeenth and Eighteenth Centuries, The Oxford History of Western Music*. Oxford: Oxford University Press, 2005.
- Tiella, Marco. 'The Archicembalo of Nicola Vicentino'. *The English Harpsichord Magazine* 1.5 (1975).
- Verlet, Blandine. *Froberger: Pieces de Clavessin: Auvidis-Astrée, E 8716*, 1989, CD
- Waitzman, Mimi S. *Early Keyboard Instruments, The Benton Fletcher Collection at Fenton House*. London: The National Trust, 2003.
- Wollny, Peter. 'Preface'. In *Johann Jacob Froberger: Toccaten, Suiten, Lamenti: The Manuscript SA 4450 from the Sing-Akademie zu Berlin*. Facsimile and Transcription. Kassel: Barenreiter, 2006.
- Wraight, Denzil. 'Celestini, Giovanni'. In *Grove Music Online*. Oxford Music Online. Oxford University Press, accessed 19 April 2015.

_____. 'Trasuntino'. In *Grove Music Online. Oxford Music Online*. Oxford University Press, accessed 19 April 2015.

_____. 'Italian Harpsichords'. *Early Music* 12.1 (1984): 151.

_____. 'Two Harpsichords By Giovanni Celestini'. *The Galpin Society Journal* 46 (March 1993): 120-136.

_____. 'A list of surviving Italian string keyboard instruments originally provided with more than 12 notes per octave.'
<http://www.denzilwraight.com/download.htm>. Accessed 23 November 2012.

Wraight, Denzil, and Christopher Stembridge. 'Italian Split-Keyed Instruments with Fewer than Nineteen Divisions to the Octave'. *Performance Practice Review* (1994): 150-181.

Yearsley, David. 'Review of Northern German Church Music in the Age of Buxtehude by Geoffrey Webber'. *Journal of Seventeenth-Century Music*. <http://www.sscm-jscm.org/v5/no1/yearsley.html>. 2012.

Musical Scores

Couperin, Louis. *Pièces de clavecin*. Edited by D. Moroney. Monaco: L'oiseau-lyre, 1985.

Frescobaldi, Girolamo. 1977. *Il primo libro di toccate d'intavolatura di cembalo e organo*. Edited by E. Darbellay. Milano: Edizioni Suvini Zerboni.

Froberger, Johann Jacob. *Volume I: Keyboard and Organ Works from Autograph Sources, Libro Secondo (1649)*. Edited by S. Rampe, 2002. Third Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2008.

_____. *Volume II: Keyboard and Organ Works from Autograph Sources, Libro Quarto (1656) Libro di capricci, e ricercate (ca. 1658)*. Edited by S. Rampe, 1995. Second Revised Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2008.

_____. *Volume III.1: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 1a*. Edited by S. Rampe, 2002. Second Revised Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2005.

_____. *Volume III.2: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 1b*. Edited by S. Rampe, 2002. Second Revised Printing. New Edition of the Complete Works. Kassel: Barenreiter, 2005.

_____. *Volume IV.1: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 2*. Edited by S. Rampe. New Edition of the Complete Works. Kassel: Barenreiter, 2003.

- _____. *Volume IV.2: Keyboard and Organ Works from Copied Sources Partitas and Partita Movements, Part 3*. Edited by S. Rampe. New Edition of the Complete Works. Kassel: Barenreiter, 2003.
- _____. *Volume V.1: Keyboard and Organ Works from Copied Sources Toccatas*. Edited by S. Rampe. New Edition of the Complete Works. Kassel: Barenreiter, 2011.
- _____. *Volume V.2: Keyboard and Organ Works from Copied Sources Polyphonic Works*. Edited by S. Rampe. New Edition of the Complete Works. Kassel: Barenreiter, 2014.
- _____. *Volume VI.1: Keyboard and Organ Works from Copied Sources New Sources, New Readings, New Works, Part 1*. Edited by S. Rampe. New Edition of the Complete Works. Kassel: Barenreiter, 2010.
- _____. *Volume VI.2: Keyboard and Organ Works from Copied Sources New Sources, New Readings, New Works, Part 2*. Edited by S. Rampe. New Edition of the Complete Works. Kassel: Barenreiter, 2010.
- _____. *Johann Jacob Froberger: Toccaten, Suiten, Lamenti: The Manuscript SA 4450 from the Sing-Akademie zu Berlin*. Facsimile and Transcription. Edited by P. Wollny. Kassel: Barenreiter, 2006.
- _____. *Froberger autographs*. Österreichische Nationalbibliothek Musiksammlung, Mus. Hs. 18706. Edited by Robert Hill. New York: Garland, 1988.
- _____. *Froberger autographs*. Österreichische Nationalbibliothek Musiksammlung, Mus. Hs. 18707. Edited by Robert Hill. New York: Garland, 1988.
- _____. *Froberger autographs*. Österreichische Nationalbibliothek Musiksammlung, Mus. Hs. 16560. Edited by Robert Hill. New York: Garland, 1988.
- _____. *Oeuvres complètes pour clavecin 1, Livres de 1649, 1656 et 1658*. Edited by H. Schott. Paris: Heugel, 1979.
- _____. *Oeuvres complètes pour clavecin 2-1, Toccatas et pièces polyphoniques*. Edited by H. Schott. Paris: Heugel, 1989.
- _____. *Oeuvres complètes pour clavecin 2-2, Suites et pièces diverses*. Edited by H. Schott. Paris: Heugel, 1992.
- Maitland, J.A. Fuller, and W. Barclay Squire. *The Fitzwilliam Virginal Book*. Edited by B. Winogron. Originally published 1899. Revised Dover Edition. London: Dover, 1980.
- Mayone, Ascanio. *Secondo libro di diversi capricci per sonare*. Napoli, 1609.

Sources Pre-1800

Burney, Charles. *'Music, Men, and Manners in France and Italy 1770'*. Originally published 1771. Edited by H. E. Poole. London: The Folio Society, 1969.

Denis, Jean. *Treatise on Harpsichord Tuning*. Translated by V. J. Panetta, Jr. Originally published 1743. Cambridge: Cambridge University Press, 1987.

Huygens, Christiaan. 'Lettre touchant le Cycle Harmonique'. In *Histoire des Ouvrages des Sçavans*. Rotterdam, 1691.

Kircher, Athanasius. *Musurgia Universalis*. Rome: 1650.

Kirnberger, Johann Philipp. *Die Kunst des reinen Satzes in der Musik*. Berlin and Königsberg, 1776-1779.

Praetorius, Michael. *Syntagma Musicum*. Wolfenbüttel, 1619.