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Music

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MUSIC THEORY IN THE BRITISH ISLES
DURING THE ENLIGHTENMENT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Louis Fred Chenette, B.A., M.Mus.

* * * * * *

The Ohio State University
1967

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FIELDS OF STUDY

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INTRODUCTION

When Antoniotto stated in 1760 that "from the middle of the last century to the present time, the harmonic art has arrived at its ne plus ultra,"¹ he was pointing out that the transition from primarily contrapuntal to predominantly homophonic tonal thinking, which was still only incipient in Britain during the Commonwealth, had reached maturity. The harmonic art of this transition period, as it is explained in the writings of music theorists in the British Isles, is described in the pages which follow.

In the introduction, the organization of the study is presented, followed by a chronological list of primary references by category and a summary of related research. Finally, the political and intellectual history of the period studied is briefly surveyed.

The Organization of the Study

Definition of "music theory."--In this investigation, "music theory" is defined as the general and abstract principles which relate to the meanings humans attach to organized sound. By this definition, music theory is that area of musical study which verbalizes the philosophical, psychological, acoustical, aesthetic, social, or other explanations of musical communication. This is a broad defi-

nition and includes more than the elementary studies of solfege, harmony, counterpoint, form, and orchestration. Other aspects are melody, rhythm, phrasing, musical acoustics, intervals, scales, and philosophical and speculative considerations. In other words, the definition of music theory used here is what Haydon calls "the theory of music theory."

The branch of musicology we call the theory of music theory includes not only the theory of what is ordinarily known as elementary theory of music, but also the theory of harmony, the theory of counterpoint, and so on. In the scope of the theory of music theory lie such tasks as the accurate definition of the technical terms used in theoretical instruction, the formulation of general principles underlying the various branches of music theory, and numerous other tasks in the discovery, verification, and organization of technical knowledge in music.2

The borders of this field of study overlap and dissolve into the related areas of acoustics, philosophy, and psychology.

Geographical and chronological limits. -- The geographical and chronological borders are described by the phrase "the British Isles during the Enlightenment." In regard to the geographical limitations, the area is conceived as a center of focus, relating to theoretical developments on the continent. In regard to the chronological limits, the period of time centers in the years 1660-1760. This is after the Commonwealth governed by Oliver Cromwell, for in 1660 English government again became a monarchy with the restoration of the Stuarts to the throne. The period fades to its conclusion in the latter part of the eighteenth century as harmonic systems and theoretical treatises

become relatively stabilized with the didactic function of explaining "classical" harmonic practice.

Need for the study.--Up to this time, no studies have been made of the development of theoretical ideas in the British Isles during this period. Rather, knowledge of the development of new theoretical concepts by musicians in the British Isles has tended to be eclipsed by an interest in origins, which has emphasized earlier theorists, and by focus on Rameau, whose theoretical writings form one of the most important chapters in the history of music theory. There are reasons for this neglect: no single theorist, or closely associated group of theorists, dominated the British scene; sources were not always readily available; writings were scattered chronologically and theorists were somewhat diverse in point of view.

Yet the musical and intellectual climates were fertile for ideas relative to the meaning of sound as music. Newman listed fifty composers of sonatas active in England during the period, half of them English. As has been pointed out by Bukofzer, consort music flourished during the time of the Commonwealth.

In the field of instrumental music the Commonwealth regime acted indirectly as a strong furthering factor so that the line of tradition has in no other field been better maintained than here. In the absence of courtly patronage, private music of the middle class and the nobility flourished in an unprecedented manner, and as a result more music was printed for the public than ever before.

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After the Commonwealth, with the encouragement and example of Charles II, music activities in church and court again were encouraged. There was a new surge of creative activity in Anglican church music with composers such as Cooke, Humphrey, Blow, and Purcell. Likewise, renewed interest in dramatic music began with Blow's Venus and Adonis and Purcell's Dido and Aeneas. The early histories of music by Hawkins⁶ and Burney⁷ provide detailed information regarding the music and musicians and the musical history of the time has been summarized by Bukofzer⁸ and Walker⁹. However, none of these works is directed specifically to theoretical considerations.

The musical compositions of the period illustrate harmonic developments. One of these developments is the clarification of tonal and modal resources. The early seventeenth century composer is still largely guided by the church modes, but by the middle of the eighteenth century tonal relationships of the major or minor modes are common. Entering the seventeenth century the "seconda prattica" signaled a new tonal harmonic basis for contrapuntal structures and introduced the harmonic possibilities of monody. Use of the new textures, in England as well as on the continent, resulted in an emphasis on vertical rela-


⁸Bukofzer, op. cit.

tionships of notes as chords above a bass, and these chords came to be related by sonorous and tonal criteria rather than by the melodic implications of the component parts. All of these changing harmonic ideas are reflected in the theoretical writings of the period.

Specific purposes.—This study was an investigation of the music theoretical writings of theorists during the period 1660 to 1760 in the British Isles. It is the intent, in the pages which follow, to describe the theoretical statements of the time. The following five questions were formulated to provide a focus for the analysis.

1. What melodic pitch relationships are suggested as meaningful in the treatises of the period; that is, what are the available musical expressive resources in scales and modes?

2. What harmonic relationships of musical sounds are suggested, and how are the harmonic relationships organized to achieve larger units of musical meaning?

3. What, if any, are the indications that musical knowledge of the period is related to other areas of human understanding as exhibited through the philosophical, acoustical, mathematical, psychological, political, religious, and other areas of cogent expression?

4. Are the theoretical ideas of the various writers related to each other, and is it possible to make definitive statements about the period?

5. In what ways do the practices and concepts evolve within the period?

Procedure.—Bibliographic resources were searched to discover published and unpublished writings on music theory. Copies of the
theoretical writings were obtained either in printed edition or in micro-material. The theoretical writings were first studied to discover what issues were of greatest concern to the theorists. As a result of this first examination, five categories were selected for detailed analysis. These five categories are the subjects of the following chapters, and are as follows: (1) reason and experience; (2) theories of sound; (3) scale, including tuning and temperament; (4) consonance and dissonance; (5) harmonic vocabulary. In the final chapter this information is summarized, results are listed, and implications are suggested.

Primary References

The following kinds of writings comprised the primary references: (1) didactic counterpoint treatises, (2) translations of earlier theoretical works, (3) didactic thorough bass treatises, (4) articles in the Philosophical Transactions of the Royal Society of London, (5) philosophical treatises, and (6) miscellaneous writings. In the listing which follows, the order within each category is chronological.

1. Didactic counterpoint treatises.


2. Translations of works by earlier theorists.


3. Didactic thorough bass treatises.


Heck, Johann Caspar. The Art of Playing Thorough Bass. London: John Welcker, 177?.

4. Articles in the Philosophical Transactions of the Royal Society.


______. "Concerning the Strange Effects of Music in Former Times, Beyond What is to be Found in Later Ages." Philosophical Transactions, IV (1698), 305-307.

Salmon, Thomas. "The Theory of Music Reduced to Arithmetical and Geometrical Proportions." Philosophical Transactions, XXIV (1705), 243-246.


Taylor, Brook. "On the Motion of a Tense String." Philosophical Transactions, XXVIII (1713), 14-16.

Pepusch, John Christopher. "On the Various Genera and Species of Music Among the Ancients; with some Observations Concerning Their Scale." Philosophical Transactions, IX (1746), 268-272.

5. Philosophical Treatises.


———. *A Scheme Demonstrating the Perfection and Harmony of Sounds.* Westminster: J. Cluer and A. Campbell, 1726.


North, Roger. Untitled and unpublished manuscript, British Museum Additional 32549. late 17th c.


North, Roger. Untitled and unpublished manuscript, British Museum Additional 32531. c. 1710.


Related Studies

In spite of the abundance and variety of source information, little has been written about the music theory of this period. Published general works on the history of music theory are still rare, although there are a number of unpublished works available. Other studies have either been directed to the work of individual theorists or to the origins of a single theoretical concept.

General histories of theory.--There are only three published general works on the history of music theory, and none of them deals with the work of English theorists of the hundred years following the Restoration. The earliest of these was by Fétis. Next came Riemann's Geschichte der Musiktheorie. It appeared in its second edition in 1920. The first two books of the Geschichte, with a preface, commentary, and notes are available in an English translation by Haggh. The third general history of theory is Shirlaw's Theory of Harmony. This is the only general history which closely scrutinizes

10 François-Joseph Fétis, Esquisse de l'histoire de l'harmonie considérée comme art et comme science systématique (Paris: Burgoyne et Martinet, 1840).


various harmonic systems from Zarlino to the present day. It provides a thorough and detailed analysis of the works of Rameau and of selected theorists after Rameau. This book was presented as a contribution to the history of the theory of harmony; Shirlaw did not at all claim to be writing a complete history of theory. He wrote from the "natural law" point of view; that is, he evaluated the contributions of the theorists analyzed, using as criteria their success in basing their theories consistently on natural principles. The result is some pre-occupation with natural law statements in the treatises to the neglect of other aspects of theory.

Of the theorists in the English Enlightenment, Keller is mentioned by Shirlaw, but he discusses only more recent English theorists in detail. The reference to Keller is in connection with the question of origin of the idea of inversion of chords. The only treatise discussed in detail by Shirlaw between the time of Zarlino (1571) and Rameau (1722) was Descartes' Compendium (1618, trans. 1653).

Historically oriented theoretical studies.—In addition to the published general histories of theory, a number of studies have been made of specific aspects of the history of theory. Among them, are the following studies.

Daniels studied instructional theoretical writings in the twentieth century. His study was both historical and critical. The

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14 Ibid., p. 11.
15 Cf. Ibid., pp. 411-452 passim.
16 Ibid., pp. 57-62.
critical criteria were based on the assumption that "psychology is propaedeutic to a knowledge of musical experience, and that a theory of music, or, more specifically, of harmony, must be a psychological theory." Daniels' study includes a summary of some theoretical writings from the seventeenth and many from the eighteenth and nineteenth centuries. His work is omnibus in scope relative to treatises with an intended didactic function. However, his information on English sources is incomplete and apt to mislead regarding the mutual influences between England and the continent. An example is the statement,

The only Englishman in the period who was influenced by Rameau is John Holden. His work, An Essay Towards a Rational System of Music rests heavily on Rameau's fundamental bass.

It is true that Holden's work expresses ideas on fundamental bass which are similar to those of Rameau, but, it is not true that Holden was the only Englishman influenced by Rameau (infra, p. 311).

Jacobi studied music theory in England after Rameau. He wrote primarily about the theorists' resources for melody, harmony, and rhythm. His introduction includes a brief overview of music

\[18\] Ibid., p. 60.

\[19\] Ibid., p. 124.


\[21\] Jacobi, op. cit., p. V.
theory in England up to 1764, and he mentions the writings of Playford, Simpson, Mace, Holder, Tans'ur [or Turner], Ceminiani, Pepusch, Malcolm, and Bremner. Jacobi points out that Rameau is mentioned in none of these works. Omitted are three theorists in whose writings a possible relationship to Rameau might be demonstrated. These include Roger North, Lampe, and Antoniotto.

The work of Jones covers approximately the same period of the history of theory as was emphasized by Shirlaw. Jones made a historical survey of theoretical systems from 1722 to 1900, studied the relation of theory to practice, and outlined the development of specific aspects of harmonic vocabulary. According to Jones, Rameau was the first to give harmony a scientific basis. Jones mentions Francis North and Birchensha's translation of Alsted. He discusses the theory of consonance based on beats and the pendulum analogies of Holder and mentions that Lampe's Art of Musick is a protest against the mathematical viewpoint in music, but he does not describe English developments in detail.

22 Ibid., pp. 1-9.
23 Ibid., p. 9. In Keinem der Werke dieser Gruppe finden wir Rameaus Namen erwähnt.
25 Shirlaw, op. cit.
26 Jones, op. cit., p. 11.
27 Ibid., p. 11.
28 Ibid.
29 Ibid., p. 23.
Palisca studied the beginnings of Baroque music from the point of view of music theory. In addition, he has published the annotated texts of the letters of Girolamo Mei written to Vincenzo Galilei and Giovanni Bardi. In his studies, Palisca described the emergence of Baroque music theories in the revival of Aristoxenianism in the late sixteenth century. He outlined the development of "empiricism in musical theory and expressionism in musical esthetics" which "found their synthesis in the counterpoint treatise of Galilei." He pointed out that Vincenzo Galilei, father of the astronomer, trained in the Renaissance Neo-Platonism of Zarlino, in attempting to gain understanding regarding tuning and intonation, turned for clarification to Girolamo Mei, a Florentine humanist who resided in Rome.

The result of the musical intellectual activities, which Palisca describes in detail, was a resurgence of empiricism, which carried with it an abandoning of the syntonic diatonic tuning used by Zarlino. Rationalism versus empiricism is discussed with the addition of seventeenth century insights, by the English theorists of the Enlightenment.

30 Palisca, op. cit.
Miller\textsuperscript{34} studied melodic and harmonic resources listed by selected theorists, including Coperario, Campion, Bevin, Butler, Forbes, Simpson, Salmon, Locke, Blow, Mace, Francis North, Purcell, and Holder. She included biographical information and described the melodic resources and harmonic idioms.

Ruff\textsuperscript{35} studied the seventeenth century English music theorists. She summarized the rudiments of music and the theory of composition as expressed in seventeenth century treatises and traced the development of certain harmonic ideas, including modulation, cadences, and polyphonic techniques. In addition, she summarized some of the important social and intellectual ideas associated with the seventeenth century treatises.

The work of Wilson\textsuperscript{36} has made available much of the information in the Roger North manuscripts, along with supplementary information which answers many questions of the relationship of North to his time. Wilson's description and dating of the manuscripts are included in the book.\textsuperscript{37} Wilson points out the similarity between North's "proper base" and Rameau's "basse-fondamentale," and cites evidence that North was probably aware of the

\begin{itemize}
\item \textsuperscript{34}Gertrude B. Miller, \textit{Tonal Materials in Seventeenth-Century English Treatises} (Rochester, New York: University of Rochester Press, 1961).
\item \textsuperscript{37}\textit{Ibid.}, pp. 361-364.
\end{itemize}
principle of chord-inversion at least twenty years before the Traité was printed. 38

Studies of individual theorists or theoretical problems.--
Other studies have been made on the writings of individual theorists, harmonic procedures by composers of the period, or related musical topics. Some representative works are listed.

Meyer 39 compiled a bibliographical list of all editions, numbered and unnumbered, of Playford's Introduction. He compared them in format, content, and manner of presentation. Included in his study are facsimiles which show Campion's "Art of Descant," as it appeared in the early editions, compared with Purcell's revision which was in the 1694 and all later editions. 40

Beswick 41 traced characteristics of tonality as revealed in selected seventeenth century music.

Houle 42 studied the development of metric ideas in the

38 Ibid., p. 91.
40 Ibid., p. 24.
Baroque. He mentions some of the English sources, including Turner and Tans'ur. 43

McArtor studied the contributions of Geminiani as a composer and theorist. 44 His finding regarding theory was that "Geminiani's treatises were of doubtful value to his contemporaries." 45

Clarke's dissertation on Blow 46 and Hughes's article about Pepusch 47 were directed primarily to the work of Blow and Pepusch as composers rather than theorists.

Studies of theorists of the period include Hyde's dissertation on Mersenne; 48 the work of Ahnell 49 and Keane 50 on Rameau; and Squire's article on Purcell. 51

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51 W. B. Squire, "Purcell as Theorist," Sammelbände der Internationalen Musikgesellschaft, VI (1905), 521-567.
Barbour\(^52\) made a survey of writings on the subject of tuning and temperament. His survey was a valuable resource in studying the tuning problems of the English theorists. Warrack\(^53\) discussed the relationships of music and mathematics; Phillips\(^54\) studied the relationships of music and literature; Lloyd,\(^55\) Shackford,\(^56\) and Babbitt,\(^57\) wrote about the relationships of music to the areas of philosophy and psychology.

**Political and Intellectual Developments**

Turning from the information on organization and resources, attention is directed to the political and intellectual climates of the period. Political and intellectual activities of the time have been summarized by various historians, including the authors of


The New Cambridge Modern History and the Durants. Following is a brief survey which is included to provide a background from which to view the theoretical writings.

Toward political and intellectual freedom.—Oliver Cromwell ruled as Lord Protector of England from 1653 to 1658. Disillusionment attended Cromwell’s dictatorial religionism, and after the death of Cromwell his son found it impossible to maintain the Commonwealth government. On May 8, 1660, Parliament proclaimed Charles II King of England "amid such popular rejoicing as exceeded anything in England's memory." Charles II, with manners polished at the French Court, symbolized the spirit of the times. In reaction to the restrictions of Puritanism there were new freedoms which found expression in the intellectual curiosity of the age. In spite of theological differences, men were free to pursue truth, generally without fear for their safety. It is in this context that the Royal Society of England was founded and chartered in 1662.

Although Charles II supported the Anglican Church, he made profession of the Roman Catholic faith at his death. In 1685, he was followed by his brother, James II, a Catholic, as King of England. This succession brought about an intensification of religious struggles. Protestant England rejected Catholic rule, thereby


60 Durant, op. cit., p. 244.
forcing James from the throne in the 'glorious revolution' of 1688. At this time the provisional government passed the throne to William as King and Mary as Queen--Mary by right of accession to the throne of her father, and William by virtue of a distant relationship to Charles I. A second result of the glorious revolution was the limitation of the monarchy. Parliament stated and asserted its right to protect the citizenry from arbitrary actions of the king--limitations which exist to the present. The death of Queen Mary in 1695 and of King William in 1702 left the throne to Mary's sister Anne. Anne was followed in 1714 by George I.

From the religious and political ferment emerged the freedom and desire to express new ideas in new ways. The Durants expressed this as follows:

The reigns of William and Mary and Anne (1689-1714) were vital years in the history of England. Despite moral laxity, political corruption, and internal strife, they accomplished a dynastic revolution, they declared England irrevocably Protestant, and they definitively transferred governmental supremacy from the Crown to Parliament. They saw the development of powerful ministers still further reducing the rule of the monarch, and they witnessed in 1707 the last royal veto of parliamentary legislation. They established a wider degree of religious toleration and freedom of the press. They peacefully united England and Scotland in a stronger Britain. They turned back the attempt of the most powerful of modern kings to make France the dictator of Europe; instead, they made England mistress of the seas. They expanded, to historic effects, England's possessions in America. They saw the victories of English science and philosophy in Newton's Principia and Locke's Essay Concerning Human Understanding. And the brief twelve years of the gentle Anne saw such an outburst of literature--Defoe, Addison, Steele, Swift, and the first period of Alexander Pope--as was not matched in that age anywhere in the world.61

61 Ibid., pp. 310-311.
Some of the facets of the intellectual climate are here discussed in more detail because of the close relationship they have to ideas expressed in the theoretical treatises. These include developments in natural philosophy and mathematics, which were accompanied by the rise of empiricism in philosophy, and a retrospective factor—the interest in the writings of the ancients.

The rise of natural philosophy.—The term "natural philosophy" refers to the studies regarding the physical universe of the late seventeenth and early eighteenth centuries, and is used to denote the incipient scientism of that period. Seventeenth century natural philosophy developed out of the rationalism of the late middle ages which sought truth "through a metaphysical analysis of the nature of things, which would thereby determine how things acted and functioned." Natural philosophy appealed to experiment and the inductive method of reasoning. From natural philosophy and mathematics emerged a methodology for scientific inquiry. Also, the interest areas of natural philosophy sprouted into the new sciences of physics, chemistry, physiology, and biology.

The developments in natural philosophy and mathematics influenced music theory in various ways. For example, the methodology and spirit of inquiry associated with natural philosophy encouraged the exploring of ideas in music and related areas. In this regard, specific developments in the area of physics which were important to music theory included theories of sound and research on wave motion. Developments in physiology increased the knowledge about the human voice

and the hearing mechanism. In the area of mathematics, theorists used the newly invented logarithms for describing tuning.

Much of this development received impetus as a result of associations for the purpose of interchanging ideas. Such associations were not new. The intellectual circle surrounding the Galilei's at the end of the sixteenth century may be considered such a cooperative in the search for truth. Somewhat later, in 1657, the Accademia del Cimento in Florence took on a formal organization with the avowed purpose of experimentation without regard to existing sects or philosophies.

In England in 1662, Charles II chartered the Royal Society of London, which had its beginnings a few years earlier in intellectual discussions among some friends at Gresham College. This association of men from all classes of society provided a forum for free discussion of many kinds of knowledge. It was founded directly on the Baconian principles which eschewed the old syllogistic logic and sought truth by induction from direct observations of nature. The inspiration for the original association which led to the founding of the Royal Society was taken from the "house of Solomon" in Bacon's New Atlantis. 63

The age of the cosmopolitan man.—Members of the Royal Society who wrote about music included John Wallis, William Lord Brouncker, William Holder, James Hamilton Lord Paisley, Narcissus Lord Bishop


64 Cf. Durant, op. cit., p. 496.
of Ferns and Leighlin, Isaac Newton, Francis Roberts, and Brook Taylor. These men were among those who were not professional musicians but were rather cosmopolitan individuals with far ranging interests which included music. This is not to suggest that breadth of interest was unique to theorists of this period; however, it was a characteristic of these writers, and it is one reason for the variety of kinds of writing about music.

Some examples illustrate the broad interests of the writers. The Reverend Charles Butler, "a person of singular learning and ingenuity," published numerous works on other subjects, including an English grammar with a new system of orthography,\(^5\) as well as his *Principles of Music*.\(^6\) William Lord Brouncker, the first president of the Royal Society, in 1653 published his English translation of Descartes' *Compendium* and added "necessary and judicious animadversions."\(^6\) The distinguished mathematician John Wallis translated Ptolemy's *Harmony* and added his explanation of the subject.\(^6\) Sir Francis North, 1st Baron Guilford, solicitor-general, then attorney-general, then lord chief justice of the court of common pleas, and at the peak of his career Lord Keeper of the Great Seal, published

\(^5\)Cf. Hawkins, op. cit., p. 574.


A Philosophical Essay on Music in 1677. 69 Roger North, brother of Francis, retired from a career as a lawyer, and among his retirement activities was the writing of a number of manuscripts on musical subjects. 70 He was described by Wilson as "a man of wide interests and active mind, alive to new ideas in science and the arts, a man of culture, an engaging author, and a candid critic." 71 The Reverend Alexander Malcolm, author of an extensive treatise on music, 72 spent the last twenty-three years of his life as a school teacher and minister in America. 73

Mathematical and physical ideas of importance to music theory.--An important development in mathematics which took place in the seventeenth century was the invention of logarithms by Napier, presented in tables by Briggs. 74 The mathematical techniques made available by the invention of logarithms were used to calculate the proportions of lengths of vibrating strings. Of importance to the theory of music were developments in physics, especially in the area of mechanics. The advocacy by Galileo, and later Descartes, of Copernican


70 Essays, memoranda and criticisms relating to music by Roger North are found in unpublished manuscripts, British Museum Additional 32531-32537.

71 Wilson, op. cit., p. vii.


74 Henry Briggs, Arithmetica logarithmica (Londini: Gulielmus Iones, 1624).
astronomy had established a new understanding of the relationships of
the earth, sun, planets, and other heavenly bodies, but it was not
until the work of Kepler and Newton that the relationships were quan-
tified. The principles involved were applicable to the general sub-
ject of wave motion. Research on wave motion in the air was done by
Boyle.\(^75\) In addition, Huygens continued the study of the pendulum\(^76\)
which was begun by Galileo, and stated principles for the transmission
of force by moving objects.\(^77\)

The rise of empiricism in philosophy.--Parallel with the
development of scientific method in the late seventeenth and early
eighteenth centuries was the rise of empiricism in philosophy. In-
asmuch as the concerns of the philosophers are reflected in some of
the theoretical writings, it is necessary to summarize briefly some
of the more important currents in philosophy. The influence of Bacon
on the establishment of the Royal Society has been shown (supra, p. 23).
Other English philosophers contemporary to the period under study in-
cluded Hobbes, Locke, Berkeley, and Hume.

It was Hobbes' point of view that man's knowledge originates
in motion. He believed that man's fancy of the external world is the
result of pressure of the motions of the objects fancied.

\(^75\)Robert Boyle, *New Experiments Physico-Mechanical Touching

\(^76\)Christian Huygens, *Oeuvres completes de Christiaan Huygens*,
pub. by the Société Hollandaise des Sciences (22 vols.; La Haye:
Martinus Nijhoff, 1934). *Horologium oscillatorium* of 1673 appears

\(^77\)Huygens, *op. cit.*, *De Motu Corporum ex Percussione*,
c. 1667-1675, is in Vol. 16, pp. 1-168.
So that sense, in all cases, is nothing else but original fancy, caused, as I have said, by the pressure, that is by the motion of external things upon our eyes, ears, and other organs thereunto ordained.78

Imagination and memory are the continuing of these motions in the brain and heart.79 The function of speech is to "transfer our mental discourse, into verbal:"80 In other words, speech gives names and relations to the motions. Reason is the adding and subtracting of the "consequences of general names agreed upon for the making and signifying of our thoughts;..."81 By the rules of conservation of energy, the motions must continue eternally, unless hindered.82

Man's will is the effect of sense, memory, and similar factors, hence it is dependent on cause. The result of these ideas is a determinism with its source in the motions of material things.

The main problem dealt with by John Locke concerned the source of man's knowledge.83 Locke denied the existence of innate ideas.84 He held that there is no inborn truth. Simple ideas, he said, are obtained by sense perception and reflection.

First, our senses, conversant about particular sensible objects, do convey into the mind several distinct perceptions

79 Ibid., p. 9.
80 Ibid., p. 18.
82 Ibid., p. 9.
84 Ibid., pp. 1-25, passim.
of things, according to those various ways wherein those objects do affect them. And thus we come by those ideas we have of yellow, white, heat, cold, soft, hard, bitter, sweet, and all those which we call sensible qualities; which when I say the senses convey into the mind, I mean, they from external objects convey into the mind what produces there those perceptions. This great source of most of the ideas we have, depending wholly upon our senses, and derived by them to the understanding, I call sensation.  

These simple ideas the mind is able to compare and combine into complex ideas. Since complex ideas are collections of simple ideas, they may be "clear and distinct in one part and very obscure and confused in another." Locke describes the qualities of bodies and asserts that these qualities are of three kinds. "Primary qualities" include "the bulk, figure, number, situation and motion or rest of their solid parts," whether or not the mind perceives them. Secondary qualities include the ideas of colors, sounds, smells, tastes, and so on, which the object, "by reason of its insensible primary qualities," is able to produce "in us." The third quality is the power in any body to make changes in the bulk, figure, texture, and motion of another body. In addition to simple and complex ideas, another type of knowledge is possible, which is in the perception of the agreement or disagreement of our ideas. Thus by "intuitive knowledge" we know that black is not white and a square is not a circle.

85 Ibid., pp. 26-27.
86 Ibid., p. 182.
87 Ibid., p. 49.
88 Ibid.
89 Ibid., pp. 261-262.
"The extent of our knowledge comes not only short of the reality of things, but even of the extent of our own ideas,"\(^90\) so knowledge is true in varying degrees of completeness.\(^91\)

Locke held that a world exists outside the human perceiver which can never be completely known, the ideas of which are gained by the bodies producing sensations in the mind; in other words, that there is an external material world, and in the mind are perceptions of this world. Where Hobbes's philosophy was out-and-out materialism; that of Locke was a modified materialism.

Berkeley attempted to establish idealism, intending thereby to refute materialism and atheism. He asserted that Locke was in error in accepting a doctrine of "abstract ideas"; that is, that anything could exist apart from its being perceived. "The absolute existence of unthinking things are words without a meaning."\(^92\) Sensations or ideas exist only in a mind perceiving them. "Their esse is percipi, nor is it possible they should have any existence, out of the minds or thinking things which perceive them."\(^93\)

The table I write on, I say, exists, that is, I see and feel it; and if I were out of my study I should say it existed, meaning thereby that if I was in my study I might perceive it, or that some other spirit actually does perceive it. There was an odour, that is, it was smelled; there was a

\(^90\)ibid.

\(^91\)ibid., pp. 318-325.


\(^93\)ibid., p. 114.
sound, that is to say, it was heard; a colour or figure, and it was perceived by sight or touch. 94

"The cause of ideas is an incorporeal active substance or spirit." 95

According to Berkeley, there are two types of ideas, those of sensation, and those of reflection or memory. 96 The ideas of sense are steady and coherent among mankind and comprise the laws of nature. 97 This uniformity is evidence of "the goodness and wisdom of that governing Spirit whose will constitutes the laws of nature, ... " 98

Later, Hume 99 pressed empiricism to its logical extreme. He agreed that existing is being perceived. Knowledge has its source in experience and so is completely limited to the world of sensation. Consequently we can know nothing of God, ultimates, soul, external world, and so on; rather the only legitimate area of study is the human mental world.

Hobbes, Locke, Berkeley and Hume attempted to explain the source of man's knowledge. Does man perceive something because it is "out there" in a material world of objects, space, and movement; or is the knowing "in here" in the complex of human perceptions; or is it in related or similar movement of an external world to or with

94 Ibid.
95 Ibid., p. 126.
96 Ibid., p. 127.
97 Ibid.
98 Ibid., p. 128.
an internal world? The theoretical writings reflect the contemporary explanations for the source of man's knowledge.

A new renewal of interest in Greek theory.--The third factor mentioned as part of the intellectual climate was a renewed interest in the musical writings of the ancients. This was made possible by the availability in England of ancient Greek texts in Latin translations.

There were at least three published sources in Restoration England for information on Greek music theory. The first, and least often mentioned by the theorists is an article by Edmund Chilmead in a 1672 edition of Aratus, "De Musica antiqua Graeca."100 Chilmead, who was responsible for assembling the catalogus Manuscriptorum Graecorum in Bibliotheca Bodleiana,101 listed and discussed Greek modes and melodies. Hawkins wrote that the publication was "not unworthy the notice of a learned musician."102 A second source was the translation from Greek to Latin of Ptolemy's Harmonics by Wallis (1682), with Wallis' appendices.103 In this book, the Greek and Latin texts appear side by side, and in the appendix, Wallis compares "the true harmony with that of today." The third source was the edition by Meibom of treatises on music by Aristoxenus, Euclid, Nicomachos, Gaudentius Philosophos, Bacchius Senior, Aristides


102Ibid., p. 32.

103Wallis, op. cit.
Quintilianus, and M. Capella. This book contains Latin translations of the Greek texts as well as Meibom's introductions and notes to the various texts. For many years it was the only available source for some of these writings. Meibom visited England in 1674, and his work became well known there.

Writings of some of the Greek authors had been known second-hand through references in Zarlino (1562), Mersenne (1636-37), and Kircher (1650), but the availability of the Latin translations, especially that of Ptolemy by a mathematician with Wallis' stature, and those of the celebrated philologist Meibom, made information on Greek music theory more easily accessible to English theorists.

It has been the purpose in this introduction to provide background information to the study. The organization of the study was summarized and a chronological listing of primary references by category was given. Related research studies were listed and briefly described. Finally, a brief survey was presented of the political and intellectual climates in which theorists lived and worked.

Except for the last, each chapter which follows is written on a subject from the theoretical writings. In the last chapter, the theoretical developments are summarized.


CHAPTER I

REASON AND SENSE

"The wonderful pleasing effects of various sounds agreeing together, has been the study of the most learned in all ages, in hopes from thence to form a true system of musick..."\(^1\) wrote Lampe (1740). They might have succeeded, according to Lampe, had they looked for a "universal law of nature." Almost contemporary with Lampe, Malcolm (1721) wrote, "Now after all our enquiry for a universal character whereby the degrees of concord may be determined, we are left to our experience, and the judgment of the ear."\(^2\)

These two quotations from the writings of post-restoration English musical theorists expose for their time facets of one of the most ancient--yet contemporary--problems in music theory. The problem: Do the sources of musical meaning lie within or outside the human psychology?

In this chapter, the statements relative to reason and sense in English treatises during the Enlightenment are discussed. First, the main currents of development are outlined. Then the statements of those theorists who emphasized a rational point of view are presented. These are followed by a discussion of writings that illustrate the transition to an empirical point of view. Finally, a summary lists

\(^1\) Lampe, 1740, \textit{op. cit.}, p. 12.
\(^2\) Malcolm, \textit{op. cit.}, p. 83.
the various facets of the theorists' writings regarding reason and sense. Within each section, the statements are presented in chronological order.

**Reason or sense.** -- Do justifications for musical meanings spring from rational or sensational sources? Imagining a continuum with rational and empirical extremes, the attribution to Pythagoras of dogma supporting the rational end of the continuum is supported by his followers--notably Nicomachus Garasenus, and it was later transmitted by Boethius. Included in the ideas attributed to Pythagoras are the determination of intervals by proportions of string lengths, the music of the spheres—that is, that the heavenly bodies in their movements are harmonically related—and the completion of the system of the diapason. The empirical end of the continuum is associated with the writings of Aristoxenus. In the extreme of this point of view, musical meanings are said to exist only in their being perceived.

The consequence of this diversity of opinions, so far as it related to music, was that, from the time of Aristoxenus the musicians of earlier times, according as they adhered to the one or the other of these opinions, were denominated either Pythagoreans or Aristoxeneans, by which appellations the two sects continued for a long time to be as much distinguished as those of the Peripatetics and Stoics were by their respective names.

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3Nicomachus Garasenus, *Pythagorici Harmonices Manuale* was translated into Latin by Meibom, *op. cit.* , section 3.

4Anicius Manlius Torquatus Severinus Boethius, 480-524 A.D. *De Institutione Musica* (Venice, 1491).

5Aristoxenus' *Harmonics* was translated into Latin by Meibom, *op. cit.*, section 1. An English translation was made by Henry W. Macran *The Harmonics of Aristoxenus* (Oxford: Clarendon Press, 1902).

Old discussions renewed.--The early Baroque discussions in Italy, which have been documented by Palisca (1954), (supra, p. 15) brought about a new emphasis on Aristoxenianism. Pythagorean musical thinking had held sway during the middle ages. In the empiricism of Galilei and Mei ideas were expressed which signified the end of medieval and mathematical mysticism and the accepting of sense perception as the source of musical knowledge--a change in keeping with the precepts of Renaissance humanism. Associated with these developments was a renewal of interest in Greek music.

In England almost a hundred years later the expressions were articulated in new ways--colored by developments in mathematics, natural philosophy, and empirical philosophy. The writings on this subject by English theorists illustrated three phases of development.

1. Early seventeenth century English treatises were didactic and practical. It was assumed that what the ear enjoyed was correct and that composers agreed on the fundamentals of composition. The treatises by Coperario (c. 1610), Campion (c. 1612), Bevin (1631), Butler (1636), Playford (1653), and Simpson (1665) did not raise issues regarding reason or sense. Rather, the instructions for compositional procedures in these treatises are only practical.

2. In the latter half of the seventeenth century, the availability of Greek theoretical texts and sources from the continent, coupled with a new desire for mathematical accuracy, brought about a wave of Pythagoreanism having unique new overtones. This rationalism reappears with the editions of the writings of Greek authors by Meibom (1652) and Wallis (1682), in the English translations by Brouncker.
(1653) and Birchensha (1664), and in the quest for certainty through experimentation and mathematics by Wallis (1677 and 1698), Salmon (1688), and Roberts (1694).

3. The new rationalism was followed by a re-affirmation of empiricism which found cogent terminology in newly propounded theories of knowledge. The new empiricism is found in the works of men like Roger North (early 18th c.), Fond (1725), and Antoniotto (1760).

The Return of Rationalism

Brouncker's translation of Descartes' Compendium (1653).—The first currents of the returning wave of rationalism were brought to the English reader by William Lord Brouncker, "one of the fairest flowers in that garland of mathematicks, wherewith this century being meritoriously adorned, may, without breach of modesty, take the right hand of antiquity, and stand as well as the wonder, as envy of posterity," who in 1653 translated Descartes' Compendium and wrote "necessary and judicious animadversions thereon"—published one year after Meibom's edition of seven Greek authors was printed in Amsterdam.

According to Descartes, the delectation of the sense requires a certain proportion. In his opinion, superparticular proportions [i.e. $N:N+1$] are more clearly perceived than geometric proportions [i.e. $N:N^2$], and so are superior in determining matters of sense.

That proportion ought to be arithmetical, not geometricall. The reason wherof is, because, in that there are not so many

7Brouncker, op. cit., p. ii.
8Meibom, op. cit.
9Brouncker, op. cit., p. 2.
things advertible, since the differences are every where equall; and therefore the sense suffers not so much labour and defatigation, that it may distinctly perceive all things occurring therein: for example, the proportion of these lines is more easily distinguished by the eyes,

\[ \begin{array}{c}
2 \\
3 \\
4 \\
\end{array} \]

then of these

\[ \frac{\sqrt{8}}{4} \]

A B C

because in the first, the sense is required only to advert the unity for the difference of each line; but in the second, the parts AB, and BC, which are incommensurable and therefore, I conceive, they can by no means be perfectly perceived by the sense, together and at once, but only in order to a proportion arithmetical; so that it may advert in the part AB two parts, wherof three are existent in BC; wherin it is manifest, that the sense is perpetually deceived.\(^10\)

Descartes finds adequate proof by observing the sympathetic vibration of strings of a lute. "One sound bears the same respect to another sound, that one string bears to another string: but in every string that is greater, all the other strings, that are lesse are comprehended;..."\(^11\) Harmonic sounds are obtained from the senary division of the string, because such is the imbecillity of the ears, as that they cannot distinguish, without so much labour as must drown the pleasure, any more differences of sounds.\(^12\)

\(^{10}\) Ibid., pp. 2-3.  
\(^{11}\) Ibid., p. 8.  
\(^{12}\) Ibid., p. 9.
Included in these statements are Pythagorean number mysticism and neoplatonic ideas of plurality within unity with a suggestion of questioning empiricism. The number proportions index the relational structures not of perceptions, but of things—strings.

Brouncker is less Pythagorean. This is made apparent when he corrects Descartes and suggests that not the clarity of proportion but the "sense of hearing" should dictate the choice. The distinguishing point is whether numbers are descriptive of visible proportions or are conceived as the quantifications of a human aural response.

Now considering that not the visible proportion of chords or strings, but the audible proportion of their sounds only is considerable in musick; and that, by the sense of hearing, wee doe judge of sounds according to the geometricall, not arithmetical proportion, or proportionall division of the strings, but give them: I conceive it was rightly inferred An. 3, that chords, as to sounds, ought to bee divided according to a geometricall, not arithmetical progression; by force of the same reason (adequated to the sense of hearing) which our authour gave for the contrary opinion in his sixth preconsiderable.\(^\text{13}\)

Brouncker does make extensive use of mathematics, including division of the mean proportional of a string into seventeen equal semitones by sixteen mean proportionals.\(^\text{14}\) The division is by mean proportionals, which results in surd numbers. It is a relative or tempered division, which is acceptable "since the sense of hearing is not so perfect, as to confine the consonances to so precise a

\(^{13}\)Ibid., p. 84.

\(^{14}\)Ibid., p. 86. The publisher is in error in the preface in stating that Brouncker divides the diapason by sixteen mean proportionals into seventeen equal semitones. It is not the diapason, but the mean proportional which is so divided (infra, pp. 131-132).
The mathematical work is precise, but Brouncker's comments are, in general, Aristoxenian criticisms of Pythagorean statements.

John Birchensha.--Birchensha's translation in 1664 of Alsted's article was a statement in English of Ptolemaic theory. The philosophy of Alsted is largely neoplatonism. "Music is a mathematical science, subalternate to arithmetick." According to Alsted, the original principles of music are from metaphysics and physics. Those principles which stem from metaphysics include unity, goodness, pulchritude, perfection, order, opposition, quantity, and quality. Those principles which stem from physics include quantity, quality, motion, place and time of a natural body. "Harmony is order, and tendeth to unity, for God is the maintainer of all order." Included in his ideas are number theory and religious mysticism—with God the maintainer of all order.

From the translation it is not possible to learn much about the musical opinions of Birchensha. Hawkins mentioned Birchensha's proposal to publish by subscription a work entitled Syntagma Musicae. Additional information about Birchensha is available in some little known manuscript notes in the British Museum. The manuscript includes a copy of an advertisement for Syntagma Musicae dated the 27th day of

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15 Ibid., p. 89.
16 Birchensha, op. cit.
17 Ibid., p. 2.
18 Ibid., p. 6.
19 Hawkins, op. cit., p. 726.
December, 1672, and signed John Birchensha. Also it includes a list of thirty-three claims for "my grand scale," listed under the heading "Mr. Birchenshaw speaks," and dated June 9, 1665. In another section of the manuscript is a discussion comparing Birchensha's "grand scale" with what is apparently the syntonic. Birchensha's claims are impressive. However, he did not leave enough material to guarantee a fair assessment of his ideas. Apparently, it was his desire to integrate all preceding musical systems, but there is no record that the Syntagma Musicae was ever published. It is clear from the information available, however, that Birchensha was caught up in the current discussions on the relationships of Greek authors and other ancient authors, musical arithmetic, and the theories of his time.

John Wallis. --It was in 1682, ten years after Birchensha's advertisement, that Wallis' translation of Ptolemy's Harmonics was published. Later, in 1698, in an article in the Philosophical Transactions, Wallis asserts that the best intervals are determined by proportions of string lengths. He holds that division of the octave into twelve semitones by geometrical proportions only approximates proper proportions.

And accordingly, when we are directed to take the lengths for what are called the 12 hemitones in geometrical proportion,

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20 "Papers Relating to the Writings of John Birchensha," British Museum Additional 4388, fol. 69.
21 Ibid., fol. 67-68r.
22 Ibid., fol. 39-44v.
23 Wallis (trans.), op. cit.
24 John Wallis, "On the Division of the Monochord, or Section of the Musical Canon," Philosophical Transactions, IV (1698), 240-242.
it is to be understood not to be so in the utmost strictness, but to be accurate enough for common use; as for placing the frets on the neck of a viol, or other musical instrument, wherein a greater exactness is not thought necessary. 

Those who would temper the octave precisely are unable to use exact proportions because equal temperament requires surd numbers. Therefore, according to Wallis, to be more exact they should return to arithmetic division by superparticular ratios—syntonic tuning.

But those who choose to treat of it with more exactness, proceed thus: presupposing the ratio for an octave, or diapason, to be that of $2$ to $1$; they divide this into two proportions; not just equal, for that would fall on surd numbers, as of $\sqrt{2}$ to $1$; but nearly equal, so as to be expressed in small numbers. In order to which, instead of taking $2$ to $1$, they take the double of these numbers $4$ to $2$; which is the same ratio as before, and interpose the middle number $3$. 

In another article, Wallis details the contemporary discussion relative to the Aristoxenian and Pythagorean approaches to tuning.

The two eminent sects among the ancients, the Aristoxenian and the Pythagorean, differ much in the same way as the language of our ordinary practical musicians, and that of those who treat of it in a more speculative way. Our practical musicians talk of notes and half notes, just as the Aristoxenians did, as if the whole notes were all equal, and the half notes likewise each the just half of a whole note. But Pythagoras, and those who follow him, found, by the ear, that this equality of intervals would not exactly answer the musical appearances in concords and discords, just as our organists and organ-makers are now aware, that their pipes at equal intervals do not give the just sound. The Pythagoreans, to help this, changed the notion of equal intervals into that of due proportions; and this is followed by Zarlino, Kepler, Cartes, and others who treat of speculative music in this and the last

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26 Ibid.

age. And though they speak of notes and half notes, in a more gross way, much as others do, yet they declare themselves to be understood more nicely. 28

Wallis points out that the Aristoxenians, "... by the judgment of the ear, ..." took the fourth and fifth as known intervals comprising the octave, and composed their scale by filling in the fourth. Pythagoras and his followers, "... not taking the ear alone to be a competent judge in a case so nice, ..." distinguished intervals and the scale by proportions, rather than by the ear alone. 29

Thomas Salmon. —Salmon wished to fix the theory of music on the sure foundations of mathematical certainty. This intent is stated in his Proposal to Perform Music in Perfect and Mathematical Proportions. 30 The title page includes the claim, "approved by the mathematick professors of the University of Oxford," and the book contains remarks by Wallis. Salmon's rational bent is revealed in the dedication.

This mathematical discourse is indeed the anatomy of musick, wherein the infinite wisdom of the great Creator appears: How delightfully and wonderfully is it made! Marvelous are thy works, O Lord, and that my soul knows right well.

All the best proportions, are the best chords of musick, and strike the ear with a pleasure agreeable to the dignity of their numbers. The effects of this the sensualist is satisfied with, and desires to seek no further. 31

As background, he mentions Meibom's edition of seven Greek authors

28 Ibid., p. 292.

29 Ibid., p. 288.

30 Thomas Salmon, Proposal to Perform Music in Perfect and Mathematical Proportions (London: John Lawrence, 1688).

31 Ibid., A2v
(1652), Wallis' translation of Ptolemy (1682), and the Greek melodies published by Chilmead (1672).

According to Salmon, it is through application of proportions that music reaches its greatest perfection. Salmon's authorities in support of these claims are Descartes, Gassendus, Wallis, "... and all other learned men, who have in this last age reviewed the harmonic concerns." However, all the intervals cannot be given in true proportions. This is not "... from the defect of this proposal, ..." but "... nature itself will have it so." "Scholars are not to alter nature, but to discover her constitutions, and to give opportunity for the best management of all her intrigues; ..." The proportions are usable "where demonstration either requires or permits them." He adds that listeners may not at first appreciate the great benefits attending true proportions because their ears are "... debaucht with bearings and imperfections." This is the exactness, which reason, guided by mathematical demonstration, requires of us, and this exactness is rewarded by a proportionable pleasure, that arises from it. Indeed since musical ears, (especially where sense has no great acuteness) are commonly debaucht with bearings and imperfections, they may not perhaps at first observe the advantage offer'd; but I am sure nature desires it, and will rejoice in those proportions, which by the laws of creation she is to be delighted with.

33 Ibid.
34 Ibid., p. 24.
35 Ibid.
36 Ibid., p. 24.
37 Ibid., pp. 24-25.
In his comments, Wallis agrees in principle with Salmon. He summarizes Salmon's arguments and adds clarifying information. He points out that Salmon did not distinguish between Aristoxenian and Pythagorean points of view, and that he assumed that perfect proportions are desirable.

In order to prove the desirability of perfect proportions, Salmon (1705) performed an experiment at Gresham College.

The propositions, on which the experiment was admitted, were: that music consisted in proportions, and the more exact the proportions, the better the music; that the proportions offered were the same that the ancient Grecians used; that the series of notes and half notes were the same as our modern music aimed at, which was there exhibited on fingerboards calculated in mathematical proportion.

Two viols had the frets on the fingerboards replaced by individual frets for each string. The new frets were located by mathematical calculation so "... every stop might be in a perfect exactness."

... on these, a sonata was performed by those eminent violists, Mr. Frederic and Mr. Christian Steffkins; when it appeared, that the theory was certain, since all the stops were owned by them to be perfect. And, that they might be proved agreeable to what the best ear and the best hand performs in modern practice, Signor Gasperini played another sonata on the violin in concert with them, in which the most complete harmony was heard.

Francis Roberts.--Roberts, in an article in the Philosophical Transactions of 1692, pointed out that the pitches available on both

38 Ibid., p. 29.


40 Ibid., p. 243.

41 Ibid., p. 244.
the trumpet and trumpet marine are those sounds which are obtained by vibration in aliquot parts.42 Roberts had observed that the 7th, 11th, 13th, and 14th harmonics are out of tune. He was aware of the phenomenon of sympathetic vibration of partials, and of the relationship between frequency and length. Furthermore, "... all writers on the mathematical part of music agree,

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\begin{array}{ccc}
\text{That by} & \text{a half} & \text{an eighth} \\
\text{shortening} & \text{a third part} & \text{a fifth} \\
\text{a string} & \text{a fourth} & \text{the sound} \\
\text{} & \text{a fifth} & \text{a fourth} \\
\text{} & \text{a sixth} & \text{is raised} \\
\text{} & \text{} & \text{a sharp third} \\
\text{} & \text{} & \text{a flat third}
\end{array}
\]

and "... from this foundation all the other notes are derived."43 Roberts found that comparison of the lengths of the 7th, 11th, 13th and 14th partials with the proportions indicated shows the 7th to be flatter than B fa-bi-mi flat, 11th to be sharper than F fa-ut, 13th to be flatter than A la-mi-re, and 14th to be flatter than B fa-bi-mi flat.44

Roberts' article illustrates contemporary theoretical currents. His norms are mathematically determined and rest on the support of "all writers on the mathematical part of music." His experiments with the monochord, warranted by sense observations, provide data which explain the observations.


43 Ibid., p. 469.

44 Ibid.
John Christopher Pepusch.—Later statements of the rational point of view were made by Pepusch (1746) and Smith (1749). The article by Pepusch was a summary of his observations and opinions on scale, with particular reference to expressions on scale by the ancients. In the opening paragraph Pepusch espouses rational principles.

That musical intervals are founded on certain ratios expressible in numbers, is an old discovery. It is well known that all musical ratios may be analysed into the prime numbers 2, 3, and 5; and that all intervals may be found from the octave, 5th and 3d major; which respectively correspond to those numbers. These are the musician's elements, from the various combinations of which, all the agreeable variety of relations of sounds result. This system is so well founded on experience, that we may look upon it as the standard of truth. Every interval that occurs in music is good or bad, as it approaches to, or deviates from what it ought to be on these principles.

Examination reveals that the principles suggested by Pepusch are not the same as those of earlier authors. The prime numbers accepted by Pepusch are not the senario of Zarlino, nor are they the proportions of only superparticular ratios. Rather, the proportions acceptable as norms by Pepusch are those of the octave, fifth, and major third—the perfect accord—and other intervals are derived from these. Pepusch, who was willing to accept a justification based on number mysticism as a standard of truth, really finds his source in

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45 John Christopher Pepusch, "On the Various Genera and Species of Music Among the Ancients; with some Observations Concerning Their Scale," Philosophical Transactions, IX (1746), 268-272.


47 Pepusch, op. cit., p. 268.
the chord of nature. In the same article he is critical of the number
systems of Ptolemy.

Whoever looks into the numbers given by Ptolemy, will not only
find the primes 2, 3, and 5, but 7, 11, etc. introduced. Nay
he seems to think all 4ths good, provided their component inter-
vals may be expressed by superparticular ratios. But these are
justly exploded conceits; and it seems not improbable that the
contradictions of different numerical hypotheses, even in the
age of Aristoxenus, and their inconsistency with experience,
might lead him to reject numbers altogether.48

Pepusch is apparently willing to accept only number justifications
which can be confirmed by sense.

Robert Smith.—Smith (1749), a fellow of the Royal Society
and Plumian professor of astronomy at Trinity College, Cambridge, de-

defined sound as follows:

Sound is caused by the vibrations of elastic bodies, which
communicate the like vibrations to the air, and these the like
again to our organs of hearing. Philosophers are agreed in this,
because sounding bodies communicate tremors to distant bodies.
For instance, the vibrating motion of a musical string puts
others in motion, whose tension and quantity of matter dispose
their vibrations to keep time with the pulses of air, propagated
from the string that was struck.49

Following this line of thinking, Smith turns to the motion
of vibrating strings and decides that by means of the vibrating
string the theory of all sorts of musical sounds can be understood.

This observation reduces the theory of all sorts of musical
sounds to that of the sounds of a single string; I mean with re-
spect to their gravity and acuteness, which is the principle
subject of harmonics.50

Expanding on this principle, he provides a detailed explanation of
proportions with a new system for ordering the relative perfection of consonances by means of ratios.

The writings of Descartes (trans. 1653), Birchensha (trans. 1664), Salmon (1653 and 1705), Wallis (1682 and 1698), Roberts (1692), Pepusch (1746), and Smith (1749), illustrated the new wave of mathematical rationalism with regard to musical meanings. The writings indicate dissatisfaction with the carelessness of modern practical musicians; Beauty and Truth are sought in a return to the true principles of the ancients--now presented not only with mathematical but also with experimental evidence. The article by Pepusch (1746) exemplifies the conflicts of the time. He seeks answers by scholarly study of the writings of the ancients. He accepts as determinative the findings of his mathematical system. Yet his musical intuition tells him that these are inadequate originators for the musical meanings with which he must live.

**Thomas Mace and mysticism.**--The work of Mace (1676) demonstrated theological mysticism, and Fond (1725) pointed out such mysticism in the treatises of Simpson and Playford (infra, p. 8

Musick's Monument\(^{51}\) was a discussion of music in the church and an instructional treatise for lute and viol. In this work, Mace mentions that it is difficult to explain the beauty of the major triad and the identity of octaves.

Now reason in all these things is at a perfect stand; can say nothing satisfactorily unto it; how, or by what means, it

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should thus come to pass; but that it is so, is plain by all experience.\textsuperscript{52}

Mace's answer is parenthetical to the direct course of the discussion on nature and sense, and represents a retrospective point of view. He lists three great mysteries of music.

The 1st is, concerning the two differing, or contrapunctal qualities in whole nature, viz., the good and the evil. . . . plainly perceived by the conchords and discords; . . .

The 2d. That profound mystery of mysteries, viz. of the holy trinity, is perspicuously made plain, by the connection of those 3 harmonic conchords, viz. 1, 3, 5.

The 3d is the stupendous mystery of an octave or eight; . . .\textsuperscript{53}

Concords and discords are respectively types of good and evil, and the triad is a symbol of the Trinity. His explanation for the identity of octaves is also rooted in mysticism, as illustrated on Plate I, page 50. He explains octaves as points on a spiral which has its source, cause, and conclusion in God.

Toward Empiricism

Other theorists developed justification structures in directions contrary to mathematical rationalism and mysticism. The response had two thrusts: nature and sense. Theorists accepting justifications in nature substituted a hierarchy of external vibrating phenomena for that of mathematics directly; theorists accepting justification in sense came to have as their concern the meanings humans attach to sounds. These directions are apparent in writings of the following theorists.

\textsuperscript{52}Ibid., p. 267.

\textsuperscript{53}Ibid., p. 265.
Mysterious Center of All Mysterie;
All Things Originate Themselves in Thee;
And in Their Revolution, wholly tend
To Thee, Their Octave, Their Most Happy End.
All Things (what e're) in Nature, are Thus Rounded,
That Mystically Limited, and Bounded;
Some Harmonize in Diapasons Deep,
Others again, more Lofty Circles Keep.
But Thou, the Moving Cause in every Thing;
The Mystick Life, from whence All Life doth Spring.
That Little Spark of Life, which I call Mine,
It came from Thee: (a Precious Gift of Thine)
I Bless Thy Name, I Daily feel it move,
And Circulate towards Thee, In Highest Love.
I've almost Run my Round; 'tis well nigh past,
I Joy to think of Thee, (My First; My Last)
A Unison (at First) I was in Thee;
An Octave (now at Last) I hope shall be,
To Round Thy Praises in Eternity,
In th'Unconceiv'd Harmonious Mystery.  

54 Ibid., pp. 268-269.
William Holder (1694).—Holder used many pages in his Treatise to discuss the vibrating string and related number theories; however, he saw ultimate answers as residing in the human receiver.

"Concords are Harmonic sounds which being joyned please and delight the ear; and discords the contrary. So that it is indeed the judgment of the ear that determines which are concords." This judgment is based on "natural reasons"—the statements here possibly influenced by an earlier essay by Francis Lord North (1677).

But the ear being entertained with motions which fall under exact demonstrations of their measures, the doctrine hereof is capable of being more accurately discovered.

The "natural reasons" why concords please the ear is found in the motions by which the concords are made, which leads back to ratios and proportions of vibrating strings. In listing areas for music study, he includes "how the sounds of harmony are received by the ear and why some persons do not love music."

As to this last; the incomparable Dr. Willis [sic] mentions a certain nerve in the brain, which some persons have; and some have not. But further, it may be considered, that all nerves are composed of small fibres; of such in the guts of sheep, cats, etc. are made lute strings; and of such are all the nerves, and amongst them, those of the ear, composed. And, as such, the latter are affected with the regular tremblings of harmonic sounds. If a false string (such as I have before described) transmit its sound to the best ear; it displeaseth. Now if there be found falseness in those


56. Ibid., p. 50.

57. Francis North, op. cit.

58. Holder, op. cit., p. 50.

59. Ibid., p. 200.
fibres, of which strings are made; why not the like in those
of the auditory nerve in some persons? And then it is no
wonder if such an ear be not pleased with musick, whose nerves
are not fitted to correspond with it, in commensurate impres-
sions and motions.60

According to Holder, sound is perceived when external motions cause
the sympathetic vibration of nerves in the human receiver. The nerves
vibrate in similar fashion to vibrating string; if the vibrating re-
lationships are appropriate and the nerves are not "false", in a sense
similar to that of a "false" string, there will be musically pleasur-
able sensations.

The philosophy expressed by Holder (1694) is Hobbesian. Com-
pare the following from Leviathan (1651).

The cause of sense, is the external body, or object, which
presseth the organ proper to each sense, either immediately,
as in the taste and touch; or mediatelv, as in seeing, hearing,
and smelling; which pressure, by the mediation of the nerves,
and other strings and membranes of the body, continued inwards
to the brain and heart, causeth there a resistance, or counter-
pressure, or endeavor of the heart to deliver itself, which
endeavour, because outward, seemeth to be some matter without.
And this seeming, or fancy, is that which men call sense; and
consisteth, as to the eye, in a light, or colour figured; to
the ear, in a sound; to the nostril, in an odour; to the tongue
and palate, in a savour; and to the rest of the body, in heat,
cold, hardness, softness, and such other qualities as we dis-
cern by feeling. All which qualities, called sensible, are in
the object, that causeth them, but so many several motions of
the matter, by which it presseth our organs diversely. Neither
in us that are pressed, are they any thing else, but divers
motions; for motion produceth nothing but motion. But their
appearance to us is fancy, the same waking, that dreaming.
And as pressing, rubbing, or striking the eye, makes us fancy
a light; and pressing the ear, produceth a din; so do the
bodies also we see, or hear, produce the same by their strong,
though unobserved action. For if those colours and sounds
were in the bodies, or objects that cause them, they could
not be severed from them, as by glasses, and in echoes by
reflection, we see they are; where we know the thing we see
is in one place, the appearance in another. And though at

60 Ibid., pp. 200-201.
some certain distance, the real and very object seem invested
with the fancy it begets in us; yet still the object is one
thing, the image or fancy is another. So that sense, in all
cases, is nothing else but original fancy, caused, as I have
said by the pressure, that is, by the motion, of external
things upon our eyes, ears, and other organs thereunto
ordained. 61

Arthur Bedford.--A manuscript stating Bedford's opinions on
various musical topics has the dates "1705 or 1706" on the title
page. 62 In statements referring to the perception of music Bedford
supports the Aristoxenian point of view. He dismisses the Platonic
and Peripatetic schools with a few sentences 63 and then writes about
the affective power of music.

When we speak of musick, we understand no more than the
science of sounds, either instrumental, or vocal, according
as they are contrived by art to work upon our passions, and
to gratify our senses. 64

Roger North.--The writings of Roger North (early 18th c.) are
available in detail on the perception of sound. In his various manu-
scripts, North states points of view reflecting different philosophies
of his time. At some places in his writings, he holds to a variation
of Hobbesianism. At times he is Lockian, and at other times he holds
to the possibility of innate knowledge. He would like to find a
universal rule for good music:

An air indeed may be very pretty, but what makes it so is
not defined. They say the ear is judge; very true; and so all
objects that affect us are judged by our senses, and in most a

62 Arthur Bedford, "Observations concerning Musick made...1705
or 1706," unpublished manuscript, British Museum Additional 4917.
63 Ibid., fol. 4.
64 Ibid., fol. 6r.
reasonable account is given why. But for the pleasing of a
tune no reason hath bin given, that I know of; but yet I must
think that (besides the laws of harmony already toucht upon,
which are not to be temerated [i.e. violated]) there may be a
fund discovered and laid open out of which all pleasing tune
in musick may be drawne. 

In order to find "a criterion of good musick" it is necessary to "look
into nature itself, and the truth of things."

In initial comments in manuscripts of c. 1710 and c. 1726,
North holds a variation of Hobbesianism in which the motions cause
sensation in the mind, rather than continuing there as motion. That
is, motions produce sense phenomena in the hearer.

The action of sound is sensible to us by the effects,
which incise in our minds ideas infinitely various, but none
more egregious than those of pleasure, and distaste. Whither
it be one or other and whatever the modification is, the
active cause is but pure percussion of the air upon the
auricular membrane, or tympanum. Whence then proceeds such
exquisite passions of the mind?

However, his idea of perception is not completely materialistic.

Rather, he accepts the possibility of intuitive knowledge and asserts
that the mind has the ability to find meaning by relating experience
to previous experiences. The following quotations are illustrative.

That this effect of evenness, or unevenness, regularity
or irregularity, upon all sence may appear reasonable, I will
endeavor to examine the source of all pleasure, or disgust or
that nature;

It will be agreed to me that every thing, which is under-
stood is pleasant, and that which is confused, and not under-
stood is not so. For wee see, hear, and effect to know and
distinguish things, which done, there is a suspension, and
upon disappoint, as when things pass, and new ones come,

65 Wilson, op. cit., p. 110.
66 Ibid., p. 291.
67 Roger North, "The Musickall Gramarian," unpublished manu-
script, British Museum Additional 32,533, fol. 11r.
before they are knowne there is a discontent or uneasyness.
It is possible that many things very disorderly and unaccountable, may be not onely not ungratefull, but very pleasing to the sence; which doth not break this hypothesis, for such things have the advantage of our acquaintance with them, or with the like, and the consideration of the histories, profits, uses, fertilitys and other things that belong to them, and therefore are enjoyed with a prejudice.

We have the service from our memorys, that wee can compare, and judge spaces without actual measuring and lay one to the other, and say this is greater duple or subduple, or equall with considerable accuracy. So that a great variation may be perceived, tho a small one is not, and therefore makes no difference.

Now when upon a view wee find one part measuring another so that there is a succession of discovery in the observation, and wee find, this here equall to that there, all level, and upright, each side answering, parts of one measuring another it cannot be denyed sure, that this knowledg springing from the order and disposition of the whole doth admit [more] pleasure, then if every part were pluck't from the other, and observed apart.68

Similar ideas are found in the writings of John Locke (1690). North suggests that memory makes possible reflection and relating of simple perceptions and as a result of the sensations and reflection the mind gains ideas of pleasure and pain. The following quotations from Locke's Essay are listed for comparison.

The mind receiving the ideas mentioned in the foregoing chapters from without, when it turns its view inward upon itself, and observes its own actions about those ideas it has, takes from thence other ideas, which are as capable to be the objects of its contemplation as any of those it received from foreign things.69

There be other simple ideas which convey themselves into the mind by all the ways of sensation and reflection, viz. pleasure or delight, and its opposite, pain, or uneasiness; power; existence; unity.70

68Roger North, 32531, op. cit., ff. 45-46r.
69John Locke, op. cit., p. 40.
70Ibid.
North is talking about intuitive knowledge in a sense similar to that of Locke, rather than in innate principles. The knowledge is not innate.

This is the truest account I can make of the beauty of symmetry, which is usually ascribed to . . . impression upon our nature, in a sort of divine stamp, or some such high supposition, without looking farther after it, whereof I take it, only to proceed out of the difference between knowing or not knowing, feeding the senses or starving them which I think is a more sensible solution, then any miraculous invention in our nature.

And really and truly, there is no naturall beauty or decorum in things but it ariseth from our sense and judgment, of which I have already spoke; but I will ad that an experience of usefulness; and the opinion of what is needfull, too much or too little governs the decorum of most things, especially architecture which hath all its rules and proportions from thence.71

In other manuscripts, North presents his ideas in greater detail. For example, the following quotation expresses the relativity of musical perceptions and principles of pleasure and pain. Here he asserts again that pleasure and pain are not inherent in the causing stimuli, but are ideas resulting from sensation and reflection. They result not only from the nature of the stimulus but also from the quantity and order of the information received. In other words, the ideas of pleasure and pain are relative expressions of comparable experiences.

. . . For first sensation in it self is onely a notice of differences; if wee could suppose that one and the same impression on our sensory should continue without change, I question whither that might be termed sensation, or not, unless it be such es angells, or spirits may be supposed to have, whereof wee can have no idea. Therefore the first perception is of somewhat different, or added, by the whereof it is observed. And it is not materiall to determine what the difference is, or wherein it consists. It's enough that one impression

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71 Roger North, 32531, op. cit., fol. 46v.
varies from another. Then next that the sensitive being gained by an impression perceived, is not any knowledge of the thing causing it, but a knowledge of its own essence, so far as to determine that it is existent, which I take to be Ex Nomine a pleasure; and since nothing is found in pure sensation, but that knowledge, which, as such, is pleasant, I take all knowledge to be pleasure, and the contrary, which doubting, is conscious ignorance, pain. Then lastly, all knowledge being pleasant, whatever accumulates knowledge, exalts the pleasure, and on the other side cloudy and unintelligible impressions induce a nausea and that proceeds not from the nature, but the disorder and confusion of things, for to want what is expected, and desired, that is distinction, the defect being also sensible, must superinduce uneasiness. And thus pleasure and pain derived upon simple sensation directly, which carries neither, gains an idea positive, residing in our minds only, and not in the nature of things, and accordingly we denominate pleasure, or the contrary; but there is more of the positive in pain, for that must needs attend the dissolution of the frame by which sensation operates, and in proper degrees all manner of approach to it, must be painful; and from thence emerges a singular pleasure, which is rest, and ease from pain; for so contraries illustrate one and other; but this latter sort proceeding from violence, I am not concerned with, but only with what simple sensation affords.

I have observed that impressions have no continuance. For it is only at the first instant that differences are perceived. And for this reason we must account every pleasing sensation to be made up of (as it were) simple pulses; but of these the succession with the various modes must also be perceived, whereof the comparison by means of the more eminent, gives our idea of time, as the termini give the idea of space. And thus the intervals of pulsations, by their differences, become objects of sensation as the pulses themselves are. Now by way of accumulation, we may confer the same all over again, thro memory; and the comparisons will be not only of sensibles one with another, but of those with the memorata, which inlargeth the sphere of our sensitive capacity. The whole world is made up of unity, or of systems of many which may be taken as such. 72

Roger North holds that the mind accepts one set of sensations at a time; as a result of this characteristic, attention is a factor in musical understanding. He is also aware that when the mind receives information it gathers units of information into groups. By

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72Roger North, "An Essay of Musicall Ayre," unpublished manuscript, British Museum Additional 32536, fol. 8r-9r.
this process, a row of trees is perceived as a row rather than as individual units. In the following quotation, he applies these ideas both to sound and to time.

And I do not find any cause to think but that sensation acts accordingly, and that the mind at any one time is not affected with more than an unity. And when objects are multifariously the mind passeth from one, to the other, to and fro, intermixing some memorata, with incredible celerity. And this in the idea is a large field of perception; this I call attention, which I suppose be but of one thing at any one time, which traveling ever all swift as light, fulfills divers scientific comparisons.

Out of these perplexed schemes of sensation, pleasure and displeasure are known to arise in our minds, but how, not so familiarly. I have already charged it all upon knowledge, whereof an increase, that is more of the sensible world perceived, inspires the idea of pleasure. Now it is time to determine, that all regularity that is equal or symmetric disposition of things must impress the sense with more delight than lying in disorder. In the instances of buildings, gardens, and plantations, this is evident, for when one sees a straight row of trees at equal distances there is a perception not only of each tree in its turn, but of the order of the whole, all at once; which out of the same object is so much more knowledge, then the several parts distinctly taken afforded. And the like cannot be affirmed of any thing contingently and without order placed, but rather that the mind is in pain, caused by the suspense and labour to comprehend what sense presents. The number .10. upon a cord, is more agreeable, because from the order you know it is .10. then if the pipps were scattered irregularly, for then you must take pains to count and tell how many they are.

What is here say'd of spaces, is equally true of time, being no less real objects of sense, then is the material it self, by the termini wherof our account of time is had; and it falls out so that we make a nicer judgment of symmetrys in time than we can doe of space, because we are assisted by the pendulum-law according to which all our members (will we-nill we), must move in isochronisme; ... 73

Perception and meaning take place on both the conscious and subconscious levels, according to Roger North.

There are many things we do, and know nothing of it, as the involuntary motions of the viscera. Now I must say

73 Ibid., fol. 9r-10r.
that beyond the limit of common distinction, described by our grosser members which we know; there is a further power of distinguishing, by the means of interior, and finer parts of our bodies, which we do not know. The pulses of a continued sound are to the mind really distinguished by such sounds, intermix in due symmetry and proportion, is strangely touching to our spirits; but more because good sounds have a limitation which they do not well exceed, and that is taken from human capacity.

At this point, North is not certain that knowledge is only the result of experience. He suggests the existence of some sort of primitive or a priori knowledge in the listener.

It will be needful to remove a powerful objection, which will not be done without disclosing a prodigious search in nature, which is that all positive science, and reflex knowledge of ourselves hath nothing to do with sensation, and the consequences, as to pleasure and pain; for the knowledge that I have insisted on is insensible. And under the operation of it, we do not so much as know that we know, that is, we are sensible of good, and evil, which proceed from knowledge, or ignorance of things, and not sensible, and do not perceive neither the what nor the why.

...Therefore experimental skill, and reflexion is a new faculty superinduced upon what is properly animal, the which comes and goes with life itself, and requires no art, paines, or skill to accomplish it.

So the only way Roger North can explain the effect of music in its most mysterious manifestations is through innate knowledge.

In summary, Roger North's ideas on the perception of sound as music are eclectic. When he is writing about the stimulus and its immediate effect on the listener, he is materialistic, and holds that the motion of matter causes sensation. In discussing the roles of sensation, memory, reflection, pain and pleasure he is Lockian. When treating the problem of the effect of music at subconscious levels

74 Ibid., fol. llv.
75 Ibid., fol. 12r.
and in knowledge of the what and why of its effects, he turns to innate knowledge.

Alexander Malcolm. -- In his treatise, published in 1721, Malcolm tried to be syncrétistic; yet the philosophies expressed were predominantly Lockian. 76

He begins by emphasizing the judgment of the ear. "The mechanism of this noble organ has still great difficulties, which all the industry of the most capable and curious enquirers has not surmounted." 77 However, he suggests that the ancients could have corrected their mistakes had they been aware of the vibration of a string in partials.

Had he [Pythagoras] listened to the duration of the different sounds of a string, in its free vibration, what then must have been his surprise at the harmony he would there have found, when he was so astonished at the sounds of hammers. 78

I am very far from denying the praises due to the merit of the ancients for their endeavors, but reason and experience convinces me, they ought to be no patterns for us in musick, since their systems are founded on such defective principles. 79

What is the true answer? Malcolm suggests that the search for this truth includes study of the hearing mechanism.

There are questions still unsolved about the use of some parts, and perhaps other necessary parts never yet discovered; but the most important question among the learned is about the last and immediate instrument of hearing, or that part which last receives the sonorous motion, and finishes what is necessary on the part of the organ. 80

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76 Malcolm, op. cit.
77 Ibid., p. 3.
79 Ibid.
80 Ibid., p. 4.
In spite of this emphasis on sense perception, he proceeds to detailed purely mathematical manipulations, based on the contradictory sup-
position that though the ear is infallible, reason is superior. Mu-
sical meanings are relative to human experience, yet they are stable and unchangeable, and perceptions are predictable in terms of mathem-
tical proportions or ratios of vibrating strings.

It was first found by experience, that many sounds differing in tune, tho' the measures of the differences were not yet known, raised agreeable sensations, when applied either in con-
sonance or succession; and that there were degrees in this pleasure. But while the measure of these differences were not known, the ear must have been the only director; which tho' the infallible judge of what's agreeable to its self; yet per-
haps not the best provisor. Reason is a superior faculty, and can make use of former experiences of pleasure to contrive and invent new ones; for by examining the grounds and causes of pleasure in one instance, we may conclude with great prob-
ability, what pleasure will arise from other causes that have a relation and likeness to the former; and tho' we may be mis-
taken, yet it is plain, that reason, by making all the probable conclusions it can, to be again examined by the judgment of sense, will more readily discover the agreeable and disagree-
able, than if we were left to make experiments at random, without observing any order or connection, i.e. to find things by chance. And particularly in the present case, by discover-
ing the cause of the difference of tune, or something at least that is inseparably connected with it, we have found a certain way of measuring all their relative degrees; of making dis-
tinct comparisons of the intervals of sound; and in a word, we have by this means found a perfect art of raising the pleasure of which this relation of sounds is capable, founded on a rational and well ordered theory, which sense and experi-
ence confirms.81

Theories predicting new experiences can be constructed after examining the "relations of the motions" that are the cause of sound. As a result "harmony is brought under mathematical calculation."82

In his use of numbers, Malcolm's writings reflect Berkeley's statement

81 Ibid., pp. 41-43.
82 Ibid., p. 65.
that "In arithmetic ... before we regard not the things but the signs, which nevertheless are not regarded for their own sake, but because they direct us how to act with relation to things, and dispose rightly of them."  

After introducing his definitions and justifications for detailed use of mathematical calculation, Malcolm presents the ideas of "first and second causes" dealing specifically with the problem of universal truth, known only to God, and that portion of such truth which man can know. Especially at this point, Malcolm states a Lockian point of view.

... We now enquire into the grounds and reasons of their different effects. When two sounds are heard in immediate succession, the mind not only perceives two simple ideas, but by a proper activity of its own, comparing these ideas, forms another of their difference of tune, from which arise to us various degrees of pleasure or offence: these are the effects we are now to consider the reasons of.  

Malcolm asserts that the world is the "product of infinite wisdom;" God is the first cause and the "ultimate reason and cause of every thing." Man is a created intelligence and cannot know "the original reason and grounds of the relations and connections which we see among things." Man, in his mortal state, can never know "whether that connection flows from any necessity in the nature of things, or be altogether an arbitrary disposition; for to solve this would require to know things perfectly,"—knowledge known only to God. Man can only know the "secondary reason of things." The secondary reason is

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84Malcolm, op. cit., p. 66.
discovered by observations and inquiries into nature, "that from
nature's constant and uniform operations we may learn her laws."85
Knowledge is gained by the mind perceiving simple ideas which are
compared by the process of reflection and from this process arise
the relative and simple ideas of pleasure and pain.

These comments are important to Malcolm's later analyses of
theoretical systems. He finds it impossible to find perfect answers
in either mathematics or natural law, but this does not negate the
validity of the search. Man's purpose is to observe, generalize, and
postulate—realizing always that there is something else beyond, which
is a perfect answer to the inquiries. An example of this is found in
gravitation, upon which principle "we can give a good reason why
timber floats in water, and why smoke ascends. I call it a secondary
reason, because it is founded on a principle of which we can give no
other reason but that we find it constantly so.86 The gravitation
analogy is from the philosophical writings of the time. Berkeley,
among others, used this analogy and concluded that searching for gen-
eral laws is a worthy activity for philosophers.

... by a diligent observation of the phenomena within our view
we may discover the general laws of nature, and from them
deduce the other phenomena, I do not say demonstrate; for all
deductions of that kind depend on a supposition that the
author of nature always operates uniformly, and in a con-
stant observance of those rules we take for principles; which
we cannot evidently know.87

85 Ibid., pp. 66-69.
86 Ibid., p. 69.
87 Luce and Jessop, op. cit., p. 88.
This is how it is in "matters of sense," according to Malcolm. The harmony of sounds can be expressed by proportions, "... we know by experience what proportions and relations of tune afford pleasure, what not; ... by this means we should know where nature has set the limits of concord and discord; so we don't enquire why we are pleased, but what it is that pleases us."88 However, he is unable to find any single system which answers to all of the knowledge from experience. In spite of the fact that hundreds of pages in his Treatise deal with harmonic arithmetic and natural law justifications, his conclusion is that "when a question is about the agreeableness of any thing to the senses, the last appeal must be to experience, the only infallible judge in these cases; and so in musick, the ear must inform us of what is good and bad; and nothing ought to be received without its approbation."89

**John Fond.**—Fond (1725) looked to nature for justifications for musical practices.90 In some respects, his System is a restatement of some of the principles advanced in Salmon's Essay to the Advancement of Musick.91 However, Salmon and Fond arrive at their respective systems from opposite points of view: Salmon is Pythagorean; Fond is Aristoxenian. In looking toward nature, Fond finds there only the justifications of the ear. First, he disclaims mysticism and neoplatonism, which he considers "dreams and enthusiasm."

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88 Malcolm, op. cit., p. 69.
89 Ibid., p. 77.
90 Fond, op. cit.
91 Salmon, 1672, op. cit.
Symonds in a curious plate, resembling a plane hemisphere, learnedly shows us the wonderful relations of the seven notes to the seven planets. The same Symonds, deviating from himself, joins with Playford to prove that all notes are reducible to three; and should according to truth, be reduced to that number "Trinity." 92

Then Fond disclaims mathematical rationalism.

Others more rational than these, observing the want of the theoretical part of music, at once plunge into the depth of mathematics. They undertake to explain the difficulty of music by the greater difficulty of mathematics. 'Tis true, mathematics may come into the making of musical instruments, and the time or measure of a piece of music; but as to music itself, I don't see mathematics have any more to do with it than they have with poetry, rhetoric, or eloquence, whose affinity with music is certainly very great. 93

Mathematicians of whom Fond is critical include Descartes and Wallis.

Fond finds his originals in the music itself, as is shown in the following quotations.

In this I have no recourse to mathematics, nor any other art or science whatever. I prove the truth and reality of these twelve notes by the nature of music itself, particularly from the artful way of passing, or sliding imperceptibly from one key to another; which is by all look'd upon as a great beauty in composition. 94

Again, if music is part of mathematics, as most, if not all will have it, either the theoretical or the practical part of it, or rather both indeed should be mathematics; but it happens that neither is so. As to the theory, all the powers of mathematics cannot give us a notion of a note, nor teach us the principles of composition, nor give us the notion of gracing. I am sure mathematics cannot teach us how to dispose our throats for singing, nor how to blow, or strike and move our fingers in playing. 95

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92 Fond, op. cit., p. xxx.
93 Ibid., p. xxxii.
94 Ibid., p. xl
95 Ibid., p. lxxiv.
He mentions the possibility that music is a part of natural philosophy, but in his opinion, all extra-musical means to musical judgments are invalid.

Some indeed pretend to teach how sounds do please; they attempt to show the immediate manner of the sound's pleasing; but I am afraid they had better rank this among impossibilities; for if neither music, nor mathematics, nor even natural philosophy can account for this, as certainly they cannot, we may safely pronounce that nothing can: ... 96

John Frederick Lampe.--Lampe (1740) had no sympathy with mathematical justifications. The ancients erred, said Lampe, in looking to mathematics for the rules of music.

The original cause of the mistakes, that have been made by some of the most learned among the ancients in musick, was that they took their first principles from the mathematicks, and by endeavoring to make musick subservient to numbers and lines, and by calculating proportions, have done themselves infinite prejudice, but enduring thousands of years in a manner uncontrolled, and the latter age fettered by custom, those looked no farther, but took all they had found for all that could be found, and those rarely venture out of their steps, but take from them everything upon trust, and sacrifice their judgment and understanding to the authority of the ancients, and meanly give up the great prerogative of thinking and judging for themselves. 97

Rather, they should have studied the sense of hearing.

Had it been duly considered, that the knowledge of all sounds depend upon the sense of hearing, they would have easily found, that musick is not confined to mathematicks, nor would they have taken so much pains to settle a system upon such principles, which (were they strictly followed) would deprive us of the greatest part of the beauties of musick. 98

Rather than dealing with the problem of human perception, which he has exposed, Lampe looks to nature for the answer.

96 Ibid., p. 11.
97 Lampe, 1740, op. cit., p. 2.
98 Ibid., p. 3.
"Nature," he says, "has given us musical sounds by which the soul of every thinking creature must be touched, ... Can Mathematicks furnish us with such principles as are proper upon these occasions?"  

Nature has given us the sounds, and art refines and embellishes the materials which nature produces, teaches us to enliven the subject, and to dispose every thing to the best advantage, and opens to the mind a vast space of beauty, and variety by experiments; judgment confirms what is really good, and gives solid and pleasing thoughts.  

According to Lampe, the ancient systems were too restricted in their thinking to provide understanding of musical meaning. Had Pythagoras "consulted nature" and only "made use of numbers and words to assist the memory, he might, as he was a studious and wise man, have made a wonderful progress in this science."  

In turning to nature, Lampe only accomplished the substitution of another hierarchy for the mathematical: that of the overtones of the vibrating string. "Nature in her free operation, by one pulse of a string in the pitch of AA, gives the following combined sounds, and their species of harmony:" second sound A, third sound E, fourth sound A, fifth sound C². "Nature has established but three different species or kinds of sounds to make a perfect harmony," root, third, fifth, and "all other sounds have their derivation and being from one of those." This parallels or follows similar statements by Rameau,

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99 Ibid., p. 3.  
100 Ibid., p. 7.  
101 Ibid., pp. 13-14.  
102 Ibid., p. 20.  
which have been discussed in detail by Shirlaw.\textsuperscript{104} A quotation by Lampe makes it clear that he was aware of the work of the French theorist.\textsuperscript{105}

\textbf{Georgio Antoniotto.}--Later in the eighteenth century, Smith's Harmonies (1749) illustrated the rational point of view and Antoniotto's \textit{L'arte arménien} (1760) illustrated the empirical point of view. Smith's mathematical approach is discussed in the chapters on scale (infra, pp. 164-168) and consonance and dissonance (infra, pp. 215-219). Antoniotto lists Smith as one of many who have used ratios as the "supposed intervals"; the list includes Euclid, Geudentius, Nicomachus, Ptolemy, Zarino, Huygens, Dechaies, Descartes, Wallis, Malcolm, Euler, and Smith.

All, and many others have used the word harmony to be applied to the ratios of the above supposed interval betwixt the different sounds. But in this treatise, where the sounds are not considered in the ratios of their supposed intervals, but only in the immediate effect, which alone, or combined in their progression, produce into the sensation; we shall define, that harmony is a product of the progression of two, three, or more different or dissonant sounds (distinctly perceived by the sensation) joined together and artificially combined.\textsuperscript{106}

Antoniotto is practical. His analyses of musical sounds and intervals is for the purpose of understanding what effects the sensations produce in the auditor.

The word music . . . signifies no more than a succession of sounds in themselves agreeable and properly expressed, which alone or differently combined, in changing from low to high, or from quick to slow movement, or vice versa, delights and gives

\textsuperscript{104}\textcite{Shirlaw, op. cit., pp. 63-285 \textit{passim.}}
\textsuperscript{105}\textcite{Lampe, \textit{op. cit.}, pp. 46-47.}
\textsuperscript{106}\textcite{Antoniotto, \textit{op. cit.}, p. 22.}
pleasure; consequently the sounds are the matter of music; the disposition of those sounds, either alone, or combined in a pleasing succession, is the art and the end to affect the passions with agreeable sensations, which become more or less so, not only from the degree of perfection the art is arrived at, but also from the different constitutions and habits of the auditors, as marked in the introduction. 107

Summary of the Statements on Reason and Sense

In the streams of ideas affecting musical thought in England in the period after the Restoration, evidence from the theorists shows that a vital question was whether an empirical or rational point of view is best to explain musical meanings. The heritage from early seventeenth century English writers was practical rather than philosophical, but Brouncker's translation of Descartes' Compendium (1653) made available to the English reader Descartes' rationalism relative to music theory. Brouncker's "animadversions" on the Compendium were statements of a more empirical point of view. Later, Birchensha's translation of Alsted's article (1672) exemplified neoplatonism. The translations of Leibniz (1652) and Wallis (1682) made available Greek theoretical writings in Latin translations. At the same time these works were being published, the development of experimental methods and developments in mathematics gave impetus to the investigation of sound phenomena with improved mathematical precision. The result of these influences was a renewal of rationalistic musical thinking, expressed in the writings of Wallis (1696), Roberts (1705), and Salmon (1688 and 1705), with modifications by Pepusch (1746) and by Smith (1749). In addition, co-existent with the new mathematical rationalism, resulting in part from the religious interests of the time, there still existed traces of medieval mysticism, apparent in the writings
of Playford (1653), Simpson (1655), and especially Nace (1676).

Against the wave of rationalism, there came a counter-wave of empiricism, reflecting the interests in natural philosophy and new expressions in philosophy by Hobbes (1651), Locke (1690), and Berkeley (1710). Statements by Goldar (1694) relative to perception tended to be Hobbesian. Roger North's writings (c. 1700-1726) were eclectic. He began with the idea that sensation is caused by motion in matter, but went on to state in Lockian terms that musical meanings result from the comparison of simple experiences by reflection. In explaining the emotional effects of music he asserted the existence of innate knowledge. Contemporary with North, Malcolm attempted to be syncretistic, but he stated Lockian ideas of first and second causes. Bond (1725) held that musical meanings could only be explained as human perceptions.

Two late treatises, one by Smith (1749) representing the Pythagorean side of the discussion, and the other by Antonietto (1760) representing the Aristoxenian side, transmitted the issues to succeeding theorists. Whatever their point of view, theorists wrote about natural phenomena as though they were external. Their writings relative to sound phenomena are the subject of the following chapter.
CHAPTER II

THEORIES OF SOUND

In the preceding chapter, statements about reason and sense in English critical writings were discussed. With the increased emphasis on empiricism came the development of experimental techniques in natural philosophy. Men described the world in terms of human experience; they chose to write about a practical world with its borders and meanings defined by sense response or perceptions shared by other men. The spirit of the age was expressed by John Locke, "Ideas of the leading qualities of substances are best got by shewing, . . . " and " . . . ideas of their powers best by definition."

Newton's "Rules of Reasoning in Philosophy," spelled out a methodology. Both empirical philosophy and experimental methodology gave impetus to the study of the nature of musical sound. The theorists' knowledge about sound is described in the theoretical writings, and in the writings of men like Roger North (c. 1700-1726), Lampe (1740), and Holden (1770), the knowledge about sound is used to explain harmonic structures.

The purpose in this chapter is to describe the state of understanding about musical sound by the theorists. First, background

1Locke, op. cit., III, chap. 21, pars. 21-22.

2Isaac Newton, Mathematical Principles of Natural Philosophy (Berkeley, Calif.: Univ. of Calif. Press, 1946 printing of the 1729 translation by Andrew Motte of the second edition, 1713), pp. 398-400.
information is listed. This is followed by a discussion of theories of sound generation. Next, attention is directed to theories for the transmission of sound. Finally, statements about the reception of sound by the hearing mechanism are mentioned.

Background Information

Writing on the subject of sound was recorded at least as early as Aristotle and the history of such research was summarized by various authors, including Miller and Lindsay. Of direct importance to the theorists of the English Enlightenment were the developments in the preceding century when the theory of vibrating strings was developed by Giovanni Battista Benedetti, Galileo Galilei, and the Franciscan Friar, Marin Mersenne. Later, Joseph Sauveur in France studied characteristics of musical sound. His contributions, and those of other authors, are mentioned as they relate to the writings studied, but the emphasis in the pages which follow is on the contributions of the theorists of the English Enlightenment.

References:


butions of the English theorists, who developed theories of sound generation, propagation, and reception.

The Generation of Musical Sound

Music theorists in England in the late seventeenth and early eighteenth centuries were concerned with many aspects of the generation of sound. Their writings in this connection tend to fall into two broad categories: theoretical and practical. In the first category are theories of sound generation. In the second category are examples of the application of these theories in the design of musical instruments.

Theories of Sound Generation

One of the problems discussed by the theorists was how the motion perceived as sound could emanate from the sounding body. What was it that vibrated in the sounding body, and how could sound detach itself from the sounding body and so be able to pass through the medium to the auditor? Attempts to answer these questions resulted in at least four theories for the generation of sound by English theorists of the Enlightenment. The theories are first listed, then discussed.

1. Sound results from the motion of minute particles of matter in the surface of the sounding body.
2. Sound results from the percussion of body against body.
3. Sound results from the percussion of matter against the air particles, or air particles against other air particles.
4. Sound results from the vibration, as a vibrating spring, of either the generator or of an enclosed quantity of air.
The theory of surface particles. According to this theory, it is not the motion of the sounding body as a whole, but rather the motion of small particles near the surface which causes musical sound. The theory was an effort to provide an explanation for what seemed to be conflicting information, obtained from observations of various kinds of generators. Strings, tubes, and other objects of many sizes and shapes could produce sound. Explanations for the variations of sound loudness, quality, and pitch from length, mass, amplitude, and tension of vibrating strings did not explain the different qualities of sound from various shapes of tubes, bells, or vibrators of other shapes and kinds. Similarly, a theory that mass or body determined sound quality did not explain why a flute made of metal could scarcely be distinguished in sound from one constructed of wood. The surface particle hypothesis, as explained by Perrault and transmitted by Malcolm (1721), attempted to provide an explanation.

According to Perrault, the reason flutes made of various materials sound about the same is that the sound is caused by "the insensible motion of the particles of the surface, for these being very little different in all bodies, if we suppose the sound is owing to their motion only, it can have none or very small differences; . . ."9 Perrault's hypothesis was that matter is composed first of all of very small particles which are absolutely hard. These particles combine to constitute "other bodies greater," and the "other bodies greater" combine to constitute "those gross bodies that are visible

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and touchable. . . . The first and smallest parts are absolutely hard; the others are compressible, . . . " but neither of the two smaller units can be perceived as entities. It is the compression and restoration of the second kind of particles which makes "sonorous motion which is propagated to the ear."¹⁰

But observe that it is the insensible motion of these particles next to the smallest, which is supposed to be the immediate cause of sound; and of these, only those next the surface can communicate with the air. Their motion is performed in very small spaces and with extreme velocity; the motion of the whole, or of the greater parts being no further concerned than as they contribute to the other.¹¹

By Perrault's hypothesis, it is not the observed vibration of the sounding body which is the cause of sound, but rather the movement of particles near the surface, which are too small to be otherwise noticed by the sense.

The theory of mutual percussion and the theory of percussion against air.--Because of the similarity of the second and third theories, they are discussed together. The second, the mutual percussion theory, explains sound as arising from the percussion of one body against another. The third theory explains sound as arising from the percussion not of two solid bodies, but of one solid body against the particles of the air. The theory of mutual percussion explains the sound of drums, bells, and so on. The theory of percussion against air explains the sound of wind instruments. Malcolm (1721) stated these theories.

¹⁰ Ibid., p. 6.
¹¹ Ibid.
That motion in any body, which is the immediate cause of its sounding, may be owing to two different causes; one is, the mutual percussion betwixt it and another body, which is the case of drums, bells, and the strings of musical instruments, etc. Another cause is, the beating or dashing of the sonorous body and the air immediately against one another, as in all kind of wind instruments, flutes, trumpets, hautboys, etc. . . .

The second theory is adequate in explaining instants of sound but fails to explain how percussive sounds endure in time. The third theory is inadequate, for if it is the percussion of the walls of the generator with air particles which give rise to sound, flutes constructed of different materials should produce different sounds. Also, this theory fails to explain how the generator is caused to vibrate to produce the "dashing" motion, and it cannot explain why closing the end of a sounding tube results in an octave change in pitch.

The theory of vibrating springs.—Roger North was aware of the inadequacies of the first three theories. He asserted that sound results from the vibration of either the matter of the generator or of an enclosed quantity of air, in a manner similar to the vibrating of a spring. By this theory, all musically sounding bodies have characteristics which make it possible for them to vibrate isochronously: inner tensions exist which make possible a vibrating motion similar to that of a tense string. In the case of wind instruments, it is not the instrument but an enclosed quantity of air which vibrates, and which motion is transmitted to the external air. An example is the sound of a cannon.

\[12\text{Ibid., p. 5.}\]
For on the firing the barrell is evacuated of air, which returning with the force of its spring is stopped at once by the solid mettall, and so very much crowded into the barrell from whence with a very violent spring it erupts againe, and sends forth a mighty comprest wave, with much more force than the first or any naked explosion makes.13

He presents the theory, as it relates to music, in detail.

Lastly bodys that start forth and returne in the air with considerable swiftness at every stage create sound. And such are the vibrations or jarrings of springy bodys, and particularly distended strings, and mettalline and so also as I shall shew afterwards as pipes and whistles, of which there is infinite variety, and our musicall reflections flow from this class, for which reason wee must consider the particular with more care. The sounding effect of these motions is due chiefly to swiftness. For if the returns are slow as when a cartrope or common pendulum swings, or a bell is put in motion with out its clapper, no sound follows. But if a small string well distended be put out of place, the returns make a continuall sound, for the air doth not conforme to movements so swift, and is therefore at every vibration comprest. If the body be very ponderous and consequently of much force as the mettall of a bell, and yet (which is also the effect of its strength) takes a very swift vibrating motion, it emitts a sound almost as loud as cannon, ... so that as sound in generall created by exciting a compression so in particular in cases of vibrations, a certain celerity is requisite to produce the effect, ...

In the case of sounding pipes,

... the filme governed by the spring of the included air, moves in and out of the pipe by isocronous vibrations, as other springs doe, and at every pass strikes the substance of the pipe upon the edge or pallet, whence proceeds the tone, the same as when struck externally, modified by the tension or spring of the included air, and so the pipe from the force of a competent blast, makes a sound as wee are all acquainted with.15

For if wee consider the beginning of the sound, it is no other but a stroke, which actuates the spring of the air but a little,

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13Roger North, untitled manuscript, British Museum Additional 32537, fol. 71.

14Ibid.

15Ibid., fol. 79r.
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13 Roger North, untitled manuscript, British Museum Additional 32537, fol. 71.
14 Ibid.
15 Ibid., fol. 79r.
and in the manner of a shock, which sends forth a compressed wave only from the vent of the pipe, where it takes its beginning.16

Generators of Musical Sound

In addition to theories of sound generation, the theorists made statements regarding various sound generators.

The vibrating string.—When Simpson (1665) claimed to show "... that all the concords, and other intervals of music, arise from the division of a line or string into equal parts; ..."17 he was not only presenting to the English reader the scenario of Zarlino (1571), but he was calling attention to the way sound originates in a vibrating body. Later, studies by Wallis (1677), Roberts (1692), Holder (1694), Taylor (1713), and North (c. 1700-1726) provided additional information about the string as a sound generator. These theorists used both the monochord and the trumpet-marine—a special type of monochord which by being touched lightly at various places is caused to vibrate in aliquot parts—to study the vibrating string. The monochord was used to explain the laws of vibrating strings, relative to weight, mass, tension, and frequency; a pendulum analogy was used by some theorists in this regard. Also, new knowledge was expressed on the vibration of partials. It is not clear whether the English theorists knew about the co-existence of vibrations of partials, although this fact is mentioned by Sauveur.18 In addition, Taylor (1713)

16Ibid., fol. 79v.

17Christopher Simpson, A Compendium of Practical Musick in Five Parts (London: W. Godbid for Henry Brome, 1667), fr. the intro.

presented the first dynamical explanation of the motion of the vibrating string. Some of the important ideas regarding the vibrating string are listed here in more detail.

An article by Wallis (1677) is apparently the first to mention that a single string vibrates both as a whole and in parts.19 The article is often quoted in the history of musical acoustics, having been mentioned by Sauveur,20 in an anonymous treatise of 1771,21 and by Lindsay in the introduction to Rayleigh's Theory of Sound.22 Wallis (1677) mentions an experiment by William Noble of Merton College and later by Thomas Pigot of Wadham College.

It is this, whereas it has been long since observed, that if a viol or lute string be touched with the bow or hand; another string on the same or another instrument not far from it, if an unison to it or an octave, or the like, will at the same time tremble of its own accord. The cause of it having been formerly discussed by divers, I do not now inquire into. But add this to the former observation, that not the whole of that other string trembles, but the several parts severally, according as they are unisons to the whole, or the parts of that string which is so struck.23

Wallis observed the nodes of vibration by wrapping bits of paper lightly about the string. He noted the vibration of halves, thirds, and quarters, and added that "The like will hold in less concords, but the less remarkably as the number of divisions increases."24

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20 Sauveur, op. cit., p. 353.
22 Rayleigh, op. cit., p. xiv.
24 Ibid., p. 381.
Another study, using the trumpet marine was done by Roberts (1692).\textsuperscript{25} Roberts pointed out that the compass of notes produced by the trumpet marine was the same as that produced by the trumpet.

Here we may make two inquires. 1. Whence it is, that the trumpet will perform no other notes in that compass besides those in the table, which are usually called by musicians trumpet notes. 2. What is the reason that the 7th, 11th, 13th, and 14th notes, are out of tune, and the others exactly in tune.\textsuperscript{26}

Roberts mentioned the experiments done earlier by Wallis which showed that not only was the sympathetic vibration that of the string as a whole, but if the octave is struck the string will vibrate sympathetically in two halves and if the twelfth is struck the string will vibrate sympathetically in thirds. Therefore he concluded that the requisite for a string to sound a "synchronous" tone is that the tone sound the pitch of an aliquot part of the string, "In this case, the vibrations of the equal parts of a string being synchronous, there is no contrariety in their motion to hinder each other . . ."\textsuperscript{27} And these aliquot parts are the same which sound the notes of the trumpet. Comparing the notes available from the trumpet marine with those obtained by division of a monochord in just intonation, he finds the seventh harmonic of the trumpet marine to be flatter than B fa-bi-mi flat, the eleventh harmonic to be sharper than F fa-ut, the thirteenth harmonic to be flatter than A la-mi-re and the fourteenth harmonic to

\textsuperscript{25}Roberts, op. cit., pp. 467-470.

\textsuperscript{26}Ibid., p. 467.

\textsuperscript{27}Ibid., p. 468.
be flatter than A fa-bi-mi flat. Apparently, both Wallis and Roberts assumed string length to be the only important factor in determining pitch.

The pendulum analogy to explain the laws of the vibrating string was used by Francis North (1677), Holder (1694), and Roger North (c. 1700-1726). This is evidence of the influence of early Baroque Italian theorists, for the laws of the movement of the pendulum were developed by Galileo Galilei by 1583. Holder (1694) uses the pendulum analogy to illustrate the relationships of string length, tension, and frequency of vibration, and concludes as follows.

He explains the motion of the vibrating string as similar to two pendulums, tacked together. He points out that to double the frequency of vibration of a pendulum, it must be shortened to one-fourth of its former length and to halve the frequency, the pendulum must be made four times as long. Strings, moving as double pendulums will halve the frequency by doubling the length and double the frequency by halving the length. Holder does not state laws relative to tension, but mentions that tension is a factor in determining pitch.

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28 Ibid., p. 469.


Tension is proper to chords or strings . . . as when we wind up, or let down the strings, i.e. give them a greater or less tension, in tuning a viol, lute, or harpsichord, and is of great concern, and may be measured by hanging weights on the string to give it tension; but not easily, nor so certainly.32

Francis North (1677) preceded Holder in using the pendulum analogy, but his statements in this regard were brief. Using the pendulum analogy, he explained the strange sounds of false strings. As a pendulum with two weights at different locations on the plummet will vibrate in complex ways, so a string with uneven mass or thickness will vibrate unevenly.33 Roger North (c. 1715-1720) also used the pendulum analogy.34

Malcolm's statement (1721) of the laws of vibrating strings was more detailed than those of Holder or Francis or Roger North. He pointed out that the time of a vibration varies inversely as the square root of the tensions or weights stretching a string,35 that frequency varies inversely with length,36 and that the frequency of vibration varies inversely as the square root of the weight of the string; that is, inversely as its diameter.37 Accepting the hypothesis of Perrault that sound is the result of the movements of particles near the surface, Malcolm mentions quality as a variable

32Ibid., pp. 17-18.
33Francis North, op. cit., p. 17.
34Roger North 32534, op. cit., fol. 72r.
35Malcolm, op. cit., p. 52.
36Ibid., p. 54.
37Ibid., p. 53.
component of sound along with loudness, acuteness, and duration.\textsuperscript{39}

Taylor (1713) studied the motion of a tense string and asserted that the motion of the string was comparable to the motion of a pendulum with a time isochronous to the time of the string. He stated two propositions; one, that the ratio of the curvature of a string pulled from a position of rest is proportional to its distance from the axis; and the second, that the acceleration from the tension of a string is proportional to the curvature of the string at that point.

Lemma 1.--Let ADFB, and AA\textsuperscript{40}B [Fig. 1, top] be two curves, so related that, drawing any ordinates CB, EF, it is everywhere C : CD :: E : EF. Then the ordinates being diminished ad infinitum, so as the curves may coincide with the axis AB; I say that the ultimate ratio of the curvature in to the curvature at D is as C to CD.

Lemma 2.--At any instant of its vibration, let a tense cord, stretched between the points A and B, take any form of curve AB [Fig. 1, bottom]. Then will the increment of the velocity of any point P, or the acceleration arising from the force of tension in the string, be as the curvature of the string in the same point.\textsuperscript{40}

From these two lemmas it is possible to find the acceleration of any point in the string. The acceleration

\[ \text{... of any given point in the string will be as its distance from the axis. Hence by sect. 10, prop. 51, of Newton's Principia, all the the vibrations, both great and small, will be performed in the same periodical time, and the motion of any point be similar to the oscillation of a body vibrating in a cycloid.} \textsuperscript{41}\]

\textsuperscript{38}Ibid., p. 25.

\textsuperscript{39}Ibid., p. 15.

\textsuperscript{40}Brook Taylor, "Of the Motion of a Tense String," Philosophical Transactions, XXVIII (1713), p. 14.

\textsuperscript{41}Ibid., p. 16.
Fig. 13.

Fig. 14.

Fig. 1.--The motion of a tense string

The studies of Wallis (1677) and Roberts (1692) on the vibrations of partials and the study of Taylor (1713) were contributions to the knowledge about vibrating strings. Except for these articles, the information on vibrating strings written by the theorists repeated the discoveries documented by Galileo Galilei (1638) and Mersenne (1636-37). It seems to be assumed by all of these authors that strings are continuous between fixed extremities, round and of uniform diameter and density, free from friction or distortion from any cause, and that they vibrate only transversely. Such strings exist only in theory.

Turning from the vibrating string to other generators, Roger North mentioned other musical sound generators as well as the vibrating string. His studies included organ pipes, flutes, oboes, trumpets,

\[42\] Ibid., pl. 1.
bells, and vibrators of unusual shapes and sizes. His observations are mostly those of a perceptive practical musician, rather than being carefully organized and controlled, detailed, and precise.

**General principles of organ pipes.**—In his critique of Francis North's Essay, Roger North is critical of his brother's theory of sound and knowledge of the movement of air near a sounding organ pipe. Apparently, Francis North held that vibrations of the walls of the pipe caused vibration of the air outside the pipe. Holding a flame near the orifice of the pipe in such a way that the flame split at the orifice, North observed that the flame vibrated both inside and outside of the pipe. He concluded that the air inside the pipe vibrated as well as that on the outside.

The author's account is that the air eddy's on the outside but not within, because of the protection there is from the sides of the pipe; therefore the flame having less support within than without, the eddy breaks thro by alternate forces, which makes the sound as in fig. [Fig. 2]

I find this is not true by tryall, for I have placed an organ pipe of about a-re comodiously; and when sounding, apply'd the flame of a candle to the orifice, so as the coal of the wick came below the vent and nothing but pure flame toucht the orifice, and it was manifest that there was no breaking of the air thro the flame, for the flame was undisturbed unless upon the very palatt. And then the flame seem'd to splitt, and flutter both within and without. Holding the candl to the side of the pipe near the orifice, the wind would draw it towards the middle and there split and flutter as before. This is all I could discover by the eye and stands represented in the fig. [Fig. 3]

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43 Roger North, 32531, *op. cit.*, fol. 50v.
North explains the motion by the theory that the air in a pipe vibrates as a spring.

So when the filme is suck't into the pipe, it enters with a force (striking the pallat by the way) and makes a sudden compression in the pipe, which in a wave passeth away at the vent, wherever it is; and there following thick one after another, the whole body of the included air, is broken into waves, in equall parts, that doe not hinder but rather assist each other; whereby there is not onely a stroke upon the pipe, but a comprest wave from the body of the included air, acting together, which produceth the clear and eminent sound of pipes; the divers diversifications of which, as whistles, shawmes, flutes, regals, etc. are not of this place to be considered. It is enough to know that pipes sound by vertue of spring and isocronous vibration's, as other springy instruments doe, which is necessary to be remarked. In order to shew they
all alike fall under the general laws that govern musical tones, and harmony.  

**Comparison of trumpet and trumpet marine.**—Roger North compared the operation of the tube trumpet to the harmonic vibration of the monochord in terms very similar to those of Roberts (1692). Indeed, a copy of Roberts' research appears in one of the North manuscripts. North points out that the tube trumpet in the enclosed air and the monochord in the motion of the string produce harmonic sounds by vibration in aliquot parts. This is illustrated in Plate II, page 88.

I have often bin pleased with a fancy, that if in a tube of glass, the nodes formed by the breaking of the tone into sharper [higher] accords, were so nebulous, or discoloured, as thro the glass to be easily discerned, it would be very diverting to observe them increas, diminish, and dance to and fro, upon shifting the tones, for they are stationary during the sound of any one tone, but ambulatory as the tone is changed. The standing part is represented in the annexed scheme, in which I have collated both trumpets, the tube and marine, whereby the conformity of their corresponding nodes is manifested.

**Resonators.**—Roger North (1726) expressed ideas about the resonating areas associated with the strings in viols and harpsichords. The "augmentation of sound" in these instruments "is to be ascribed partly to the material, and form, the sounding string is put upon, and partly to the body of air annex [adjacent] to it." Specifically in the case of viols,

... where the tremulations caused by the vibrations of the string upon it, affect the whole included air with the like,

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44 Roger North, 32537, *op. cit.*, fol. 80r.
45 Roger North, Untitled and unpublished manuscript, British Museum Additional 32549, fol. 31-35.
46 Roger North, 32535, *op. cit.*, fol. 138r.
47 Ibid., fol. 147r.
COMPARISON OF THE VIBRATIONS OF THE TRUMPET AND TRUMPET MARINE
which communicating abroad, with the outward air, either by some vents, or spiracles, or by some parts of the material, cooperates with the vibrations of the string, and those following and returning exaggerates the sound.48

In speaking of resonators, North describes the function of the bridge and soundpost, muting, and suggests characteristics of material and craftsmanship. Other musical sound generators.—Also, Roger North made observations about other kinds of generators, including solids, hoops, direct springs, pipes, and the voice.

In the case of plain solids,

Every table, bench, door, and what not shew it [sound]. And it is as notorious that all these have a tremola when struck as springs have. And out of the material of wood as well as metals direct springs are made; so these struck all vibrate more or less for some time.49

In the discussion of direct springs, Roger North repeats his statements about vibrating strings, including vibrations of partials.50

In pipes and the voice, it is an enclosed chamber of air which acts as a vibrating spring. He illustrates this motion in the sounding tubes and with the voice, as follows.

Single reed instruments.—Instruments of the "regoll sort" are caused to vibrate by use of a "thin springy plate," illustrated in Figure 4.

It works thus; A blast is sent into the pipe (the spring being free to play, and for the end a cover pipe is made to come over it) then the air passing downe the spring closes and stops the current but the column of air in the pipe goes on stretching.

48Ibid., fol. 148r.
49Roger North, 32537, op. cit., fol. 123v.
50Ibid., fol. 125v.
it self, till it recoyles with a force and compresseth aga
in the pipe and so emitts a comprest wave; this recoyling opens
the spring, and then the blast, which is perpetually urging,
enters and joynes with the air then going outwards again, for
it vibrates, till the spring stops againe, and then the recoyling makes a compression in the pipe and emitts another
wave, . . . 51

Fig. 4.--Diagram of "regoll sort" assembly

Pitch is controlled by both the vibrating spring and the tube length.

Double reed instruments.--The action in double reed instru-
ments is similar to that of single reed instruments.

The haut boy; that hath a splitt cane, in 2 parts bound

together and inserted into the pipe. This closeth and opens
with the blast, upon the entrance and recoyling of the air;
and being litle of a spring, but onely so much as serves just
to open it, when free, complie's with any vibrations, so that
here the tube of air wholly governes them. And therefore the
pipe is adjusted by length . . . 52

The human voice.--Sounds of the voice are produced in a manner
similar to those of the double reed instruments.

The vocall sounds of men and animalls, are produced from a
continuance most like the haut boy, that is the larinx or head
of the wind pipe, which is a carilaginous, and muscular lump,
having a slitt or two, by which the wind passeth to and from
the lungs; these slitts by opening and shutting organise the
voice, which is modified by the mouth one way inlarring and an-
other contracting the cavity of the mouth and throat . . . 53

51 Ibid., fol. 129r.
52 Ibid., fol. 127.
53 Ibid., fol. 127v.
The author of Harley 4160 also wrote about the physiology of the voice. The following quotations illustrate his understanding of the vocal mechanism and reveal his incorrect guesses at reasons for differing qualities of vocal sounds.

The longs are the instruments of breathing and voice, for no other creature that wants them utters a voice and from the longs goeth the Aspera Arteria which is the windpipe and it consists of cartilages, and is called the rough artery, but the smoother that the pipe is, the clearer and sweeter is the voice.

Boys do begin to break or change their voice at the years of puberty, i.e. at the age of 14 or 15, for then much of the moisture of the body which did irrigate the parts is drawn to the spermatic vessels.

The largeness and straitness of the Aspera artery is the cause of men and boys singing a base mean and treble. Those that sing a base have the largest artery, and those that sing a mean have a less, and those that sing a treble have the least of all according to the latitude and longitude of the concave that the artery doth bear.

This same reason—the size and roughness of the walls—is given for the tone quality differing between instruments constructed of various materials.

All reflex concurrent do make sounds greater but if the body that createth either the original sound or the reflexion be clean and smooth it makes them sweeter, for when a sound is created in the wind instrument—between the breath and the air if the sound be communicate with a more equal body of the pipe it meliorates and makes the sound sweeter, for there will

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55 Ibid., p. 8.

56 Ibid.

57 Ibid., p. 9.
be a differing sound in a trumpet of wood and a trumpet of brass for the sound hath communication with the matter of the sides of the pipe and the spirits that are therein contained. 58

Trumpet type instruments and those of the flute family. --

In the instruments of the trumpet type, "the sound is modified by means of the spring of the air contained in the tube, which by the management of the lipps is made to break and vibrate in aliquot parts, ... 59 In pipes of the "flute sort," spring-like vibration of the air within the pipe is caused by the motion of air against the pallet. Roger North claims to be the first to understand this correctly.

The next thing to be shewed, is the manner how the flute sort of pipe is made to speak, so loud, and smooth as it doth. And this is as delicate a consequence of an air moved as any other. For the spring, or pallet as I may terme it of the sound is made of the air it self. And I have not found the right manner of the action touched by any neither Mersennus, nor the honorable author of the Philosophical Essay, the latter hath not onely mist the right, but chosen one that is of a comon flute pipe is better knowne, then can be described. [Figure 5]

Fig. 5.--The common flute pipe

Onely take notice that the sound is made by an edge opposite to a vent, thro which the air comes very thin, and falls as truely upon that edge, as the maker can contrive.

Now when the air passeth thro the slit, whether it enter the tube or not (but it is designed and commonly doth)

58 Ibid.

59 Roger North, 32537, op. cit., fol. 129v.
the very movement draws along the air in the pipe somewhat, but if it enter's or parts, then it propells the air along the pipe, and the outward air following at the mouth, drives in the filme of air all into the pipe which augments the force and compresseth the air in the tube, then that recoyling towards the mouth, drives the filme out, and the air of the tube following stretcheth, which makes a contraction againe, and then the filme returns into the pipe alternately venting and sucking at the mouth, the filme of air is made to play in and out cross the edge, in manner of a spring.60

Open and stopped pipes.---Roger North also mentions the operation of the air in open and stopped pipes. A closed pipe operates as a spring in filling and emptying of air through the mouth.

There is no difficulty here to imagine that opening the pipe at the end, makes way for the compressure to vent that way, as well as at the mouth, which must ease the motion and shorten the column, that raiseth the tone an octave.61

Summary of sound generation.---To later acousticians, the researches on the generation of musical sound by Roger North and the other theorists of the Enlightenment in England may seem superficial. Except for the study of the vibrating string by Taylor (1713) and statements of relationships of length, frequency, and tension of the vibrating string, little effort was made to quantify information about sound generation in the sense in which it was later done by Bernoulli,62 D'Alembert,63 and Chladni.64

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60 Ibid., fol. 130v.
61 Ibid., fol. 132r.
64-E. F. F. Chladni, Die Akustik (Leipzig, 1802).
The Transmission of Musical Sound

In addition to writing about sound generation, theorists wrote about the transmission of sound. They agreed that sound moves through space, but they did not agree on how it moved. First, the theories for sound transmission are listed and discussed, including influences on the theories and problems to which the theories are related. Second, specific ideas of various theorists are listed.

Theories of transmission

English theorists of the Enlightenment suggested two theories for sound transmission.

1. The earlier of these two theories was that a musical tone is transmitted as a series of "cracks," caused by certain size particles of the air rushing in to fill a space from which they have been driven. This was the theory held by Francis North (1677).

2. The second, and later theory was that sound is transmitted as pulses moved through the air, resulting when particles of the air moved in simple harmonic motion—the particles of the air acting on each other according to the laws of mechanics. This theory was held by Roger North (c. 1700-1726).

The theory of "cracks."—The theory of "cracks" was expressed in 1677 by Francis Lord North.

I suppose the air we breath in to be a mixture of divers minute bodies which are of different sorts and sizes, though all of them are so small as to escape our senses. The grosser of them are elastical, and are resisted by solid bodies, which are in no sort pervious to them; the smaller parts pass through solid bodies but not with that ease but upon a sudden and violent start of them they shock the parts of solid bodies that stand in their way, and also the grosser parts of the air; and there may
be another degree of most subtil ethereal parts with which the interstices of these and all other bodies are replete, which find freer passage every where and are capable of no compression, and consequently be the medium and cause of the immediate communication of sight. The middle, sort of these I esteem the medium and cause of sound, and that at any time when the grosser air is driven off any space, and leaves it to be possessed by these and other more subtil bodies, and returns by its elasticity to its former place, then are these parts extruded with violence as from the center of that space, and communicate their motion as far as the sound is heard... so that sound may be caused by the tumble of solid bodies without the presence of gross air when it has been divided with any violence.65

The requirement for a musical tone, according to Francis North, was that the "cracks" be closely enough spaced to be perceived as a continuous tone. What spacing of pulses is perceived as tone?

The compass of musick extends from such tones whose intervals are so great that the several pulses are distinguishable by sense, to those whose interstices are so very small that they are not commensurate with any other.66

Francis North used this theory to explain consonance and dissonance and sympathetic vibration and for a physical explanation of chords: "... chords are more or less perfect, according as they are more or less coincident."67 This theory of consonance and dissonance is treated more fully in chapter three.

The theory of harmonic motion of air particles.—This theory, resulting from the new discoveries in Newton's Principia (1687), was stated by Roger North in connection with his critique of Francis North's Essay. Roger North held that the theory of "cracks" was an inadequate explanation of the observed phenomena.

65Francis North, op. cit., p. 6.
66Ibid., p. 7.
67Ibid., p. 9.
The author suposeth that upon every sound the air is divided and . . . a Torricellian space made, and that the close of the air is that which makes the crack or sound.

I think this doth not clearly enough explain the laws of sound. . . . 68

North's further comments show the influence of contemporary science and mechanics, especially that of Boyle (1662) and Newton (1687).

The sound is not made by the passage of the string but at the instant of the rebound. For the string being in motion one way, carries the ambient air with it, and upon the sudden return with a force, crossing the movement strikes a pressure upon the spring of the air, which diluted and observed and this is the action which he calls vibration and fills the air with little circling forces, following successively as thick as the vibrations are. And if wee had any sense to survey it, wee should see the air full of circles, as the water would be if any force should touch the calme surface, with synchronous pulses, which would present a pretty sort of purle, . . . 69

So according to North, sound is transmitted through the air by the motion of the particles. The sounding body causes simple harmonic motion of adjacent air particles, these moving in little circles cause the motion of particles next them, and so on. As Newton pointed out, the harmonic motion can be understood according to the law of the oscillating pendulum. Motion is transmitted from particle to particle according to the laws of motion.70

Problems Relating to the Transmission of Sound

With their theories of sound, the theorists attempted to answer questions. How was it that the air could be the vehicle for both sight and sound? Why did light move through this medium almost

68: Roger North, 32531, op. cit., fol. 42r.
69: Ibid., fol. 48v.
instantly, whereas sound moved at speeds which were relatively simple to measure? Why did a hearer apparently have full knowledge about pitch and quality of sound, though he sensed only a small fraction of the radiated motion? These and other questions formed the subjects of investigation.

Problem of the Torricellian vacuum.--The formulation of the theory that sound is transmitted by harmonic motion of gross particles of air was delayed because theorists did not know that air is a medium for the transmission of sound through space. In experiments using what was termed a "Torricellian vacuity"--the space evacuated above the mercury in a mercury barometer--sound apparently passed through a space devoid of air. Kircher\textsuperscript{71} and Von Guericke\textsuperscript{72} performed the familiar experiment of a bell ringing in an evacuated jar. Either they did not achieve sufficient vacuum or they did not have the bell insulated from the sides of the container. Hearing the bell in spite of the partial vacuum, they concluded that sound could travel without the medium of gross air. It was in 1660 that Boyle,\textsuperscript{73} with improved controls, showed that the intensity of sound diminishes as air is evacuated. Apparently, Francis North (1677) was unfamiliar with Boyle's experiments when he stated that "sound may be produced in the Torricellian vacuity."\textsuperscript{74}

\textsuperscript{71}Athanasius Kircher, \textit{Musurgia Universalis sive ars magna consoni et dissoni} (Rome: F. Corbelletti, 1650).

\textsuperscript{72}Otto von Guericke, \textit{Experimental Nova ut vocant Magdeburgica de vacuo Spatio} (Amsterdam: 1672).

\textsuperscript{73}Boyle, \textit{op. cit.}

\textsuperscript{74}Francis North, \textit{op. cit.}, p. 5.
Problem of the nature of the air.--To explain how the air could be the medium for both light and sound and also be the fluid which was breathed, Newton (1687) and later Roger North (c. 1700-1726) suggested a tri-partite hypothesis for the composition of the air; that is, that the air consists of three different kinds of particles. The smallest of these particles was considered absolutely hard and incompressible; since these particles were very small they could permeate some solid objects, as glass, and because they were incompressible they could account for the instantaneous transmission of light. The middle size particles were thought to be compressible, hence they were subject to rarefaction and compression and formed the medium for sound. The largest size particles formed the "gross air" which was breathed.

The Theorists, on the Transmission of Musical Sound

The theories, influences, and problems mentioned are illustrated in the writings of the theorists.

Francis Lord North.--In 1677 Francis North summarized the "phenomena of sound" as follows.

1. It may be produced in the Torricelian vacuity.
2. It causes motion in solid bodies.
3. It is diminished by interposition of solid bodies.
4. If the bodies interposed are very thick, its passage is wholly obstructed.
5. It seems to come to the ear in straight lines when the object is so situated that it cannot come in a straight line to the ear.
6. When the air is not in motion its extent is spherical.
7. When there is a wind, the sphere is enlarged on the part to which the wind blows, and diminished on the contrary part.
8. That it arrives not to the ear in an instant but considerably slower than sight.
9. That it comes as quick against the wind as with it, though not so loud nor so far.
there are many other observable appearances.\textsuperscript{75}

Narcissus.--Narcissus, in an article in the \textit{Philosophical Transactions} of 1683,\textsuperscript{76} wrote about the propagation of sound. He compared sound to light and suggested three divisions to the science of acoustics: acoustics, discoustics, and catacoustics. These apply respectively to sound heard directly, that which is reflected, and refracted sound. Narcissus's observations seem superficial and his suggestions are sometimes impractical or impossible. For example, he suggests using echoing bodies to return a note in thirds, fifths, and octaves.\textsuperscript{77} This is impossible, for no echoing body could reflect a sound which it had not received, and single harmonics could not be reflected without also having spurious reflections. Narcissus mentions the following characteristics of sound: (1) sound intensity varies, depending on the medium, (2) sound can be reflected and reverberate, (3) sound decreases in loudness according to distance, (4) sound can be focused or diffused.\textsuperscript{78}

\textit{William Holder}.--Holder (1694) summarized the contemporary knowledge about sound.

1. All sound is made by motion, \textit{viz.} by percussion with collision of the air.
2. That sound may be propagated, and carried to distance, it requires a medium by which to pass.
3. This medium (to our purpose) is air.

\textsuperscript{75}Francis North, \textit{op. cit.}, p. 5.


\textsuperscript{77}\textit{Ibid.}, p. 9.

\textsuperscript{78}\textit{Ibid.}, pp. 7-9.
4. As far as sound is propagated along the medium; so far the motion passeth. For (if we may not say that the motion and sound are one and the same thing, yet at least) it is necessarily consequent, that if the motion cease, the sound must also cease.

5. Sound, where it meets with no obstacle, passeth in a sphere of the medium, greater or less, according to the force and greatness of the sound: of which sphere the sonorous body is as the centre.

6. Sound, so far as it reacheth, passeth the medium, not in an instant, but in a certain uniform degree of velocity, calculated by Cassendus, to be about the rate of 276 paces, in the space of a second minute of an hour. And where it meets with any obstacle, it is subject to the laws of reflexion, which is the cause of echo's, meliorations, and augmentations of sound.

7. Sound, i.e. the motion of sound, or sounding motion, is carried through the medium or sphere of activity, with an impetus or force which shakes the free medium, and strikes and shakes every obstacle it meets with, more or less according to the vehemency of the sound, and nature of the obstacle, and nearness of it to the centre, or sonorous body. Thus the impetuous motions of the sound of thunder, or of a cannon, shake all before it, even to the breaking of glass windows, etc.

8. The parts of the sounding body are moved with a motion of trembling, or vibration, as is evident in a bell or pipe, and most manifest in the string of a musical instrument.

9. This trembling, or vibration, is either equal and uniform, or else unequal and irregular; and again, swifter or slower, according to the constitution of the sonorous body, and quality and manner of percussion; and from hence arise differences of sounds.

10. The trembling, or vibration of the sonorous body, by which the particular sound is constituted and discriminated, is impressed upon, and carried along the medium in the same figure and measure, otherwise it would not be the same sound, when it arrives at a more distant ear, ...

11. If the sonorous body be requisitely constituted, i.e. of parts solid, or tense, and regular, fit, being struck, to receive and express the tremulous motions of sound, equally and swiftly, then it will render a certain and even harmonical tone or tune, ...

Holder's first point identifies his theory of sound transmission as the theory of "cracks." Other points illustrate principles

79Holder, op. cit., pp. 1-5.
of sympathetic vibration, spherical propagation, and reflection, but
provide no new information.

Derham of Upminster.—Experimental work on the velocity of
sound was done by Derham (1708). Derham reported velocities for sound
listed by various authors of from 968 to 1474 feet per second, but
found their experiments not sufficiently controlled. He sought answers
to nineteen questions about sound.

In order to find out the truth amidst such a variety of
observations, I have made several experiments at different
distances, viz. from 1 to 12 miles and upwards: and for measur­
ing the time, employed a very accurate portable movement, with
a pendulum vibrating half seconds. And, to proceed with the
greater certainty, I proposed to myself to resolve the follow­
ing queries: 1. How much space sound passes through in a
second, or any other interval of time? 2. Whether a gun dis­
charged towards the observer, transmit the report in the same
space of time, as when discharged the contrary way? 3. Whether,
in any state of the atmosphere, when the mercury either ascends
or descends in the barometer, sound pass over the same space in
the same interval of time? 4. Whether sound move with greater
velocity in the day-time than in the night? 5. Whether a fa­
vourable wind accelerate sound, and a contrary wind retard it;
and how winds affect sound? 6. Whether sound move with a greater
velocity in a calm day, than when the wind blows? 7. Whether a
violent wind blowing transversely accelerate or retard the motion
of sound? 8. Whether sound have the same degree of motion in
summer and winter, by day and by night? 9. And whether also in
snowy and fair weather? 10. Whether a great and small sound
have the same degree of motion? 11. Whether in all elevations
of a gun, viz. from point blank to 10, 20, etc. to 90 degrees,
sound reach the observer's ear in the same space of time?
12. Whether all sorts of sounds, as those of guns, bells,
hammers, etc. have the same degree of motion? 13. Whether the
different strength of gunpowder vary the motion of sound?
14. Whether sound pass over the same space in the same interval
of time on the tops of high mountains, and in the bottom of
valleys, or in the highest and lowest parts of the atmosphere? 15.
Whether sound in acclivities and declivities have the same de­
gree of motion; or whether it descend from the top to the bottom
of the hill with the same velocity, as it ascends from the bottom
to the top of the same? 16. Whether sound move swift in the be­
ginning, and slower in the end, as is the case in a great many
other violent motions? 17. Or whether it be not rather equable?
viz. moving in half the time over half the space, in a fourth
part of the time a fourth part of the space, etc. 18. Whether
sound have the same degree of motion in all climates, both north and south, in England, France, Italy, Germany, etc.? 19. Whether sound pass from one place to another in a straight line, or in the shortest way, or whether it move along the superficies of the intermediate earth? 80

Apparently Derham perceived sound as some kind of motion in the sounding body which was transferred to particles in the air, but he was not certain what particles were the vehicle for sound.

The causes of these variations I leave to others to determine, as also to assign the proper medium or vehicle of sound: whether it be the aethereal and more subtile part of the atmosphere, or the vapours and grosser parts thereof, or both together. 81

In seeking answers to his questions, Derham's procedure was to time the duration of arrival of the sound of fired guns. He erred in finding no variation in the velocity of sound at different atmospheric pressures.

... but I, having a better chronometer, and being at a more convenient distance, never found the velocity of sound different at these times: for in all weathers, whether fair and clear, or cloudy and lowering; and whether it snow or rain (both which weaken very much the audibility of sound) and whether it thunder or lighten; in hot or cold weather; by day or by night; in summer or in winter; in short, in all the various states of the atmosphere (excepting only the winds) the motion of sound is neither swifter nor slower; ... 82

He found the motion of sound to be equable; that is, the distance of propagation is directly related to time.

And this I found to be the same with what the Academy Del Cimento had determined; for sounds pass over half the distance in half the time, and a fourth part of the distance in a fourth part of the time, and so on; ... 83

80 Derham, op. cit., pp. 381-82.

81 Ibid., p. 391.

82 Ibid., p. 384.

83 Ibid., p. 385.
And he determined correctly that the speed of sound was influenced by the speed and direction of the wind.

The Academy del Cimento found by experiments, that the motion of sound was neither retarded by contrary winds, nor accelerated by favourable ones, but that from whatever quarter the wind blew, sound passed over the same space in the same time. Gassendus, and almost all the other philosophers, were of the same opinion, though the contrary appears from experience; ... And not only do winds with or against the sound accelerate or retard its motion, but likewise according to the various degrees of their strength and weakness, is the sound more or less promoted or impeded, ... 84

Finally, he concluded from his experiments that the velocity of sound is 1142 feet in a whole second,85 which is the same value listed by Newton in the 1713 revision of the Principia.86

Isaac Newton.—According to Newton (1713), sound is propagated by the sounding body moving the particles near it, those in turn moving other particles, and so on, all particles moving in simple harmonic motion.87 Newton reasoned thus: A pendulum of 39 1/5 inches completes one oscillation in two seconds. The velocity of sound is measured by that of the harmonic motion of air, and the height of uniform air to give pressure equal to 30 inches of mercury is 29725 feet, radius of a circle 18678 feet in circumference. A pendulum of such length will perform an oscillation in 190 3/4 seconds, therefore sound will go 18678 feet in 190 3/4 seconds or 979 feet in one second.88

84 Ibid., p. 391.
85 Ibid., p. 393.
86 Newton, op. cit., p. 393.
87 Ibid., pp. 375-381.
88 Ibid., p. 392.
Newton makes the following additional explanation, bringing his determination of the speed of sound to that found experimentally by Derham (1708).

But in this computation we have made no allowance for the crassitude of the solid particles of the air, by which the sound is propagated instantaneously... We may add $979/9$, or about 109 feet, to compensate for the crassitude of the particles of the air: and then a sound will go forwards about 1088 feet in one second of time.

Moreover, the vapors floating in the air being of another spring, and a different tone, will hardly, if at all, partake of the motion of the true air in which the sounds are propagated... and therefore the motion of sounds above discovered must be increased in that ratio. By this means the sound will pass through 1142 feet in one second of time.89

Roger North. --Roger North's most complete statements on sound are found in his manuscripts "Theory of Sound" (c. 1715-20, 1726, 1728).90 His intentions are expressed in the opening pages.

It may be thought reasonable to bring together such notions as I can recollect concerning the genesis and propagation of the sensible perfections of sound; which I shall doe, hoping thereby to fulfill a philosophy of the subject.91

North develops his theory of sound in great detail.

Sound hath its rise in the ayre, and is caused by some motive force acting upon it, as percussion, pulsian, explosian, whence is derived a proceding of the same force... as from a center, without any knowable limits. And in this process the air successively, and everything residing in it receives an impulse, and in particular the organ of hearing; and from thence, as from a touch (the force being competent) wee perceive and that in a manner different from all other means of sensation whatever, and call it hearing, or sound. For this reason the air is termed the medium of sound. It is not restrained to the gross air wee breath, but the action is

89Ibid., p. 383.
91North, 32534, op. cit., fol. 2r.
propagated in a more refined or interstitial matter, to which water, glass, wood, etc. as the grosser air is continually permeable, which divers pneumatick experiments shew, but then the vigor of it is accordingly abated, and the sound, which in aperto would be loud, so confined becomes much softer: . . . 92

He wonders how both light and sound can be carried by the medium of air.

It is commen to hear it alledged, that the air is the medium of light, as well as of sound, for it is a corporeall touch upon the eye, which gives us the sence of light, as upon the ear that of sound. But it seems the immediate touch of light is by the interstiticall matter, for the gross air doth not permeate the membranes, and humours of which the eye is composed. But it is necessary that a force that passeth thro the interstices of air and of other diaphonous body, must strike upon and affect the sensitive part of the eye . . . 93

. . . There appears here a matter of great wonder, which is that from an ordinary impulse as the discharge of a gun for instance, the air as a common medium should all at once convey influences so discrepant as light and sound are.94

Motion of the particles of air which form the medium for sound he explains using principles of mechanics and pendulum analogies.

And it is also notorious that the circlings in large exquisibly, and is the radius increaseth equall lengths in equall times, whereof the cause is deduced from the first principles of mechanics, for upon comon impulses, equalls upon equalls excite

92Ibid., fol. 2v.
93Ibid., fol. 3r.
94Ibid., fol. 4r.
equall velocity, and at the same instant successively rest. And this action is a cause of such impulses successively, and may be explained thus, let the balls a b c d e, be equall and just not touching, suspended severally at h.i., and a certain force of another equall from f falls upon a (impediments of the medium and friction allways preserved). [Fig. 6] Those equalls will impell each other and send away an equall at g. with the same velocity, and the others all rest as before. So that it looks as if a live action past through all those bodies from f to g. 95

The transfer of force is explained by the laws of motion. North is aware that in this analogy the explanation is two dimensional, whereas sound radiates in three dimensions.

The image of this process is ordinarily, and with very much reason, presumed to agree with the phenomena of sound; and the chief difference betwixt them is, that the waves are circular; and sound is in orb. 96

North makes other observations regarding sound phenomena, including comments on secondary radiation, complex wave forms, and reflection of sound. Plate III, page 107, is North's diagram illustrating the point that wave motion radiates in circles from either the generator or from a secondary source.

... and it is remarkable that when the waves have passed a strait, and fall into broad water again, they spread de novo and the mouth of the strait blooms a new center, as if the waves A. reflect from the obstacle except from the foramen [aperture] at a. Then past thro a. the waves begin at the center a. a new course as at B, and so by the foramens at b. and c. forming upon these points waves as centers; which are express at C. and D. And if the foramina are wide the spreading will mixt of both orders, that is somewhat more confused near the passage but then become regular again as beginning the passage in which the new center will fall. 97

95 Ibid., fol. 7r.
96 Ibid., fol. 6v.
97 Roger North, 32534, op. cit., fol. 9v.
NORTH'S EXAMPLE OF SECONDARY RADIATION
The following quotation from the *Principia* states essentially the same ideas. It is illustrated in Figure 7.

Case 2. Let us suppose that de, fg, hi, kl, mn represent pulses successively propagated from the point A through an elastic medium. Conceive the pulses to be propagated by successive condensations and rarefactions of the medium, so that the densest part of every pulse may occupy a spherical surface described about the centre A, and that equal intervals intervene between the successive pulses. Let the lines de, fg, hi, kl, etc., represent the densest parts of the pulses, propagated through the hole BC; and because the medium is denser there than in the spaces on either side towards KL and NO, it will dilate itself as well towards those spaces KL, NO, on each hand, as towards the rare intervals between the pulses; and hence the medium, becoming always more rare next the intervals, and more dense next the pulses, will partake of their motion. And because the progressive motion of the pulses arises from the continual relaxation of the denser parts towards the antecedent rare intervals; and since the pulses will relax themselves on each hand towards the quiescent parts of the medium KL, NO with very near the same celerity; therefore the pulses will dilate themselves on all sides into the unmoved parts KL, NO with almost the same celerity with which they are propagated directly from the centre A; and therefore will fill up the whole space KLON, Q.E.D.

And we find the same by experience also in sounds which are heard through a mountain interposed; and, if they come into a chamber through the window, dilate themselves into all the parts of the room, and are heard in every corner; and not as reflected from the opposite walls, but directly propagated from the window, as far as our sense can judge.98

In connection with his discussion of radiation, North states that all the complexities of an existing set of sound waves and reflections are the result of "circlings."

But the most wonderful consequence of these circlings, is that how many setts so every are excited, they all cross each other, and make no disturbance or confusion, but follow their courses and over and through another, as if the surface was perfectly smooth. Nay if there be numerous reflections upon reflections, which puts the surface into such a ripple, that to our view it

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is all confusion, yet there is no single heave which hath not relation to its proper origen, and doth its work according to the exigence of that. 99

**Fig. 7.—Newton’s example of direct and secondary sound waves** 100

In conclusion, Roger North knew of the existence of beats, as did Sauveur (1701). 101

I have already shewed that the regular concords arising by the . . . division of the monochord, have a formed character which as the divisions fall upon smaller aliquot parts, is more expressly distinguished by a slight purle in sound, which was ascribed to the nearer perception of the coincidences and separations become wider, that is one after the other in time less frequent, those incidents will be more grosly perceived, and by the artists are termed beats. And those are all ways an indication of disagreement between the pulses. 102

99Roger North, 32534, *op. cit.*, fol. 9v.

100Newton, *op. cit.*, p. 369.


102Roger North, 32534, *op. cit.*, fol. 38r.
Anonymous Harley 4160.—The author of "Harley 4160" (c. 1700) was aware that strings vibrate in aliquot parts, and he was familiar with Wallis' experiment with consonant strings.

... for let there be one string tuned a diapason to another and lay a small piece of paper or straw on one of the strings and strike the other, it will make the string to tremble and to shake off the paper or straw, ... 103

In addition, he makes statements which are tangent to those already listed.

Sound doth spread around so that there is an orb or spherical area of the sound, yet they move strongest and go furthest in the forelines from the first local impulsion of the air, and it is also evident and is one of the strangest secrets in sound—that the whole sound is not in the whole air only, but the whole sound is also in every part of the air so that all the curious diversity of articulate sound of the voice of man will enter into a small cranny unconfused. 104

He comments on the relationship of loudness and pitch.

The loudness and softness of sound is a thing distinct from the magnitude and exillity of sound, for a base string tho softly struck giveth the greater sound, but a treble string if hard struck will be heard much farther; the cause is for that the base string strikes more air and the treble string less air but with a sharper percussion, and that which is called majoration of sound is loudness and melioration of sound in making it sweeter. 105

Writing about resonance chambers, he says that "music is meliorated by mingling open air with pent air," 106 and various shaped rooms will "meliorate and majorate music;" 107 that is, will make it

104 Ibid., p. 10.
105 Ibid.
106 Ibid., p. 11.
107 Ibid., p. 12.
more pleasing and louder. He quotes an "ancient musician" on sympathetic vibration of a window frame,\textsuperscript{108} and mentions resonance under an arch.\textsuperscript{109} He lists three kinds of reflection: (1) concurrent, which is close enough in time to add resonance to the sound; (2) iterant, which is echo; and (3) tautological, which is repeated echo, or reverberation.\textsuperscript{110}

A number of other observations by the author of "Harley 4160" help illustrate the contemporary knowledge about sound as well as illustrating the spirit of inquiry of the age.

1. He suggests study of the effect of sound during various states of consciousness of the hearer, that is, awake or asleep or half-wakeful.\textsuperscript{111}

2. He says that sound is "meliorated and majorated" by various "touches" upon the virginal and also by octave doubling.\textsuperscript{112}

3. He says that sound is "meliorated" by good tuning.\textsuperscript{113}

4. He quotes Mersenne and Boyle on the speed of sound.

Mersenne suggested that the speed of sound was 240 yards per second, whereas Boyle "hath more than once diligently observed that the motion of sound passeth above 400 yards in the time of a second, here in
England, ... " The author's conclusion is that sound moves more rapidly in France than England! 114

5. He states an hypothesis regarding how bodies of unusual shapes and sizes generate sound, quoting a treatise by Boyle.

... perhaps twil not be absurd to enquire whether in bodies of a very differing appearance from strings the various textures and conexions and complications that nature or art or both may make of the parts may not bring them to a state equivalent to the tensions of the strings of musical instrument ... 115

6. He points out that a study of the sound of bells shows that the distance sound can be heard is not directly proportional to the amount of sound generated, for "... 2 bells of an equal bigness, having the same note and of the like loudness ... (rung exactly together) ... would not be heard twice as far as one alone ... neither will 2 candles of light be seen twice as far as one alone." 116

Summary of sound transmission.—Two different theories of sound transmission were stated by English theorists of the late seventeenth and early eighteenth centuries. Francis North (1677) and Holder (1694) held the theory of "cracks." Later, Roger North (c. 1700-1726) stated in detail the theory of the harmonic motion of air particles, a theory influenced by the researches of Boyle (1662) and Newton (1687). In addition to stating theories of sound transmission, the theorists investigated many of the physical aspects of sound transmission, including the velocity of sound, reflection of sound waves, sympathetic vibration, and combination of sound waves.

114 Ibid., p. 18.
115 Ibid., p. 20.
The Reception of Musical Sound

As well as discussing the generation and transmission of sound, Malcolm (1721), Turner (1724), and Roger North (c. 1715-20) made statements about the hearing mechanism—the physiology of the ear. The statements are not detailed explanations, but express limited anatomical knowledge.

Malcolm (1721), for example, described the anatomy of the ear. Sound, he said, passes through the medium of air through the cavity or passage, to the tympanum, "till it reaches at last to the auditory nerve, and there the sensation is finished as far as matter and motion are concerned; and then the mind by the laws of its union with the body, has that idea we call sound."

Turner (1725) mentioned the ear drum, but did not discuss the mechanism in detail. He wrote that sound "... though it be not matter, considered simply as such, [is] but only a production of matter, by agitating the air; which when it is put into a convulsive motion, strikes violently against the drum of the ear."

Roger North (c. 1715-20) mentioned functions of the organs of hearing including the "tube of the ear," and the "drum membrane."

Hitherto I have considered sounds on the part of the cause, and now I come to the effect, which is found by our sense of hearing, and ought to have an especiall notice taken of it. The fabric of the ear is very considerable, with regard, not only to the perceiving, but judging of sounds. The place of the sensible touch, is reputed to be the drum membrane, for by

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117 Malcolm, op. cit., p. 4.
118 Turner, op. cit., p. 2.
119 Roger North, 32534, op. cit., fol. 19.
modes of the attack upon that, we judge the modes of the percuss

cussion, as quick, dull continued, or otherwise as the case is.

Summary.--It has been the purpose of this chapter to describe
the information about sound that was mentioned by the theorists. The
theorists developed theories for sound generation, transmission, and
reception, reflecting the knowledge and methodology of the time.
Immediate antecedents came from developments on the continent, includ­ing
developments by Benedetti (1585), Mersenne (1636-37), Galileo
Galilei (1638), Kircher (1650), and the Academia del Cimento.

Four theories for sound generation were stated in the theoreti­
cal writings.

1. Sound results from the motion of particles of matter in
the surface of the sounding body.
2. Sound results from the percussion of body against body.
3. Sound results from the percussion of matter against the
air particles, or air particles against other air particles.
4. Sound results from the vibration, as a vibrating spring,
of either the generator or of an enclosed quantity of air.

The theorists also listed characteristics of specific kinds of
vibrators. Wallis (1677) described the vibration of partials of a
string. Roberts (1692) compared the pitch of sounding harmonics in
the trumpet and trumpet marine with the pitches of a scale in just
intonation. Holder (1694) used a pendulum analogy to describe move­
ment of the vibrating string. Malcolm (1721) listed laws of vibrating
strings. Taylor (1713) showed that the motion of a tense string was

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120 Roger North, 32535, op. cit., fol. 95v.
comparable to the motion of a pendulum with a time isochronous to the
time of vibration of the string. Roger North (c. 1700-1726) discussed
the characteristics of strings and other kinds of generators, including organ pipes, plain solids, single and double reed instruments and
the human voice.

Two theories of sound transmission were stated by the theo-
rists.

1. Sound is transmitted as a series of "cracks" caused as
certain air particles rush in to fill a space from which the particles
have been expelled. This theory was stated by Francis North (1677).

2. Sound is transmitted as pulses, resulting as particles of
the air move in simple harmonic motion and move other particles accord-
ing to the laws of mechanics. This theory, based on principles
asserted by Newton, was described by Roger North (c. 1700-1726).

In order to explain how air could be the medium for both light
and sound and also be the fluid which was breathed, Newton (1687) and
North (c. 1700-1726) suggested that the air consists of three kinds
of particles: the smallest particles, absolutely hard and incompress-
ible accounting for the transmission of light; the middle-size parti-
cles, compressible, forming the medium for sound; the largest size
particles forming that part of the air which is breathed.

Other theorists also wrote about the transmission of sound.
Narcissus (1683) compared light and sound and suggested three divi-
sions to the science of acoustics: acoustics, discoustics, and
cataacoustics for the areas of direct sound, reflected sound, and re-
fracted sound. Holder (1694) summarized the contemporary knowledge
about sound. The author of "Harley 4160" (c. 1700) discussed resonance and echo and listed three kinds of reflection: concurrent, which adds resonance to the initial sound; iterant, which is echo; and tautological, which is reverberation. Derham (1708) timed the duration of arrival of the sound of fired guns and found the average velocity of sound to be 1142 feet per second, the same velocity used by Newton in the 1713 revision of the Principia. Roger North (c. 1715-1720) applied the laws of mechanics to explain the transmission of sound as wave motion. In addition he mentioned the existence of beats and suggested that beats might be useful for musical composition.

Regarding the reception of sound by the hearing mechanism, the theoretical writings showed only limited knowledge of anatomy. Malcolm (1721) mentioned the cavity or passage, the tympanum, and the auditory nerve. Roger North (c. 1715-20) mentioned the tube of the ear and the drum membrane and Turner (1725) mentioned the ear drum.

The theorists' statements about perception and about sound are background to their writings about tonal resources. The tonal resources are described in the following chapters.
CHAPTER III

SCALE

While striving to explain the "why" and "how" of pitch relationships during a time of transition, theorists during the Enlightenment described scale systems. As harmonic relationships to a tonal center became more formalized and the homophonic point of view brought added emphasis to the functions of pitches in vertical as well as horizontal relationships, old scale systems were distorted in an attempt to meet the demands of homophony. Resulting scale theories are described by the theorists as they write about proportions, tuning and temperament, and use of syllables.

It is the purpose in this chapter to examine the statements of the theorists regarding scale. After an explanation of approaches to scale, the writings of the theorists are discussed in chronological order. In conclusion, the ideas of the theorists are summarized.

Approaches to Scale

The publications by Meibom (1653) and Wallis (1682) made available Latin translations of Greek theoretical writings. Of the tuning systems described in these works, three were most useful to English theorists.¹ One of these is the ditonic system of Pythagoras,

Ptolemy's Diatonic Ditoniaion, in which the tones of the scale are obtained from successive perfect fifths, resulting in the intervals within the octave C to c of 9:8, 9:8, 256:243, 9:8, 9:8, 256:243. Another is Ptolemy's Diatonic Syntonon or "syntonic" resulting in the proportions 9:8, 10:9, 16:15, 9:8, 10:9, 9:8, 16:15. The third is Didymus' Diatonic, resulting in the proportions 10:9, 9:8, 16:15, 9:8, 10:9, 9:8, 16:15. In addition to the proportional systems, meantone tuning was mentioned by some of the theorists. In meantone tuning, four successive fifths—for instance, C-G, G-D, D-A, A-E—are each made smaller than the perfect fifth by one-fourth of the syntonic comma, providing a just major third—C-E. The ditonic system of Pythagoras, Ptolemy's syntonic, Didymus' diatonic, and meantone tuning all provided certain just proportions in one key. However, maintaining the just proportions when modulating to other keys results in complications of the system.

The practical answer to the problem of modulation is some kind of equal temperament. Philosophically, such a system was available from the time of Aristoxenus, and was detailed by Euclid. It was mathematically accessible from the early seventeenth century by the use of the newly developed mathematics of logarithms. Although equal temperament was probably being practiced in England in the early seventeenth century, as indicated in the treatise of Butler (1636), few theorists were willing to leave the certainty which they felt resulted from the real numbers of pure proportions for a system of relationships which could be described only in surd numbers.
Turning to the subject of solfeggio, developments in the use of syllables also had unique complexities, reflecting the problem of modulation to other keys. In general, the theorists adapted existing syllable systems to the practices and needs of the time.

Charles Butler on Scale and Mode

In the opening pages of his treatise, Butler (1636) discusses the meanings of the mode names "Dorik, Lydian, Aeolik, Phrygian, and Ionik," relating the "mood" to Greek geographic regions, and referring to Cassiodorus, Aristotle, Tullius, Pythagoras, Homer, and others.² According to Butler, the names of the notes, ut, re, mi, fa, sol, la, were invented for didactic purposes,³ and the principal note of the series is "mi."

For the 7 notes, there are but six names (ut, re, mi, fa, sol, la). The seventh note, because it is but a half-tone above la, as the fourth is above mi; (whereas the rest are all whole tones) is fitly called by the same name: the which being added, the next note will be an eighth or diapason to the first: and consequently placed in the same letter or clef, and called by the same name.

Of these seven notes, that named MI is the principal or matter-note: which being found, the six servile notes do follow, (both ascending and descending) in their order. As in example [Fig. 8].

![Fig. 8. Butler's seven syllables, showing location of MI](image)

But the perpetual order of the notes in the gamut (as of the months of the year) is most fitly exemplified in that figure, which hath no end.

²Butler, op. cit., pp. 3-12.
³Ibid., p. 12.
Fig. 9.—Butler's circle of the scale^4

In the example, Figure 9, Butler has added the syllable "pha" for the seventh degree, a semi-tone above la. However, the common English usage was of only four syllables: mi, fa, sol, la.

These names, though they be still taught in schools (according to the first institution,) among other principles of the art; yet the modern vulgar practice doth commonly change ut and re, the one into sol, the other into la: so that for the 7 several notes, they use but 4 several names: which doth not a little hinder the learners both in singing, and in setting. But if you will needs retain this change; then take this short direction. After MI, sing fa, sol, la twice upward; and la, sol, fa twice downward: and so come you both ways to MI again, in the same cleff.^5

The four syllable system was common to other of the English treatises of the period, and had some points in its favor. It provided these proportions to fill in the fourth: 16:15, 9:8, and 10:9. The practice of the period placed the semitone between mi and fa, the greater tone between fa and sol, and the lesser tone between sol and la.


^5Ibid., p. 13.
Replacing ut and re respectively with sol and la helped achieve the alternate use of greater and lesser tones, with the greater tone next to the semitone, insuring just major thirds and minor thirds.

Either Butler misunderstood this function or he passed it by in favor of another point of view, for his statements regarding proportion present an equal tempered system:

And this is the doctrine of concord-proportions, received from antiquity. Unto which (Calvisius c. 5 and Mutinensis) some of our neoteriks have added proportions of the other concords, to wit sesquiquarta of ditonus, sesquiquinta of semiditonus, superfibartiens tertias of tonus-diapente, and supertripartiens quintas of semitonium diapente: which happily they hammered out of the known difference between the proportions sesquitercia \([1, 1/3]\) and sesquialtera \([1, 1/2]\) which difference is \(1/6\): whereunto the distance between the concords diatessaron and diapente (which is a whole tone) does answer. So that \(1/6\) in proportion answers to a tone in sound; and \(1/12\) in proportion, to a hemitonium.

By which thesis or maxim, as by a Lydias lapis, all the proportions in an eighth may be found and tried.

For seeing that a diapason is of the dupla proportion; whatsoever is the number of any chord, the number of his diapason must be so much more: as if the mean ut be 12, the bass ut [his diapason] will be 24. Likewise Pha having accounted 12, the same sound ut, has unto it the proportion of 12 (which is one entity) and \(5/6\) of 12 [or 22.] So sol or re being 12, the ground has the proportion to the one, of 1, \(3/6\), \(1/12\) [or 1, \(1/2\) and \(1/12\)] which is 19; and to the other of 1, and \(1/6\), [or 14] and so of the rest. A type of all the proportions of a common ground to the other notes in an eighth, both tones and hemitones, followeth in 2 examples. Where note that the number set after any note, is the proportion of the ground to the same note; as 1, \(2/6\) [or 16] set after mi, is the proportion of ut to fa, not of fa to ut. And likewise that 12 set after the ground, is the proportion of every note to the same ground.6

Butler makes it clear that he is describing a system of equally proportioned semi-tones.

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6 Ibid., pp. 33-34.
Concerning the tune of notes, from mi to fa, and likewise from la to pha, is but half a tone; between any other two notes is a whole tone: as from fa to sol, from sol to la, likewise from pha to ut, from ut to re, and from re to mi: which thing is manifested in a lute: ...8

Butler also presents his syllable system in a chart which is similar to charts used to explain the hexachord system, as illustrated in Figure 11. This chart shows that Butler's scale system is similar to the hexachord system in being movable. The seventh syllable "pha" on the seventh degree would require the use of both B⁵ and E⁵ in the scale "mollatis." In summary, Butler's system of solfeggio is a movable syllable system providing major scales with tone centers on C, F, and B⁵.

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7 Ibid., p. 34.
8 Ibid., p. 22.
Renatus Descartes and William Lord Brouncker

Descartes (1618, trans. 1653) termed the intervals of the diatonic scale "degrees," and suggested two reasons why such degrees are necessary.

For two causes chiefly are degrees required in musick; (1) that by their assistance a transition may be made from one consonance to another, which cannot, so conveniently, be affected by consonances themselves with variety, the most grateful thing in musick; (2) that all that space, which the sound runs over, may be so divided into certain intervals, as that the tune may always passe through them more commodiously than through consonances.

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9Ibid., p. 19.

10Brouncker, op. cit., p. 25.
The first reason is that diatonic motion is needed for transition from one consonance to another. Descartes allowed as consonances the octave, fifth, fourth, major third, minor third, and major and minor sixths, all in just proportions. Proportions between these consonances are of four kinds: 8:9, between the fifth and fourth; 9:10, between the fifth and major sixth; 15:16, between the fifth and minor sixth or the fourth and major third; and 24:25, between the two kinds of thirds or two kinds of sixths.

If we consider them in the first capacity; there can be only four kinds of degrees, and no more: for then they ought to be determined from the inequality, found between consonances, and all consonances are distant from each other 8/9 part, or 9/10, or 1/16, or finally 1/25; ... 11

Descartes' second reason is that the consonant intervals should be divided into diatonic scale degrees for melodic convenience. His method of division is by arithmetical proportions.

Hence also is it manifest, that degrees cannot divide a whole eighth, unless they divide a ditone, a third minor, and a fourth; which is thus done. A ditone is divided into a tone major and a tone minor; a third minor is divided into a tone major, and a semitone majus; a fourth into a third minor, and also a tone minor; which third again is divided into a tone major and a semitone majus, and so the whole eighth doth consist of three tones major, two tones minor, and two semitones majora; as is manifest to him who seriously perpends their scheme. And here we have only three kinds of degrees; for a semitone minus is excluded, because it doth not immediately divide consonances, but only a tone minor. 12

So Descartes' scale divisions divide the consonant intervals by proportions which occur as the difference between consonant intervals. In addition, it is his intent to provide just thirds, fourths,


12Ibid., pp. 27-28. Descartes' ditone is the just major third, 4:5, not the Pythagorean ditone, 64:81.
fifths, and sixths from each note of the scale. He accomplishes this by allowing the schism to be used as needed to achieve the just proportions.

... therefore it is necessary, that in some place we use a certain fraction, which may be the difference betwixt a tone major and a tone minor, which we nominate a schism; or also between a tone major and a semitone majus, which contains a semitone minus with a schism: to the end, that by the help of these fractions the same tone major may, after a sort, be made moveable, and so perform the office of two tones; which is easily perceptible in the figures here delineated, where we have turned the whole space of an eighth into a circle, ... 13

Optional use of the schism makes possible major or minor thirds in just proportions throughout the scale, as illustrated in Figures 12 and 13.

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third appears between G with the schism and Bb and between A and C.

![Diagram of musical tones and intervals]

**Fig. 13.**--Alternate location for B

Similarly, Descartes indicates alternate locations for B.

... there can be only two kinds of an artificial voice, viz. ∘ and □: because the space between A and C which is not divided in the natural voice, can only be divided by two modes; so as that a semitone be set in the first place, or the second.

Using the alternate locations for B allows either a just major third or a just minor third above G and a just minor third or a just major third below D. Using the optional schism the alternate location for B as needed, it is possible to construct the proportions of Didymus' diatonic throughout the diapason in the keys of C, F, and G.

By using each note of the scale and accepting a division of the octave by fourth and fifth or fifth and fourth--similar to normal and hypo modes--Descartes has fourteen modal possibilities. Two of these he considers unacceptable because of the location of the tritone.

... for an eighth can be divided into degrees only seven ways, every one of which may be again divided by a fifth

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two ways, except two; in one of which is found a fifth false in place of a fifth, whence there ariseth onely twelve modes, of which foure are lesse elegant, for this cause, that a tritone is found in their fifths, so as they cannot, from a fifth principall, and for whose sake the whole tune seems composed, ascend or descend by degrees, but of necessity there must occur a false relation of a tritone, or a fifth false. 17

Brouncker explains in the "Animadversions" that the four "lesse elegant" modes are those from F to F, A to A, B to B, and E to E using B flat; or from C to C, E to E, F to F, and B to B using B natural. 18

Brouncker also lists the scalar combinations possible from Descartes' theories. Using three major tones, two minor tones, and two major semitones in every possible order, Brouncker found 210 possible combinations in the octave. His procedure was as follows:
let a represent a major tone, b represent a minor tone, and c a major semitone. The following orders are possible:

aaabbcc
'aaabcbc
aaabccba
aaacbbca
aaaacbcb
and so on. 19

The three kinds of tones may be ordered twelve ways in fifths and six ways in fourths. Therefore, there are seventy-two ways of ordering the tones of the octave while maintaining the division by fifths and fourths. At this point, Brouncker seems to have forgotten that Descartes allows both authentic and plagal modes; that is, the

17 Ibid., p. 56.
18 Ibid., p. 84.
19 Ibid., pp. 80-83.
octave may be divided into fourth and fifth or fifth and fourth, making possible another seventy-two orders. Examination of Brouncker's list of 210 "moods" reveals that 144 of them do have perfect fifths and fourths or perfect fourths and fifths. Brouncker's listing is an exploration of modal means. To him such an exploration must have been academic, for it was based on arbitrary assumptions of validity for arithmetic proportions—proportions which he held were improper for judging matters of sense.

It was Brouncker's opinion that a system of division using geometric proportions is more appropriate than a system using arith-
metic proportions.

Now considering (as was said An. 1 and 3) that not the visible proportion of chords or strings, but the audible proportion of their sounds only is considerable in musick; and that, by the sense of hearing, wee doe judge of sounds according to the geometricall, not arithmetical proportion, or proportionall division of the strings, that give them: I conceive it was rightly inferred (An. 3) that chordes, as to sounds, ought to bee divided according to a geometricall, not arithmetical progression; by force of the same reason (adequate [adequate] to the sense of hearing) which our authour gave for the contrary opinion in his sixth precon-
siderable. It therefore remaineth that I heere shew what division it is I mean, and how it may be performed.20

Brouncker's recommendation is to divide the mean proportional of a string into seventeen equal semitones by sixteen mean proportionals,—the terms "extream" and "mean" ratios being used as explained in the Elements of Euclid, 30.6. In this division the proportion of the whole string to the longer segment is proportional to the longer segment to the shorter segment, or, as stated by the printer:

20 Ibid., p. 84.
As the number of parts in the first term, to the number of parts in the third:
So the number of rations between the first and second, to the number of rations between the second and third.

Which new invention alone, is more than enough, on the one side, to give the capable part of scholars a grateful relish of the inventors extraordinary abilities in the noblest member, or heart of learning the mathematicks: ... 21

Brouncker suggested two methods for accomplishing this division. The first was algebraic, "by the latter table of Potestates Chapter 12. of Mr. Oughtreds Clavis Mathem." 22 The other was by the use of logarithms. Brouncker's procedure is shown on Plate IV.

Brouncker suggested two other applications of the system. One application, stated earlier by Mersenne (1636-37), divides half a string into twelve equal semitones by eleven mean proportionals 23 The other, also using proportionals or logarithms, divides the chord "harmonically." By "harmonic" Brouncker means a proportion where the length of a segment of the chord is to the chord length as the chord length minus twice the length of the segment is to the segment. The effect of this division is to divide a sharp minor tenth by fifteen

\[
\begin{align*}
ZA &= B \\
ZQ &= A \\
QA &= B - A \\
\end{align*}
\]

By definition, in harmonic division \( A:B \) as \( B-2A:A \)

<table>
<thead>
<tr>
<th>Z</th>
<th>Q</th>
<th>A</th>
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</thead>
</table>

Fig. 14.—Harmonic division of a string 24

---

21 Ibid., in "The Stationer to the Reader."

22 Ibid., p. 85.

23 Ibid., p. 91.

24 Ibid., p. 93.
AZ equals B
AS equals A
Therefore ZS equals B minus A
B-Z equals to A as A is to B
A equals B^2 minus BA
A plus BA equals B^2
A plus BA plus \( \frac{1}{2} B^2 \) equals B^2 plus \( \frac{1}{2} B \)
A plus \( \frac{1}{2} B \) equals the square root of the sum of B^2 plus \( \frac{1}{2} B^2 \)
A equals the square root of the sum of B^2 plus \( \frac{1}{2} B^2 \), minus \( \frac{1}{2} B \)
B equals 10
B^2 equals 100
\( \frac{1}{2} B^2 \) equals 25
B plus \( \frac{1}{2} B \) equals 125
Square root of the sum of B^2 plus \( \frac{1}{2} B^2 \) equals 11.180,339,887,5-
\( \frac{1}{2} B \) equals 5
A equals 6.180,339,887,5-
B minus A equals 3.819,660,112,5-
B equals 10,000,000,000,0, logarithm 1,000,000,000,0
B-A equals 3.819,660,112,5, logarithm 0.582,024,716,2
Difference of log. B and log. B-A is 0.417,975,283,8
This is divided by 17
The quotient is 0.024,586,781,4 equals the ratio of 1.058-

Logarithm of B-A is 0.582,024,716,2 equals ZS 3.820-
Quotient plus ZS 0.606,611,497,6 equals ZR 4.042+

BROUNCKER'S SYSTEM FOR DIVISION OF A STRING BY MEAN PROPORTIONALS25

25 Ibid., pp. 66-67, 85-86. Brouncker's symbols are explained and modernized.
proportionals. It is illustrated in Figure 14.

So by Brouncker's system, not only the octave is suitable for division by proportionals but also the eleventh and the minor tenth. By applying the principles, theoretically it would be possible to divide any interval into any number of divisions. By algebra, any regularly decreasing order of string lengths can be continued in proportion to any desired number of divisions. Using logarithms, the procedure is even simpler. Allowing 10,000, the logarithm of 1, to represent the total number of units in a string, $S$ number smaller than 10,000 to represent the other extreme of the tempered interval and $N$ the number of proportionals. Subtract $\log S$ from $\log 10,000$ and divide the remainder by $N$. The result is the logarithmic increment for each step. Subtraction of the logarithmic increment $N$ times to 10,000 minus $S$ expresses the logarithm of each string length. Since Henry Briggs, in 1624, published tables of common logarithms of numbers from 1 to 20,000 to fourteen places, the technical information had been available for almost three decades prior to Brouncker's "animadversions."

A statement in the publisher's preface has led to misunderstanding of Brouncker's system. The publisher writes "... with a view to farther improvement of the Systema Participate, he proposes a division of the diapason by sixteen mean proportionals into seventeen equal semitones; the method of which division he exhibits in an algebraic process, as well as in logarithms." Nowhere does Brouncker

---

26 Briggs, op. cit.

27 Ibid.
divide the octave into seventeen equal semitones, indeed, that would be a conflicting use of terms--if semitone means half a tone. What Brouncker does is divide the mean proportional of a string into seventeen equal semitones by sixteen mean proportionals. Brouncker makes his division of the diapason by means of sixteen mean proportionals of a whole string. This provides twelve equal tempered intervals to a slightly flat octave.

Plates V and VI, adapted from Brouncker's "Animadversions," show the relationships of proportional division of the mean proportional, equal tempered division of the octave, harmonic division, and the diatonic scale of Didymus which was recommended by Descartes. The chart shows that Brouncker's division of the mean proportional by sixteen mean proportionals closely approximates just thirds and sixths.

John Birchensha

Birchensha's translation (1664) of Alsted's article listed the "old diatonic scale" and the "new and perfect syntonian scale." The former has Pythagorean proportions, the latter has Ptolemy's syntonic proportions.28

In the advertisement for his proposed publication, Syntagma Musicae, Birchensha made extravagant claims for his "great scale."29 Little would be known about this scale if it were not that a collection of material relating to music in the British Museum contains an

28Birchensha, op. cit., p. 23.
### PLATE V

**COMPARISON OF TUNING SYSTEMS**

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<th>Cents</th>
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## Comparison of Tuning Systems, Continued

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anonymous author's comments on "Mr. Bирchensha's scale."^ Anonymous author's comments on "Mr. Bирchensha's scale."^ Bирchensha's scale, as described in the anonymous manuscript, divides the octave into thirty-three intervals using repeated 9:8 proportions. The procedure is as follows: the octave with proportions 1:2 consists of the fifth, 2:3 and the fourth, 3:4; these points can be described by the numbers 2:3:4; the ditone, composed of two major whole tones, as in Pythagorean tuning, is 9:8 plus 9:8 or 81:64; adding ditones, assuming octave transposition to bring the notes within an octave, Bирchensha finds proportions representing all the needed pitches. The proportion for the octave which allows Bирchensha to construct with whole real numbers the intervals he considers desirable is 5,159,780,352 to 10,319,560,704.

Plates VII and VIII, pages 136 and 137, show the relative proportions of Bирchensha's scale, as described in the anonymous notes. Column A lists the factors of the proportions; columns B, C, and D indicate the mathematical operation needed to construct related proportions, for example, column C illustrates that the ratio of pitch 1 to pitch 6 is 8:9; column E indicates the numbers which multiplied form the quotient in column A; and column F gives Bирchensha's name for the pitch location. The dieses are arithmetical means of the adjacent proportions. The rationale for these structures is given in Plate IX, page 138.

Plate X, page 139, illustrates the relations of these divisions in string lengths. This information shows that Bирchensha's "Grand Scale" used Pythagorean tuning as a norm. The scale described

[^31]: Anonymous 4388, op. cit., fol. 69.
<table>
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<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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COMPUTATIONS FOR BIRCHENSHA'S SCALE
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COMPUTATIONS FOR BIRCHENSHA'S SCALE, CONTINUED
### Rationale for Birchenha's Scale

| As  | 2 | 3 | 4 | 6 | 8 | 9 | 11 | 12 | 14 | 15 | 16 | 17 | 18 | 20 | 22 | 23 | 24 | 25 | 26 | 28 | 31 | 32 |
|-----|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 9   | 3 | 3 | 3 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 8   | 2 | 2 | 3 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 7   | 2 | 2 | 2 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 6   | 2 | 2 | 2 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 5   | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 4   | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 3   | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 2   | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

**As** indicates the number of times a card is flipped, while **so** indicates the number of cards stacked. The rationale for Birchenha's scale is that it provides a systematic way to count and organize cards using a simple and efficient method, allowing for quick and accurate card counting in various card games.
has the following intervallic possibilities.

Major whole tones (9:8) above A, B, C, D, E, F, G.

Perfect fourths (4:3) above B, C.

Perfect fifths (3:2) above B, C.

Perfect octaves.

Ditones (81:64) above A, B, C, D, E, F.

Tritones (729:512) above A, B, C, D, E.

Tetratones (6561:4096) above A, B, C, D.

Hexatones (49049:32768) above B, C.

The anonymous author is critical of Birchensha's scale because it does not allow just thirds and sixths. He does not mention the fact that selecting the scale pitches from those available by Birchensha's multiple division would allow very close approximations of just intervals.

Therefore now, seeing Mr. Berchinshaw would have his greater third to be a ditonus reterum; two major whole tones I say that by this clear and full demonstration, his scale must be either this, or worse than this. 34

The example referred to is a scale with Pythagorean tuning.

Christopher Simpson

Simpson's statements on scale and mode included instructions for use of syllables. After listing the syllables of the hexachord,

Simpson writes:

Four of these, to wit, mi, fa, sol, la (taken in their significance) are necessary assistants to the right tuning of the degrees of sound, as will presently appear. The other two,

34 Ibid., fol. 42.
ut and re, are superfluous, and therefore laid aside by most
modern teachers.

We will therefore make use only of mi, fa, sol, la, . . .
Mi hath always fa, sol, la, both above and under it, . . . I
will therefore only give you a rule for placing of mi, and the
work is done.35

Simpson's rule places "mi" on B, E, A, or D.

The first and most natural place for mi is in B. But if
you find in that line or space which belongs to B, such a little
mark or letter as this (b) which is called a b flat, and excludes
mi wheresoever it comes, then is mi to be placed in E, which
is its second natural place. If E have also a b flat in it; then,
of necessity, you must place your mi in A.

I have seen songs with a b flat standing in A, in B, and in E,
all at once; by which means mi has been extruded from all its three
places: but such songs are irregular (as to that which we call
solfaing a song,) being designed for instruments rather than for
voices: However, if any such song should be proposed to you, place
your mi in D, with fa, sol, la, above it and under it, as formerly
delivered.36

Simpson's four syllable system is identical to the system which
Butler said was the "modern vulgar practice" (supra, p. 120). The
location of mi is emphasized by Simpson. He builds the scale as shown
in figure 15.

\[
\begin{align*}
\text{fa} & \quad \text{sol} & \quad \text{la} & \quad \text{MI} & \quad \text{fa} & \quad \text{sol} & \quad \text{la} \\
F & \quad G & \quad A & \quad B & \quad c & \quad d & \quad e
\end{align*}
\]

Fig. 15.--Simpson's scale

This use of the four syllable system indicates that Simpson was more
concerned with proper interval relationships surrounding a leading
tone and key note than with the construction of scales from key note to
key note. His instructions locate the key note within the scale in a
manner similar to the location of the final in hypo modes. Similarly,

35Christopher Simpson, A Compendium of Practical Musick in

36Ibid., p. 6.
in the seven syllable system of Butler [ut, re, mi, fa, sol, la, pha]
the syllables refer to a diatonic series of notes with a minor seventh
degree above ut. Apparently, fa rather than ut was considered the key
center in "sharp" [major] keys, and re was considered the key center in
"flat" [minor] keys. Simpson presents the following rule for "flat"
and "sharp" keys.

Every composition in musick, be it long or short, is (or
ought to be) designed to some one key or tone, in which the bass
doeth always conclude. This key is said to be either flat or
sharp, not in respect to itself; but in relation to the flat or
sharp 3d which is joyned to it. 37

John Playford

Playford's comments on scale and mode are similar to those of
Butler (1636) and Simpson (1667). Referring to ut, re, mi, fa, sol and
la; Playford makes the following statements.

These six notes were used for many years past in this order,
ascending and descending, but now four only are in use, viz, sol,
lâ, mi, fa, (so that ut and re are changed into sol and la) which
are sufficient to express the several sounds, and are less burthen-
some to the practitioner's memory. 38

... First, observe that mi is the principle or master note,
which leads you to know all the rest; for having found out that,
the other follow upon course; and this mi hath its being in four
several places, but it is but in one of them at a time; its proper
place is in B mi; but if a B fa which is a B flat, ... be put in
that place, then it is removed into F la mi, which is its second
place; but if a B flat be placed there also, then it is in its
third place, which is A la mi re; if a B flat come there also, then
it is removed into its fourth place, which is D la sol re; ... 39

37 Ibid., p. 43.

38 John Playford, A Brief Introduction to the Skill of Music

39 Ibid., p. 9.
Playford's listing of the gamut is similar to that of Butler, but with four lower notes added and five fewer notes on the high end of the range.

<table>
<thead>
<tr>
<th>Note</th>
<th>Sol</th>
<th>Re</th>
<th>Ut</th>
<th>Fa</th>
<th>Mi</th>
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<tr>
<td>aa</td>
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<td>re</td>
<td>la</td>
<td>la</td>
<td>mi</td>
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<td>fa</td>
<td>#</td>
<td>mi</td>
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<td>fa</td>
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<td>CC</td>
<td>fa</td>
<td>ut</td>
<td>fa</td>
<td>sol</td>
<td>sol</td>
</tr>
</tbody>
</table>

B duralis  B naturalis  B mollaris

1  2  3

Fig. 16.—The gamut as explained by Playford

Thomas Salmon

Profiting from the researches of Wallis (1682), Thomas Salmon published in 1688 his Proposal to Perform Music in Perfect and

40Ibid., p. 5.
41Wallis, op. cit.
Mathematical Proportions.\textsuperscript{42} Salmon claimed as his authorities "Cartes's Musick, Gassendus's Introduction, and Wallis's Appendix and all other learned men, who have in this last age reviewed the harmonical concerns."\textsuperscript{43} Salmon advocated the use of just proportions. His instructions for setting the frets on a stringed instrument in order to obtain these proportions are as follows.

The experiment must be thus: You are to take any one string, and suppose it to be the key A, when it is open: then measure the 9th part of it, you will have B or one gradual note.

- from B $\frac{1}{16}$ of the remaining length C
- from C $\frac{1}{10}$ D
- from D $\frac{1}{9}$ E
- from E $\frac{1}{16}$ F
- from F $\frac{1}{9}$ G
- from G $\frac{1}{10}$ a

These proportions result.

\begin{align*}
A : & B : C : D : E : F : G : a \\
9:8 & 16:15 10:9 9:8 16:15 9:8 10:9
\end{align*}

In addition to advocating the diatonic scale, Salmon explains chromatic half steps and "enharmonick" music.

Chromatic half notes arise by the division of diatonick whole notes into the two best proportions, \ldots

A chromatick half note is truly made by placing the fret exactly in the middle between the two frets of the diatonick whole note: This I first learned by the mathematical division of an octave or duply proportion into its natural parts; then I was confirmed in it by Aristides, lib. 3. pag. 115, who requires such a fund for the enharmonical diesis, and since I find practical musicians very much satisfied in the experiment of such a division as fully answering their expectations.\textsuperscript{45}

\textsuperscript{42} Salmon, 1688, \emph{op. cit.}

\textsuperscript{43} \emph{Ibid.}, p. 14.

\textsuperscript{44} \emph{Ibid.}, p. 9.

\textsuperscript{45} \emph{Ibid.}, p. 15.
Enharmonick musick is that which ascends and descends gradually by quarter notes, which the ancients called dieses: I don't mean that the whole octave, either in this or the chromatic musick, did consist only of these; but after having used some of them, they took wider steps and larger intervals afterwards to complete the fourth and fifth.46

In the final pages of Salmon's Proposal there are comments by John Wallis on Salmon's ideas. Wallis summarizes the tuning theories of Pythagoras, transmitted by Euclid, wherein the major whole tone is the normative interval. He mentions the syntonic scale of Ptolemy and suggests syntonic tuning for the octave.

In addition, he corrects Salmon on his statements regarding the placing of frets in the "middle" to achieve the semitone. According to Wallis, it should be a musical middle, which is achieved by super-particular ratios—the major whole tone, for example, being divided by proportions of 16:17 and 17:18. "And this, I presume, . . . is the meaning of Aristides at the place cited and your meaning here."47

Additional comments by both Salmon and Wallis on the subject of tuning are found in articles in the Philosophical Transactions.

An article by Salmon (1705) was written about an experiment performed at Gresham College.48 In the experiment, the frets on a viol were located by mathematics, with individual frets for each string to provide a scale with just tuning. According to Salmon, this experiment demonstrated the "true theory of music."49 Apparently, since writing his Proposal, Salmon became convinced that the syntonic

46 Ibid., p. 16.
48 Salmon, 1705, op. cit.
49 Ibid., p. 246.
tuning advocated by Wallis was more appropriate than the tuning of Didymus diatonic, for in the article Salmon uses syntonic proportions.

Two articles by Wallis on the subject of tuning appeared in the *Philosophical Transactions* of 1698.\(^{50}\) Both articles review tuning theory and mention problems which result from tempered tuning.

But when an eighth or octave is said, in common speech, to consist of 12 hemitones, or 6 tones, this is not to be understood according to the utmost rigour of mathematical exactness, of such 6 tones as called the diazeuctic tones, or that of la mi, \([9:8]\) which is the difference of a fourth and fifth; but is exact enough for common use. For 6 such tones, that is, the ratio of 9 to 8, repeated 6 times, is somewhat more than that of an octave, or the ratio of 2 to 1; and consequently such a hemitone is somewhat more than the 12th part of an eighth or octave, or diapason. But the difference is so small that the ear can hardly distinguish it; and therefore in common speech it is usual so to speak. And accordingly, when we are directed to take the lengths for what are called the 12 hemitones in geometrical proportion, it is to be understood not to be so in the utmost strictness, but to be accurate enough for common use; as for placing the frets on the neck of the viol, or other musical instrument, wherein a greater exactness is not thought necessary. And this is very convenient, because thus the change of the key, upon altering the place of mi, gives no new trouble; for this indifferently serves any key, and the difference is so small as not to offend the ear.\(^{51}\)

In the article "On the Imperfections of an Organ," Wallis reviews tuning theory from Pythagoras and Aristoxemus. He settles again on syntonic tuning as the most perfect tuning system. However, the current practice in England during his time, according to Wallis, is equal tempered tuning.

But, instead of these successive proportions for each hemitone, it is found necessary so to order the 13 pipes, containing


\(^{51}\) Wallis, "Division," *op. cit.*, pp. 240-41.
12 intervals called hemitones, as that their sounds, as to
gravity and acuteness, be in continual proportion, each to
its next following, in one and the same proportion: which,
all together, shall complete that of an octave or diapason,
as 2 to 1. Whence it happens, that each pipe does not ex­
press its proper sound, but very near it, yet somewhat
varying from it; called bearing. Which is somewhat of im­
perfection in this noble instrument, the chief of all.52

William Holder

Holder (1694) reviewed various tuning systems, including
Mersenne's calculation of 58½ commas to the octave,53 Mercator's
measurements, and Greek modal and tuning systems.54

Holder, as Salmon in his Proposal, advocates Didymus' diatonic
proportions. However, he does not construct the chromatic tones with
super-particular ratios, but rather by using the major semitone, 16:15,
and the minor semitone, 25:24. Using super-particular ratios, the
minor tone, 10:9, divides into the semitones 20:19 and 19:18; and the
major tone, 9:8, divides into the semitones 18:17 and 17:16. Holder,
on the other hand, divides the minor tone into the proportions 25:24
and 16:15 and the major tone into the proportions 27:25 and 25:24, as
illustrated in Figure 17. Locating the semitones by Holder's system
provides additional just intervals above the chromatic notes. For ex­
ample, both a just fourth and fifth are available above C♯. However,
Holder asserts that some temperament is needed in order to provide for
modulation, and he recommends what is approximately meantone tuning.

52Ibid., p. 291.
53Holder, op. cit., p. 104.
54Holder's statements regarding Mercator were discussed by
Fig. 17.--Holder's chromatic division of the octave

Holder's practical tuning system is illustrated in Figure 18 and described in the quotation following.

Fig. 18.--Holder's tuning system

By this you may see the reason, why, to put an organ or harpsichord into more general usefull tune, you must tune by 8ths and 5ths; making the 8ths perfect, and the 5ths a little bearing downward; i.e. as much as a quarter of a comma, which the ear will bear with in a 5th, though not in an 8th. For example, begin at C flat; make C sol fa ut a perfect 8th to it, and G sol re ut a bearing 5th; then tune a perfect 8th to G, and

56 Ibid., opp. title page.
a bearing 5th at D la sol re; and from thence downwards (that you may keep towards the middle of the instrument) a perfect 8th at D sol re: and from thence a bearing 5th up at A; and from A, a perfect 8th upwards, and bearing 5th at E la mi. From E an 8th downwards; and so go on, as far as you are led by this method, to tune all the middle part of the instrument: and at last fill up all above, and below, by 8ths from those which are settled in tune; according to the scheme annexed. Observing to tune the eighths perfect, and the fifths a little bearing flat; except in the three last bars of fifths, where the fifths begin to be taken downward from C as they were all upwards before: therefore, as before, the fifth above bore downward; wo here, the fifth below must bear upward. . . . 57

Though he accepts temperament as a practical necessity, Holder rejects it theoretically. In his opinion, it is "unreasonable to measure intervals by irrational numbers, when we can so easily discover and assign their true rations . . . 58

Arthur Bedford

In his article, Bedford (1705) favors equal tempered tuning with twelve divisions to the octave—a division which he accomplishes using logarithms. He is aware of contemporary discussions regarding proper tuning procedures.

There are many nice disputations concerning these twelve distances of sound among those who are skilled in the mathematical part of music. 59

. . . [they] have been, pardon the expression, more nice than wise in their disputations . . . 60

Bedford makes the following arguments in favor of equal temperament: (1) Sense cannot perceive the difference. (2) Placing
of frets on a stringed instrument is according to equal temperament.

(3) Major thirds must all be the same for flexibility in modulation.

(4) Fifths must be equal for flexibility in modulation. In addition to division of the octave by twelve equal tempered intervals, Bedford suggests that logarithms might be used to divide the tone into "... 3, 4, 6, 10, or any other equal parts." Also, he suggests the possibility of dividing the octave into 10, 20, 30, or any other equal parts or any part of a string into any other number of equal parts. However, he provides no practical instructions for accomplishing the suggested tuning.

Alexander Malcolm

The statements regarding scale and mode in Malcolm's Treatise (1721) included information from other sources. For example, Malcolm refers to Descartes' Compendium and states that the scale degrees must serve both melodic and harmonic functions. However, unlike Descartes, Malcolm puts the major whole tone below the minor, following syntonic tuning. His reason is that the greater tone is more natural to the voice.

This scale not only shows us, by what degrees a voice can move agreeably, but gives us also this general rule, that two degrees of one kind ought never to follow other immediately in a progressive motion upwards or downwards; and that no more

61 Ibid., pp. 48-60 passim.
62 Ibid., p. 71.
63 Ibid.
64 Malcolm, op. cit., pp. 219-20.
65 Ibid., p. 236.
than three tones (whereof the middle is a lesser tone, and the other two are greater tones) can follow other, but a s.
[semitone] or some harmonical interval must come next; ... 66

Malcolm asserts that the arrangement of intervals in a scale shows the relationships of pitches to a fundamental, or principal key. From the "tone greater" one ascends the "tone lesser" to the third easily because of harmonic strength of the 3d, "owing to the idea of the fundamental, to which the ear seeks the harmonical relation of a 3d greater ..." 67

The emphasis on the relation of pitches to a fundamental, rather than to each other, can be observed in the system which Malcolm uses to detail the proportions within an octave—a system also used by Salmon (1705) but without comments suggesting tonal implications. For the major scale the proportions are used as follows.

1, 8:9, 4:5, 3:4, 2:3, 3:5, 8:15, 1:2

With this system the string length for each note is measured from the principal note. 68

Malcolm points out that diatonic instruments with fixed pitches cannot play this "natural" scale in other than the original key. 69 However, modulation requires a system of "continued geometrical proportions," and it is desired that these "fall in with the divisions of the natural scale." 70 It is necessary both to divide

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66 Ibid., pp. 250-51.
67 Ibid., p. 237.
68 Ibid., p. 254.
69 Ibid., pp. 285-86.
70 Ibid., p. 288.
the whole tones into two semitones and to compromise the perfect proportions in tuning.

To achieve division of the whole tone, Malcolm offers two systems. One of these is the division by super-particular ratios. The other is a division using the proportion 15:16, with the second semitone receiving whatever proportion remains.

... every tone of the diatonic series is divided into two parts or semitones, whereof the one is the natural semitone 15:16, and the other is the remainder of that from the tone, viz, 128:135 in the t. g. and 24:25 in the t. l. and the semitone is put in the lowest place in each, except the t. g, betwixt f and g, where 'tis put in the upper place; ...

\[
\begin{align*}
G &: G^\# : D &: D^\# : E &: F &: F^\# : G \\
\end{align*}
\]

\[
\begin{align*}
G &: G^\# : A &: B^b &: B &: c \\
\end{align*}
\]

According to Malcolm, this system makes possible the greatest perfection. The other system of division—that using super-particular ratios is similar to the system used by Salmon (1705) (supra, pp. 143-45). However, Malcolm places the larger interval below the smaller; Salmon places the smaller below the larger.

With regard to tuning, Malcolm mentions that some tuners tune the fifths and fourths "perfect," whereas others follow meantone tuning. "... others that affect a greater nicety pretend to diminish all the 5ths, and make them deficient about a quarter of a comma, ...

\[71\text{Ibid., p. 294.}
\[72\text{Ibid., p. 295.}
\[73\text{Ibid., p. 307.}\]
William Turner

Statements about scale by Turner (1724) offer nothing new to scale theory. He followed the English system of using four syllables, although he was aware that the French used a seven syllable system with si.

These names thus clapt together, have no manner of signification in themselves; but are contrived for the sake of order and distinction only, and answer the end of the office for which they were intended, in every circumstance; to wit, in expressing all the different tones in the seven degrees of sound, (as whole tones and semitones) to which they are applied.

. . . the French, to this day, use seven: for to the syllables that we are here speaking of, viz ut, re, mi, fa, sol, la, they add another; which they call si (pronounced see) the syllables ut and fa, being applied to the two semitones; and re, mi, sol, la and si, to the others: but this is not accounted (by the English) so good a method as we have practised, some centuries, as finding it much easier, and more elegant to use no more than four of these syllables; which are mi, fa, sol and la, the t, in the syllable ut, being too dead a mute to express a sound well, and the r in re, too harsh a liquid; so instead of ut we put fa; for re, sol; and for si, mi; . . . \(^\text{74}\)

Ambrose Warren

Warren (1725) presented plans for a monochord and, using logarithms, recommended a division of 31 intervals to the octave. After studying problems with the tuning systems currently in use, he concluded that intermediate notes are needed " . . . between two several notes in the scale or gamut." These notes, having "different tendencies and relations," are what the "best masters on the violin

\(^{74}\)Turner, *op. cit.*, p. 33.
observed and performed." Warren was familiar with harpsichords and spinets made by Mr. Player and others "with splitt keys," to provide some of the intermediate notes. Warren's conclusion was that "instead of thirteen . . . there really is, and ought to be thirty-two distinct and different degrees of notes, adjuncts, or supplements . . . " He claimed that "this table of compliments is entirely new for ought I have ever seen or heard of, . . . " Plate XI shows, however, that Warren's system is exactly like that of Huygens (1691). The similarity in numbers in Huygens' and Warren's systems may be from the convenience of using a scale with length a multiple of 10, inasmuch as the logarithm of 10 is 1. This method was also used by Brouncker (1653).

Roger North and Préncourt

Roger North (c. 1710) provided information on the use of syllables and some information on tuning, although he was not interested in proportions. In his annotated transcription of the Préncourt tract, syllable systems are treated in detail. Préncourt discusses the Guidonian hexachord system, but he advocates a fixed system, which is described in Figure 15, page 156. Préncourt's instructions are


77 Warren, op. cit., p. 12.

78 Brouncker, op. cit., p. 67.

79 Roger North, 32531, op. cit., fol. 1-41.
PLATE XI
COMPARISON OF HUYGENS' (1691) AND WARREN'S (1725) TEMPERAMENTS

Huygens' 31 interval division

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<tr>
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</tr>
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Warren's 31 interval division

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80 Huygens, op. cit., pp. 149-50.
81 Warren, op. cit., plate 3.
Fig. 19.—Prencourt's fixed syllable system\(^{82}\)

that "... you must never change your syllables,"\(^{83}\) but rather sing the syllable lower in pitch for a flat and higher in pitch for a sharp. Roger North points out that the system commonly in use in England is the four-syllable movable system described by Playford.\(^{84}\)

In a later manuscript, Roger North (c. 1726) presents a somewhat different approach to the use of syllables. In this manuscript he writes that "the gamut scale is exprest by these syllables ut (which we have exchanged for do), re, mi, fa, sol, la, fa."\(^{85}\) In the same manuscript, Roger North suggests still other syllables: go, ar, be, ca, do, el, fa, for respectively g, a, b, c, d, e, and f.

I have adjoined the novell syllables, as they may be used, or if others please better the choice is free, some have used the syllables of In Nomine Domini, or Gloria Patri, ... the choice of syllables imparts little.\(^{86}\)

Included in another manuscript by Roger North (1728) are instructions for tuning "clavical" instruments. The tuning instructions result in an approximation of mean-tone tuning. Fifths are tuned with the upper note bearing flat and thirds are tuned "with all the perfection that may be, onely of the two let it be rather

\(^{82}\) Ibid., fol. 27v.

\(^{83}\) Ibid., fol. 28r.

\(^{84}\) Ibid., fol. 28r.

\(^{85}\) Roger North, 32533, op. cit., fol. 26r.

\(^{86}\) Ibid., fol. 50r.
too sharp than too flat." The first paragraph in the quotation that follows instructs how to tune using beats. The remainder of the quotation and example give North's tuning system.

This is to help a learner to find out the way to come at the accord he aims at, but the justice of it, according to purest harmony, is more nice, and requires other sort of observation; and that is of the chattering wallowing or rowling of two tones sounding together, which will be very notable, till the accord is exact, and then a perfect tranquility takes place without any dissention. Of these I have already taken notice, as also that if the notes are reasonable from tune, the disorder will be chattering, or beating very distinguishable, and fast, and as it comes nearer, grow slower, and near the truth, fall into a waiving, or rowling manner, which proceeding, will quite die in accord. The artists who deall much in tuning, will by the manner of the beats, judge in what distance the notes are from accord, but scarcely which of them is superior, for be it either the beats are alike. But I am not in a capacity of subtilizing on this subject, which is peculiar to the artists I mentioned, (and who are not willing to communicate the secreats of their art) nor is it very needfull in this designe so to doe, for a gross notion of the matter will lett a scoller into the observation of them, sufficient for his use.

The business of tuning is to adjust the sounds of all the tones, and semitones in the compass of an octave, so that they shall be harmonious to each other, or as near as (the scismes considered) may be contrived. When this is done all the rest of the instrument higher or lower are tuned by octaves, and if there be divers stopps, or orders, then by unisons or octaves as designed. The octave to be tuned is commonly taken at the middle of the key's, and most begin upon C, but following the example of some organ builders, I have chosen F. for an entrance. The first thing is to tune that F. to its consort pitch, which is done by the help of a pipe, usually made for that end. I know there are divers methods of proceeding in this work, according as persons have bin taught or of themselves found out or most used, and which is the best is hard to say, but am sure every one tunes better his owne accustomed way, then after any other shewed him.

My designe is to show one which shall be more plain and precise and least perplexing to a scoller, which is express in the following lines afterwards to be explained, and I must be excused for borrowing thus much of the musicall orthography, which is of another and little belongs to this tract.

---

Roger North, 32535, op. cit., fol. 55r.
having no better means to be expressive of my intent. The order of tuning proposed is this, explained as the numbers refer.

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</table>

**Fig. 20.--Roger North's tuning procedure**

1. Is the key note F. with C. a fifth tuned upon it, but bearing, that is a little flatter then should be. And therein is a nice care, for it must not wholly corrupt the fifth, which bearing too much would doe, therefore the use is to tune the fifth perfect, and just take it off that perfection, leaving it so as the defect may not readily be perceived. Some observe the beats or wallows of the sound, and leav them to goe on in time as slow quavers.

2. This done, tune A. the sharp 3d upon F. with all the perfection that may be, onely of the two let it be rather too sharp then too flatt.

3. For convenience in proceeding it is not amiss to tune the octaves of F. and A. as the obscure notes shew, which are so made to discover the bye notes to be touched for proofs, or expedience, from the principall notes in the order of tuning.

4. These make the full accord to F. as the sounding them together shews, and therby may be observed if the elegance in any respect is wanting.

5. Then proceed in like manner to the tuning the accord upon C. and first the #3d E.

6. And upon that C. the fifth G. which must be done rather more than less bearing then the former, but still not spoiling

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88 North, 32535, op. cit., fol. 54v-56v.

89 Ibid.
altogether the accord; and then for convenience tune the octave of G. descending. Here the full accord of C. may be proved.

7. And if the sound of C. upon A. is a tolerable bearing fifth, the work is legitimate so far. If not the whole must be proved over again till it comes to be so, for this is one of the proofs.

8. The next process is to raise the full accord from (the lower) G. by tuning first, the 3rd B.

9. And then the 5th D. which must bear as much as may be, with salvo to a tolerable effect.

10. And the full accord may be proved which will help the judgment.

11. This note D. last tuned, is an exquisite proof of the cycle so far, and indeed of the whole work, for if it be touched with A. under it, and the joynt sound prove an exact fourth or onely a small matter too flatt, the work is just. But if by some failure it is found over flatt on the part of A (most frequently happening) as if that wanted to be turned up; it is not to be done without first perusing the whole from the beginning, and not surceasing till that fourth comes near the truth, but it may be allowed to sink a little, for A. above is a bearing fifth upon D.

Thus wee get the better of all the notes of the natural scale upon F. which are all those which are the long keys of the clavicall instruments. The next work is to deal with the flatts and sharps, which are the short keys, and that which often proves the most difficult part in this method will be found the easiest; for they are all tuned by sharp thirds and proved upon the 4th below and the accord of 4th and 5th hath a singular harmony that the ear immediately takes and judgeth is, as here.

13. A. tunes C. being its 3rd. the truth of which will be judged by a touch of E. la mi below (And that being tuned from E. above) becaus of the singular vertue of that accord of the 6th and fourth.

14. D. tunes F. in the same manner.

15. And the same D. tunes B, but with a 3rd descending.

16. And that will be proved by either F. the 4th below, or F. the 5th above, which is sayd to be the onely true fifth in the whole semitonian scale.

17. In like manner G. tunes E with a 3rd descending and is proved upon B the fourth below.

18. But E. tunes C. by a superior 3rd. and is proved upon B the 4th below.

Roger North wrote about the practical matters of solfeggio and tuning, but he had little interest in proportional systems.

His attitude is expressed in the following quotation.

90 Ibid.
An octave is by half the string, and the minute strokes are as
2. to one, yet it is not half the tone; nor doth quantity be-
long to such ideas of sense, as colours may be mixed of quan-
titative ingredients, but the comon idea is not quantum; as if
one should say, this is half, that three quarters green; or the
half, or whole of any sound; such things are not terminated, so
as to be capable of proportion, which requires stated terms of
distinction. Therefore I lay aside all manner of calculates of
tones and parts of tones and return to the causes of them, which
have a phisicall relation to quantity.

John Fond

The New System by Fond (1725) was a proposal to adopt a twelve-
note equal tempered system with a notation system which would provide
equal freedom for melodic and harmonic structures related to any of the
twelve notes. Fond suggested that the twelve pitches simply be called
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and that octave placement be
indicated without the complexities of clefs. He proposed that the
second line always indicate the note G, with the terms "treble,"
"tenor," and "bass" indicating the octave.

John Christopher Pepusch

The writings of Pepusch on scale and mode are found in three
sources. Earliest was his Treatise of Harmony. Another source is
an article in the Philosophical Transactions of 1746. In addition,

91 Ibid., fol. 124v.
92 Fond, op. cit., p. 30.
93 Ibid., p. 155.
94 Johann Christopher Pepusch, A Treatise on Harmony: Contain-
ing the Chief Rules for Composing in Two, Three and Four Parts (London:
W. Pearson, 1731). An edition of this work published a year earlier
under the title A Short Treatise on Harmony (London: J. Walls, 1730),
has been credited to James Hamilton Lord Paisley but is probably by
Pepusch.
95 Pepusch, 1746, op. cit.
manuscript notes by Pepusch on the subject of scale and mode are available.⁹⁶

The starting point for Pepusch's discussion of scale is the hexachord system. He is critical of those who do not teach the importance of the hexachords.

. . . We are sensible that the subject we are treating on is by many looked on as absolutely unnecessary. A very ingenious author, that published in 1721, A Treatise of Musick [Alexander Malcolm] concurs with others in running down the hexachords, which, 'tis plain, he did not perfectly understand the use of: that he was not well acquainted with the manner of using them, is evident by the way he explains the scheme he gives of them in Chap. 14, 556.⁹⁷

The system he describes uses the modal system available through the hexachords, but allows this complete system to be transposed to any degree of the "natural scale." This allows the construction of hexachords from the first, fourth, and fifth degrees of the keys of C, D, E, F, G, and A is allowed.⁹⁸

There are other striking features in Pepusch's discussion of scales, and he raises a number of questions which cannot be answered from the information available. For example, the manuscripts use the terms "gravitas" and "acumen." Comparison with the article in the Philosophical Transactions shows that by these terms Pepusch is indicating descending and ascending forms of the Greek scales. He states that "it was usual among the Greeks to consider a descending, as well as an ascending scale, the former proceeding from acute to grave,

⁹⁶Johann Christopher Pepusch, "Papers relating to the theory of music, with diagrams, in the hand of J. C. P." unpublished manuscript, British Museum Additional 29429.

⁹⁷Ibid., p. 69.

⁹⁸Ibid., pp. 69-99 passim.
precisely by the same intervals as the latter did from grave to acute." Figure 21 illustrates an octave of the "ascending and descending scales of the diatonic genus of the ancients, with the names of their several sounds, as also the corresponding modern letter."

<table>
<thead>
<tr>
<th>Ascending</th>
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<tbody>
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<tr>
<td>B</td>
<td>hypate hypaton</td>
</tr>
<tr>
<td>C</td>
<td>256/243</td>
</tr>
<tr>
<td>D</td>
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<tr>
<td>G</td>
<td>lychanos meson</td>
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<tr>
<td>a</td>
<td>mese</td>
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</table>

Fig. 21.—The diatonic genus according to Pepusch

Plate XII shows the "concinous scale" in ascending and descending forms.

According to Pepusch, the "concinous scale" was the "diatonicum intensum" of the Greeks. In passing, it can be noted that the ascending form of this scale would result in the proportions of syntonic tuning, and the descending form would result in the proportions of Didymus' diatonic. In addition to the scale from proportions, Pepusch mentions multiple-division systems. He states that Aristoxenus and others "often mention the tone is divided into 4 parts, and the semitone into 2; thus making 10 divisions or dieses in the 4th." By

99 Pepusch, 1746, op. cit., p. 269.
100 Ibid., p. 270.
101 Pepusch, 1746, op. cit., p. 271.
### Plate XII

**The Concious Scale According to Pepusch**

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<td>Lichason meson</td>
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<tr>
<td>9/8</td>
<td>Proslambanomenos</td>
<td>g</td>
<td>8/9</td>
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**Acumen**

---

increasing the "least division and diminishing the true harmonic diesis," the fourth can be divided into 13 parts, which carried through the octave leads to 31 divisions, giving "the celebrated temperature of Huygens, the most perfect of all."  

Robert Smith

Smith (1749) studied tuning problems, using just intonation as a norm.

If a musical string C0 and its part D0, E0, F0, G0, A0, B0, C, be in proportion one to another as the numbers 1, 8/9, 4/5, 3/4, 2/3, 8/15, 1/2, their vibrations will exhibit the system of 8 sounds which musicians denote by the letters C, D, E, F, G, A, B, C.  

He uses the term "perfect ratio" to apply to the intervals of just intonation, and "imperfect" or "tempered" to apply to any ratio increased or decreased from just. 

Smith presented his theories of tuning in a series of Propositions which are reviewed hereinafter. Proposition I is as follows.

A system of sounds whose elements or smallest intervals are tones major and minor and hemitones, will necessarily contain some imperfect concords.

In his explanation, Smith points out that the ratios between upper pitches of a scale in just intonation do not all have the perfection of intervals possible between upper notes and the first degree of the scale. The scale in just intonation requires three major whole tones, two minor whole tones, and two semitones. Smith arranges these in

103 [Ibid.]
104 Smith, op. cit., p. 9.
105 [Ibid.], p. 11.
106 [Ibid.], p. 25.
various orders, concluding that the orders $T, t, s, T, t, T$ \text{[syntonic]} or $t, T, s, T, t, T$ \text{[Didymus' diatonic]} are the best, because they provide the largest number of just thirds and fifths.\(^{107}\)

In Proposition II, Smith alters the "diatonic system of perfect consonances," to a system of meantone, or $\frac{3}{2}$ comma temperament. He accomplishes this by bisecting the just major third, $C$ to $E$ to form two meantones. Three such meantones fill in the tritone $F$ to $B$.

\dots \text{When the elements are ranged in this order $T, t, H, T, t, T, H$, or this, $t, T, H, t, T, H$, which two were shewed to be the best, and the arches $CD$, $DE$, $EF$, $FG$, $GA$, $AB$, $BC$, are proportional to them, let the major IIIrd $CE$, situated between the two hemitones, be bisected in $d$; and let the other two major tones, $FG$, $AB$, be diminished at both ends by the intervals $Ff$, $Gg$, $Aa$, $Bb$, severally equal to half $Dd$; and the octave will then be divided into five mean tones and two limmas, each limma being bigger than the hemitone by a quarter of a comma.}\(^{108}\)

In Proposition III, he suggests a system for achieving new temperaments by altering the relative sizes of the meantones and limmas.

If the five mean tones and two limmas, that compose a perfect octave, be changed into five other equal tones and two equal limmas, of any indeterminate magnitudes; the synchronous variations of the limma $L$, the mean tone $M$, and of every interval composed of any numbers of them, are all exhibited in the following table, by the numbers and signs of any small indeterminate interval $v$: and are the same quantities as the variations of the temperaments of the respective perfect intervals.\(^{109}\)

In the system, equal proportions are added to the two limmas, that

\(^{107}\) Ib. p. 30. In connection with the discussion, Smith mentions Mr. DeMoivre's 210 permutations. Apparently Smith was not aware that Brouncker had made this same exploration of means (supra, p. 128).

\(^{108}\) Ib., pp. 35-36.

\(^{109}\) Ib., p. 28.
same total amount in turn subtracted from the five meantones. Figure 22 is explanatory.

<table>
<thead>
<tr>
<th></th>
<th>2d</th>
<th>3d</th>
<th>4th</th>
<th>5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>M</td>
<td>L+M</td>
<td>2M</td>
<td>L+2M</td>
</tr>
<tr>
<td>5v</td>
<td>-2v</td>
<td>3v</td>
<td>-4v</td>
<td>v</td>
</tr>
<tr>
<td>L+5M</td>
<td>2L+4M</td>
<td>L+4M</td>
<td>2L+3M</td>
<td>L+3M</td>
</tr>
</tbody>
</table>

Fig. 22.—Smith's system for altering meantone temperament

For since the VIIth = 2L + 5M is supposed invariable, if the variation of L be put equal to 5v, as in the table, that of 2L is 10v, and that of 5M, as being the complement of 2L to the VIIth, is -10v; whence the variation of M is -2v.

The system rests on the arbitrary assumption that it is appropriate in scale design to balance changes of size in the limmas with opposite changes in size in the meantones.

By Smith's Propositions IV, V, and VI temperaments are found by geometrical methods. Each of these Propositions offers a design for temperament based on specific relationships of the third, fifth, and sixth.

Proposition IV: fifth and sixth in the "given ratio of r to s, and the sum of all three shall be the least possible."

Proposition V: fifth and third "shall have the given ratio

---

110 Ibid., p. 39
111 Ibid., p. 38
112 Ibid., p. 46.
of $r$ to $t$, and the sum of all three shall be the least possible."

Proposition VI: sixth and third "shall have the given ratio
of $s$ to $t$, and the sum of all three shall be the least possible."114

Plate XIII, page 168, is a diagram of the geometrical construc-
tion required to satisfy the conditions of Proposition IV. The follow-
ing explanation applies.

... from $A$ towards $K$ take $AM:AG::s:r$, and through the
intersection $p$ of the lines $AG$, $M_1$, draw the temperer $O_{1s}$; I
say $Gr$, $As$, $Et$ are the temperaments required.
For by the similar triangles $Grp$, $Asp$, and $G_1p$, $A_1p$, we
have $Gr:As::(G_1p:A_1p::G_1:AM::) r:s$ by construction, as re-
quired by the first condition.
Again, in the same line $MAC$ take $AN = AM$, and through the
intersection $p$ of the lines $AG$, $M_1$ produced, draw another
temperer $O_{1s}ST$; and by the similar triangles $GRP$, $ASP$, and $G_1P$,
$A_1P$, we have $GR:AS::(G_1p:A_1p::G_1:AN::) r:s$ by construc-
tion, which likewise answers the first condition; and it is
easy to understand, that no other temperers but these two can
answer that condition.115

After Propositions regarding the periods, beats, and harmony
of imperfect consonances, Smith returns to the subject of scale. In
Proposition XVII he suggests a system dividing the octave into 50
equal parts, which are made by use of logarithms, with the limma
equaling five and the tone eight of these divisions.

A system of commensurable intervals deduced from dividing
the octave into 50 equal parts, and taking the limma $L = 5$ of
them, the tone $T = 8$ and consequently the lesser $3d L + T = 13$,
the greater $IIIId 2T = 16$, the $4th L + 2T = 21$, the $Vth L + 3T = 29$,
etc., according to the table of elements, will differ insensibly
from the system of equal harmony: I mean with regard to the
harmony of the respective consonances in both.116

113 Ibid., p. 48.
114 Ibid., p. 53.
115 Ibid., p. 46.
116 Ibid., p. 156.
PLATE XIII

EXAMPLE OF SMITH'S GEOMETRICAL SYSTEM FOR TEMPERAMENT

\[\text{Ibid., Pl. VI.}\]
Scale developments in the Enlightenment in the British Isles

The statements regarding scale and mode by British theorists of the Enlightenment included discussions of tuning and temperament and use of syllables.

Regarding tuning practices, theories can be divided between two broad categories. The first category includes those theories that use only rational numbers or proportions to establish a scale; the second category includes those theories that use surd numbers. In other words, the first group includes those theories that attempt to maintain some form of just intonation or Pythagorean tuning and the second group includes those that advocate temperament.

Proportional systems.--In the category of theories using only rational numbers, Descartes (trans. 1653), Salmon (1688), and Holder (1694) advocated just intonation using the order of proportions of Didymus diatonic: 10:9, 9:8, and 16:15. Expanding on this system, Descartes, using the idea of a movable schism, suggested similar sets of proportions relative to C, F, and G. Wallis (1682 and 1698), Salmon (1705), Malcolm (1721), and Smith (1749) recommended syntonic diatonic tuning: 9:8, 10:9, and 16:15. Birchensha, on the other hand, (c. 1670-75) favored Pythagorean tuning, which system he expanded to achieve thirty-three divisions to the octave. Pepusch (1731 and 1746) presented Pythagorean tuning and both the syntonic and Didymic systems and attempted to apply these systems in all diatonic keys.

Inasmuch as the systems of just intonation were diatonic rather than chromatic, theorists found it necessary to select
additional proportions for the semitones. Salmon (1688) proposed that
the division should place the fret for the semitones halfway between
the frets for the adjacent diatonic pitches. Wallis, in comments on
Salmon's proposal, held that division by super-particular ratios pro-
vided the proper sound. Later Salmon (1705) used super-particular
ratios, placing the smaller semitone below the larger. Holder (1694)
used the proportion either of 16:15 or 25:24 for one semitone, with
the other semitone receiving whatever proportion was remainder.
Malcolm (1721) listed two systems. Dividing by super-particular
ratios, he placed the large interval low. Using another system,
Malcolm employed the ratio 16:15 for one of the semitones, the other
receiving whatever remained.

Systems of temperament.--Equal tempered tuning was mentioned
by Brouncker (1653), Bedford (c. 1705 or 1706), Warren (1725), Fond
(1725), and Smith (1749), but these systems of equal temperament were
not all identical. Brouncker (1653), using both the systems of math-
ematical proportions and of logarithms, demonstrated division of half
a string by twelve equal proportionals, division of the mean propor-
tional of a string by sixteen mean proportionals, and division of the
"harmonic" portion of a string by fifteen proportionals. Both Bedford
(c. 1705 or 1706) and Fond (1725) advocated equal temperament of the
octave by twelve proportionals, although Bedford suggested the possi-
bility of dividing other intervals by other numbers of proportionals.
Another system of division, identical to an earlier temperament by
Huygens (1691), was presented by Warren (1725). He suggested division
of the octave into thirty-one proportionals, twelve of which would be
used to approximate just intonation. Smith (1749) divided the octave
into fifty proportionals by use of logarithms and suggested a scale with the limma composed of five and the time composed of eight of these divisions.

Brouncker (1653), in his Animadversions, described a method by which any interval could be divided into any number of equal proportions. If the octave, the mean proportional of a string, and another interval--selected because of harmonic relationships--can provide a chromatic scale by division into $x$ number of proportionals, any interval might be so used. The use of logarithms made such divisions mathematically practical. Later authors used more divisions to the octave or computed proportionals within other intervals than the octave, but the procedures were similar. The one intellectual hurdle is assent to the use of irrational numbers in describing musical intervals. By men like Salmon, Holder, and Malcolm such assent is hardly given. Why use irrational numbers, wrote Holder (1694), "... when we can so easily discover and assign their true ratios?"\textsuperscript{118}

The various systems of equal temperament and the chromatic proportional systems were constructed to correct weaknesses in the respective systems. For example, selecting twelve chromatic tones from the thirty-one equal divisions of Warren or the fifty equal divisions of Smith made possible close approximation of just intonation. On the other hand, the movable schism of Descartes, Birchenha's Pythagorean system, the various methods of semitone division were constructed for use in modulation to other tonalities. In other words,

\textsuperscript{118}Holder, \textit{op. cit.}, p. 197.
multiple division systems may be viewed as compromises of the practical optimums of one system to achieve advantages of the other.

The writings leave no doubt that equal temperament of the octave was known and practiced, though lack of a real need for playing in keys with many sharps and flats probably encouraged tuners to skew the temperament in the direction of meantone, or one-fourth comma, tuning. As Holder (1694) suggested, if the bearings did not come out evenly, it was proper to leave the greater faults on the lesser used tones.\(^{119}\) However, there continued to exist the quest for precision and certainty—a quest helped by the availability of historical musical documents and by developing mathematical skills.

Use of syllables.—Turning to the use of syllables, the treatises of Butler (1634), Playford (1653), Simpson (1655), and Roger North (c. 1700-26) state that the English musicians of the late seventeenth and early eighteenth centuries used a four-syllable movable system. They assert that mi was considered the most important syllable in establishing tonal relationships. Although the four-syllable system was common, a variety of other systems were available. Those systems include Butler's seven-syllable movable system (ut, re, mi, fa, sol, la, pha), Pencourt's seven-syllable fixed system (do, re, mi, fa, sol, la, fa), and Roger North's various seven-syllable systems. All of the seven-syllable systems encountered in the British Enlightenment literature provide a syllable for the flat seventh degree, not a leading tone. It is probable that not do or ut, but rather fa was the syllable indicating the key center. In both four and seven syllable

\(^{119}\)Holder, 1694, op. cit., p. 183.
systems mi was located by the key signature, and was viewed as the central pitch in determining tonal relationships. To the list of syllable possibilities must be added Pond's suggestion for a fixed twelve-syllable system.

The statements by the English theorists of the Enlightenment describe an episode in the history of ideas about scale. They illustrate the writer's rational or empirical bent and show the compromises he is willing to make between theoretical ideals and practical possibilities. In addition, they illustrate an increasing awareness of the notion of tonality and they document the theorists' attempts to provide systems in which modulation to distant tonalities is practical.
CHAPTER IV

CONSONANCE AND DISSONANCE

Discussions about consonance and dissonance by the theorists during the Enlightenment era are tangent to discussions about reason and sense. The discussions are related to theories of sound and to writings on scale and mode, and they reveal transition in tonal norms during the period.

The purpose in this chapter is to examine the statements on consonance and dissonance, to list the theorists' ideas on the subject, and to describe the transition which takes place. An explanatory paragraph introduces the subject of consonance and dissonance as an issue in the search for truth. This is followed by a list of theories for consonance, after which the theoretical writings are discussed in chronological order. Finally, the ideas of the theorists are summarized and the directions of development are indicated.

The search for musical truth.—In the search for systematic truth explaining musical syntax, theorists faced the problem of explaining the meanings of vertical combinations of notes. Experience told them that simultaneously sounding combinations of tones resulted in emotion and meaning. If they could understand the nature of the combinations, they could create new musical meanings. In the search for such knowledge, they formulated theories. On the one hand, they looked to the ancients, to mathematics, or to nature for ultimate truth.
On the other hand, there were theorists who wrote only about the meanings humans in their time and place attached to sounds.

Theories of consonance and dissonance. —The theorists attempted to explain meanings of tonal combinations with the following theories for consonance and dissonance.

1. Consonance is explained by the proportions observable in the senary division of the string. This theory was stated by Zarlino (1562).

2. Consonance results from the coincidence of pulses. Antecedents for this theory were the researches of Benedetti (1585)\(^1\) and the pendulum experiments of Galileo Galilei (1638).

3. The simpler consonances are generated in time sooner than the imperfect consonances and dissonances. This theory was stated by Mersenne (1636-37) and Kircher (1650).

4. The universal rule for consonance and dissonance is found in the number of vibrations of two tones produced in equal units of time. This theory was mentioned by Malcolm (1721).

5. Added to these earlier theories were new theories developed from observation of natural phenomena, including sympathetic vibration of strings in octaves, fifths and thirds; co-vibration in partials; and difference tones.

The Theorists on Consonance and Dissonance

Writers of English treatises during the Enlightenment suggested hierarchies of intervals and offered explanations for consonance and

dissonance in the language and with the insights of their time. Their ideas are summarized in the discussions that follow.

In early seventeenth century English theoretical treatises by Coperario (c. 1610), Campion (c. 1612), Bevin (1631), and Butler (1636), intervals are categorized as consonant and dissonant. In these treatises, there is no explanation why certain intervals are discordant. Rather, concords and discords are referred to categorically as unchanging musical entities.

Elway Bevin

The categorical approach is exemplified in the treatise of Bevin (1631). He lists nine concords: the unison, third, fifth, sixth, octave, tenth, twelfth, thirteenth and fifteenth. Of these, he terms the unison, fifth, eighth, twelfth and fifteenth perfect concords and the third, sixth, tenth, and thirteenth "unperfect."²

These nine concords are comprehended in four, viz.

Unison
Eight
Fifteenth
are counted as one, for every eight is the same
Third
Tenth
likewise
Fift
Twelfth
likewise
Sixt
Thirteenth
likewise

So that in effect there are but four concords.³

According to Bevin, "The discords are a second, fourth, and seventh, with their eights, which being sometime mixt with concords,

²Bevin, op. cit., p. 1.
³Ibid.
make best musicke, being orderly taken."\(^4\) He lists the compound intervals as separate consonances, then reduces them to the simple intervals. He does not distinguish between major and minor intervals and fails to mention the tritone or any chromatically altered intervals.

Charles Butler

In his list of consonants, Butler (1636) distinguished between the consonant sound of major and minor intervals.

Of the 12 intervals 7 are consonant, and 5 dissonant: those are called, in one word, concords; and these discords.

A concord is the mixture of a grave and acute sound sweetely falling to the ear.

A discord is a jarring noise of permixed sounds offending the ear.

The seven concords are first an eigt, (which Glareanus, for perfection . . . called consonantum regina) a perfect and imperfect sext, with their compounds. Unto these interval concords is added the unison: . . . "\(^5\)

The unison, octave, "perfect third" and fifth Butler calls primary concords, the "imperfect third," fourth, and both sixths he calls "secondary concords,"

. . . Which because they sound not so sweetely as the primary do not satisfy the ear without a sweeter following; therefore none of them is admitted into the close; and a sixth or fourth scarce allowed in the beginning.\(^6\)

Butler lists the discords as the "perfect and imperfect second," "the perfect and imperfect seventh," "and the tritonium or semidiapente." He figures intervals from the bass and also between the upper parts, "as all parts must agree with the base, so must they not disagree among them selves . . . " Discords are allowed "as making the concord

\(^4\)Ibid.

\(^5\)Butler, op. cit., p. 48.

\(^6\)Ibid., p. 49.
Butler's list of the concords illustrates the fact that many theorists of the period exhibit minor peculiarities in their systems, though there is general agreement with other systems. In Butler's system, the distinctions are first, his use of the terms "perfect" and "imperfect" for what are more commonly called "major" and "minor" or "sharp" and "flat" intervals, and second, his use of "primary" and "secondary" to refer to concords, rather than "perfect" and "imperfect." Included in the "primary" concords is the "perfect third," which—with the unison, octave, and fifth—includes all the intervals between bass and upper parts of the major triad—the perfect accord.

Renatus Descartes

Descartes (1622, trans. 1653) followed Zarlino (1562) in deriving the consonances from the division of the vibrating chord into sixths—the senary division of the string. Descartes' table of consonances is listed in Figure 23.

| 1/2 Eighth | 2/3 Fifth |
| 1/3 Twelfth | 2/4 Eighth |
| 1/4 Fifteenth | 2/5 Tenth |
| 1/5 Seventeenth | 2/6 Twelfth |
| 1/6 Nineteenth | 3/6 Eighth |
| 3/4 Fourth | 3/5 Sixth |
| 4/5 Ditone | 4/6 Fifth |
| Major | 5/6 Third |
| Major | Minor |

Fig. 23.—Table of consonances from Descartes' Compendium

However, as the publisher points out, the unison is missing from this list.

---

7 Ibid., pp. 51-52.
8 Brouncker, op. cit., p. 10.
In his enumeration of the consonances, contrary to the sense of all other writers from John De Muris to Mersennus, he excludes the unison; and for this very good reason, that 'therein is no difference of sounds as to acute and grave; it bearing the same relation to consonances, as unity doth to numbers.'

Descartes is here following the Pythagoreans who said that "one" is not a number but the basis of numbers. The minor sixth is omitted in Descartes' first table of consonances, although he adds it to a later table. At this point in his treatise Descartes is consistent in following senary division.

... I can subdivide the line AB into 4, 5, or 6 parts, but no further; because such is the imbecility of the ears, as that they cannot distinguish, without so much labour as must drown the pleasure, any more differences of sounds.

In a later table, illustrated in Figure 24, Descartes includes the minor sixth.

<table>
<thead>
<tr>
<th>Eighths</th>
<th>1/2</th>
<th>1/4</th>
<th>1/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifths</td>
<td>2/3</td>
<td>1/3</td>
<td>1/6</td>
</tr>
<tr>
<td>Ditones</td>
<td>4/5</td>
<td>2/5</td>
<td>1/5</td>
</tr>
<tr>
<td>Fourths</td>
<td>3/4</td>
<td>3/8</td>
<td>3/16</td>
</tr>
<tr>
<td>Sixths Majors</td>
<td>3/5</td>
<td>3/10</td>
<td>3/20</td>
</tr>
<tr>
<td>Thirds Minors</td>
<td>5/6</td>
<td>5/12</td>
<td>5/24</td>
</tr>
<tr>
<td>Sixths Minors</td>
<td>5/8</td>
<td>5/16</td>
<td>5/32</td>
</tr>
</tbody>
</table>

Fig. 24.—Second table of consonances from Descartes' Compendium

Brouncker noted the inconsistency.

Yett, in his second figure p. 13, the author sets downe some consonances with greater differences; and page 14 he dichotomiseth A-B into eight parts for the consonances as into 16 for both tones.

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9Ibid., fr. the publisher's intro.

10Ibid., p. 9.

11Ibid., p. 13.

12Ibid., p. 68.
The second table shows that Descartes allowed compounds of one or two octaves but not three "because there are extreme limits."\textsuperscript{13}

Descartes later explains the minor sixth.

A sixth minor proceeds from a third minor, in the same manner as a sixth major doth from a ditone, and borrows the nature and affections of a third minor, nor is there any reason to countermand it.\textsuperscript{14}

The explanation rests not on proportions from the scenario but on the idea that there is some quality about the minor sixth which is similar to the quality of the minor third.

In addition to the scenario, Descartes states justifications based on observation of sympathetic vibration of fifths and ditones.

Nor let any think it imaginary, what we say, that only a fifth and ditone are generated from the division of an eighth properly, and all other consonances by accident; for experience teacheth the same in the strings of a lute or other instrument, whereof if one be stroke, the force of that sound will strike all the other strings which shall be more acute in any kind of fifth or ditone; but in the others which are distant a fourth or other consonance the same shall not happen.\textsuperscript{15}

and again

Secondly, that of two terms, required in consonances, that which is the more grave, is far the more potent, and doth in a manner contain the other term in its selfe: as is manifest in the nerves of a lute, of which when any one is percussed, those strings, which are an eighth or fifth more acute, tremble and resound of their own accord; but those which are more grave do not, at least do not appear to the sense to do so; the reason whereof is thus demonstrated. . . . but in every string that is greater, all other strings, that are lesse, are comprehended; . . . \textsuperscript{16}

\textsuperscript{13} Ibid., p. 12.

\textsuperscript{14} Ibid., p. 24.

\textsuperscript{15} Ibid., p. 15.

\textsuperscript{16} Ibid., p. 8.
Descartes departs from senary justification even further in other statements. That the fifth "of all consonances, is the most grateful and acceptable to the ear," 17 might be predicted from either senary theory or from sympathetic vibration. But a fourth "of all consonances is the most unhappy; nor is it ever used in tunes, unless by accident, and with the assistance of others. . . "18 The reason advanced by Descartes is ad hoc.

. . . [the fourth] approacheth the nature of a fifth, so nearly, that the grace of this is drowned in the sweetnesse of that. To the understanding of which, we are to note, that a fifth is never heard in musick, but that in some sort, an acuter fourth is with-all advertised. 19

Descartes lists three kinds of dissonance:

Of these there are three kinds: (1) some are generated by degrees only, and an eighth: (2) others from the difference which is betwixt a tone major and minor, which we have denominated a schism: and (3) others from the difference, which is between a tone major, and a semitone major. 20

The first kind of dissonance includes major and minor seconds, sevenths and ninths. The second kind includes minor thirds deficient a schism, 27/32; fifths deficient a schism, 27/40; fourths increased a schism, 20/27; and major sixths increased a schism, 16/27. Dissonances of the second kind may sometimes be acceptable as consonances.

. . . because the interval of a schisme is so small, as it can hardly bee discerned by the ears, therefore doe they borrow sweetnesse of those consonances to which they are nearest. Nor doe the terms of consonances so consist in indivisibili, as that if one of them be a little changed, all the sweetnesse

17 Ibid., p. 19.
18 Ibid., p. 20.
19 Ibid.
20 Ibid., pp. 43444.
of the consonance must instantly be lost: and this can only be the reason, why dissonances of this second genus may be, in a voice successive of the same part, admitted in place of consonances, from which they are divided.21

Dissonances of the third kind include the tritone, $32/45$, and the false fifth, $45/64$. According to Descartes, these are unacceptable as consonances because "they have no consonances near enough to loan sweetness."22

Birchensha's Translation of Alsted's "Musica"

In the translation by Birchensha (1664) of the article on music by Alsted,23 the consonances and dissonances are listed as follows. "There are twelve concordancies, the 1. 3. 5. 6. 8. 10. 12. 13. 15. 17. 19. 20."24 These are divided into "simple," "repli­cated," and "triplicated," depending on octave placement. The "perfect concordances" are those which may "stand alone:" the unison, fifth and octave. The "imperfect consonances" are those which may "concur in counterpoint," and are the third, sixth, and tenth.25

"The discordances are nine, viz. the 2. 4. 7. 9. 11. 14. 16. 18. 21." But "others also do number the perfect consonances thus, the 1. 3. 5. 8. because they respond to the Pythagorean quaternary."26

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21Ibid., p. 46.
22Ibid.
24Birchensha, op. cit., p. 51.
25Ibid.
26Ibid., p. 52.
However, they should "... play the philosophers of concordances more accurately." The true consonances are, in order of perfection, the unison, octave, fifth, ditone, minor third, major sixth, and minor sixth. 27

The unison is really neither consonant or dissonant "for the unison doth equisonate only, because it hath the proportion of equality, and is the principal of every interval." The fourth appears in the list of consonances but is omitted from Alsted's chart of the "seven simple consonances." Later he asserts that the fourth is a consonance obtained between the fifth and the octave; therefore, the fifth is the "radix" of the fourth, and similarly both thirds are the radixes of both sixths, and seconds of sevenths.

Here between the consonances of the octave and four, the radix is the fifth: of both sixes, both thirds. Therefore the octaves and fourth may be reduced to the fifth; and the sixth to the third. The root of simple dissonant dyads is the second, to which both sevenths may be reduced. 28

Alsted applies the terms consonant and dissonant to triads as well as diads.

The musical trias [sic] is that which doth arise from three sounds and as many dyads: otherwise called the unitrisonous radix.

And it is either consonant or dissonant.

The consonant trias is that in which a third and a fifth doth concur, yet so as that it ariseth from two thirds.

The dissonant trias is that which ariseth from seconds. 29

Alsted obtains the "unitrisonous radix" (major or minor triad) from the ratios 4:5:6 in arithmetic and harmonic proportion. 30

27 Ibid.
28 Ibid., p. 55.
29 Ibid., pp. 55-56.
30 Ibid., p. 57.
The Compendium of Simpson (1665) added little that was new to the understanding of consonance and dissonance. His chart of concords and discords is identical to the list of Alsted (trans. 1664), except for the addition of the twenty-second.

<table>
<thead>
<tr>
<th></th>
<th>Perfect</th>
<th>Imperfect</th>
<th>Discords</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-</td>
<td>6-0</td>
<td>7-0</td>
<td>1-1</td>
</tr>
<tr>
<td>6-0</td>
<td>3-0</td>
<td>2-0</td>
<td>1-7</td>
</tr>
<tr>
<td>5-0</td>
<td>3-0</td>
<td>2-0</td>
<td>4-7</td>
</tr>
<tr>
<td>4-0</td>
<td>2-0</td>
<td>4-0</td>
<td>1-7</td>
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</tbody>
</table>

Fig. 25.--Simpson's chart of concords and discords\(^{31}\)

Simpson suggests two uses for dissonance.

Discords are two ways.

First in diminution; that is, when two, three, or more notes of one part, are set against one note of a different part.

The other way in which discords are not only allowed or admitted; but of most excellent use and ornament in composition; is in syncopation or binding: \(\ldots\) \(^{32}\)

Francis North

Francis North (1677) presented a theory of consonance which was new to the English scene,\(^{33}\) although it was similar to that of Benedetti almost a hundred years earlier. With this theory, North

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\(^{32}\)Ibid., pp. 79, 81.

\(^{33}\)Francis North, *op. cit.*
presented ideas on the perception of sound as consonance and dissonance which were taken up and discussed by later English theorists.

His theory was the theory of consonance by coincidence of pulses—the theory that holds that two tones are more or less consonant as their sound pulses in the medium are more or less synchronous. North ignores number proportion and explains consonance and dissonance only in terms of human perception of pulses in the air.

When the pulses of tones are coincident one with the other, there is an union of the sounds. For when any sound is made, solid bodies within the sphere of it are moved, and if the body moved stands upon a spring (as all instruments producing tones do) it will vibrate by intervals according to the measure of the spring until the force be spent.34

When sounds are in discord, the concussions, caused by them are in opposition one to another; and the organ of sense cannot be affected by both together, but they will appear ragged and jarring and extreme noisome.35

North describes how the consonances are formed according to this theory.

Where the terms are equal, and the coincidence is at every pulse, it may be said the same sound though proceeding from several instruments: for the mixed sound has no alteration, but by being more loud and full by the addition.

Where the terms are 2 to 1, or 4 to 1, or 8 to 1, or 16 to 1, there will be coincidence to every pulse of the base, and between those terms the treble is heard alone without any mixture: so that the sound is not changed or augmented by the addition of stronger pulses at proportionable intervals, which makes the pulses superinduced appear of the same nature, though more grave or acute; this is the case of octaves.

Where the terms are as 2 to 3, every third pulse of the treble, and every other pulse of the base are coincident, but the intermediate pulses, as 2 of the treble and 1 of the base are not so, but keep certain distances, which makes the mixture produce an alteration: but the coincidences being so

34 Francis North, op. cit., p. 7.
frequent, and the distances of the intermediate pulses proportional, the mixture is very pleasing, and is the principal chord called the fifth.

Where the terms of coincidence are further off, as when they are but the fourth, fifth or sixth pulses of the treble that are coincident with the third, fourth and fifth pulses of the base, yet the mixture is pleasing, and produces chords; which chords are more or less perfect, according as they are more or less coincident.

Coincidence upon every fourth pulse of the treble is the fourth.
Every fifth pulse is the third sharp.
Every sixth pulse is the third flat.
When the fifth pulse of the treble goes with the third of the base, it is a sixth sharp: the eighth pulse of the treble going with the fifth of the base makes a sixth flat. 36

There are problems with this theory of consonance and some perceptions which it does not explain. The theory assumes that the pulse will coincide precisely at regular intervals, in other words, that the strings begin vibrating at the same instant. It assumes that the listener is affected equally and in consistent phase by the two sound sources. The problem of phase relationships is later raised by Newton (infra, pp. 206-207). If coincidence of pulses brings pleasure, why does not disagreement of pulses cancel this pleasure? Francis North’s explanation is that the various disagreements balance each other.

It may seem strange that a coincidence in this manner should unite sounds, and that the fifth and fourth pulses that are disagreeing should not hinder more, than the sixth coincident between the eighth pulse of the treble with the fifth of the base should make the sounds agreeable, notwithstanding the variance of those which are intermediate.

But this will be very clear, when it is observed that the intermediate pulses do not at all hinder, for they are all placed in such manner, in relation to one another, that where any of them distract the pulses of the concording string on the one hand, there are others that by being just as much on the other hand, set them right again. 37

36 Ibid., p. 8.
37 Ibid., p. 9.
But the answer is inadequate. A similar balancing would take place in all intervals and leave them with similar indexes of consonance, for the average amplitude of any balanced vibrating system is zero.

North provides additional explanations for the effects of the fifth and major third and to explain the quality of the fourth.

A fifth is the principal chord (for the octave cannot properly be called a chord) in which there is an acquiescence; there being no other sound to which it can change to a more grateful one, and therefore is allowed in the close to fill the sound.

A fourth by its coincidence of pulses should stand in the second place, but it is not allowed in music, according to the sweetness of its sound, because its octave below the base mends the harmony so much that it cannot be kept out of mind, but will be desired and expected: and therefore a fourth is a binding note that strongly induces a close in the fifth below. So that a fourth is not for its sweetness allowed to be a chord by most musicians, because it is not stable but subservient to a change, which change is induced, because only a sixth can be joined with it, which will be a third to the fifth below, and so increases the expectation of a change.

A third sharp is a chord so grateful that it is allowed in the close to fill the sound; it being in chord to the fifth bears it company, and its octave to reverse would change the music into a sixth flat, which is the least pleasing of all chords, and therefore is not at all regarded; but the mind acquiesces in the third sharp.

A third flat, nor the sixth flat nor sharp, claim not any place in the close, because they are in discord to the third sharp and fifth, so that they cannot be allowed, and the other are preferred. But they are in the body of a tune very grateful chords that never offend the ear, nor do they invite any change by their octaves below the base, but afford a stable and pleasant harmony.\(^{38}\)

So in spite of the theory of consonance by coincidence of pulses, North suggests that the only intervals which will allow the mind to "acquiesce" are the major third and perfect fifth. The

\(^{38}\textit{Ibid.}, pp. 29-30.\)
discussion regarding the theory of coincidence of pulses is carried on a few years later by Roger North (c. 1700-26, *infra*, pp. 193-209).

**John Blow**

Blow (c. 1680), in his autograph thorough bass treatise made the following statements about concord and discord.

Music consists in concords and discords.
That concords that are is a 3d, 5, 6, and 8.
Perfect cords is the 5th and 8th.
Imperfect is a 3d and 6th.
Discords are the 2d, 4th, 7th, and 9th.
The 9th is the same as the 2d, only it is otherways accompanied.
Discords must be prepared by concords and resolv'd into concords.39

**Godfrey Keller**

In a later thorough bass treatise, Keller (1707) presented a similar list to Blow's, but added the diminished fifth as a possible consonance.

Musick consists in concords and discords. Of concords there are four and those of two sorts, viz. perfect and imperfect. Perfect are the 5th and 8th. Imperfect are the 3d and 6th. Of discords there are three sorts, viz. the 2d, 4th, and 7th. The 9th is the same with the 2d but otherwise accompany'd. The flat imperfect 5th may be used like either concord or discord, but most commonly like the latter.40

**William Holder**

The thorough bass treatises are instruction in the art of keyboard; they do not include philosophical discussions. However, Holder (1694) did state reasons for consonance and dissonance.

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Holder's treatise can be described as eclectic relative to consonance and dissonance; that is, he presents ideas from other sources. For example, he begins his discussion about consonance and dissonance by mentioning the experience of sympathetic vibration which he traces from Aristides Quintilianus. Holder explains sympathetic vibration by analogy with the pendulum, following the lead of Galileo Galilei.

Galileo, from this doctrine of pendulums easily and naturally explains the so much admired sympathy of consonant strings; one (though untouch'd) moving when the other is struck.\(^{41}\)

This experiment is ancient: I find it in Aristides Quintilianus a Greek author, who is supposed to have been contemporary with Plutarch. But the reason of it deduced from the pendulum, is new, and first discovered by Galileo.\(^{42}\)

Later, he points out that all concords are in ratios to the number six or less except the "lesser sixth, 8 to 5." This is consonant, according to Holder, because it "is the complement of 6 to 5 [major third] to an octave, and makes a better concord by its combination with the octave."\(^{43}\) Holder lists several different definitions of concord and discord.

Consonancy and dissonancy are the result of the agreement, mixture or uniting (or the contrary) of the undulated motions of the ayr or medium, caused by the vibrations by which the sounds of distinct tunes are made.\(^{44}\)

To close this chapter, I may conclude that consonancy is the passage of several tuneable sounds through the medium, frequently mixing and uniting in their undulated motions, caused by the well proportioned commensurate vibrations of the sonorous bodies.

\(^{41}\) Ibid., pp. 45-46.

\(^{42}\) Ibid., p. 48.

\(^{43}\) Ibid., p. 65.

\(^{44}\) Ibid., p. 40.
and consequently arriving smooth, and sweet, and pleasant to the ear. On the contrary, dissonancy is from disproportionate motions of sounds not mixing, but jarring and clashing as they pass, and arriving to the ear harsh, and grating, and offensive.\textsuperscript{45}

Concords are harmonic sounds, which being joined please and delight the ear; and discords the contrary. So that it is indeed the judgment of the ear that determines which are concords and which are discords. And to that we must first resort to find out their number. . . . But the ear being entertained with motions which fall under exact demonstrations of their measures, the doctrine hereof is capable of being more accurately discovered.\textsuperscript{46}

Apparently Holder is not certain whether consonance resides in the agreement of vibrations, in the delights of perfect proportions, or in the judgments of perception.

Alexander Malcolm

Malcolm (1721) investigated various theories of consonance and dissonance and found them all inadequate. At moments he directs attention to human perception.

When two sounds are heard in immediate succession, the mind not only perceives two simple ideas, but by a proper activity of its own, comparing these ideas, forms another of their difference of tune, from which arise to us various degrees of pleasure or offence; . . . there is a great difference betwixt knowing what it is that pleases us, and why we are pleased with such a thing: pleasure and pain are simple ideas we can never make plainer than experience makes them, for they are to be got no other way; . . .\textsuperscript{47}

However, he suggests that it is appropriate to inquire into the true reasons for different effects. He is enamored of the search but skeptical of success, "for to solve this would require to know things

\textsuperscript{45} Ibid., p. 49.
\textsuperscript{46} Ibid., p. 50.
\textsuperscript{47} Malcolm, op. cit., p. 66.
perfectly, . . . which belongs only to that Glorious Being on whom all others depend." Since "it will remain a question whether that connection flows from any necessity in the nature of things, or be altogether an arbitrary disposition;" we should accept the "secondary reasons."

It has been pointed out (supra, pp. 27-29) that these doctrines of simple and complex ideas and of primary and secondary causes are typical of the philosophy of John Locke.

Malcolm investigates justifications advanced by other authors. First he discusses justification from proportions.

By experience we know, that these ratios of the lengths of chords are all concord, tho' in various degrees, viz. 2:1, 3:2, 4:3, 5:4, 6:5, 5:3, 8:5, that is, taken any chord for a fundamental, which shall be represented by 1, and these sections of it are concord with the whole, viz. 1/2, 2/3, 3/4, 4/5, 5/6, 3/5, 5/8, for, as 2 to 1 so is 1 to 1/2, and so of the rest.

Is the universal rule in number? The natural series 1:2:3:4: 5:6 proves out, he says, but "there are other ratios that are agreeable besides what are found in that continued order, whereof I have mentioned two, viz. 3:5 and 5:8 . . . ." 50

Is the universal rule found in the number of vibrations of both chords accomplished in the same time? Totaling the two numbers of the proportion leads to this order:

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48 Ibid., p. 68.

49 Ibid., p. 70.

50 Ibid.
Unison 1:1
Octave 2:1
Fifth 3:2
Fourth 4:3
Sixth greater 5:3
Third greater 5:4
Third lesser 6:5
Sixth lesser 8:5

However, this is not the true rule.

But it is not so, for by this rule 4:7 or 5:7, both dis-
cords, are preferable to 5:8 a concord, tho indeed in a low
degree; and 1:3, an octave and fifth compounded, will be pre-
ferable to 1:4 a double octave, contrary to experience.52

Next he seeks the true rule in the number of coincidences
per unit time. The resulting order is as follows.

<table>
<thead>
<tr>
<th>Ratios</th>
<th>Coincidences</th>
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<tbody>
<tr>
<td>8ve</td>
<td>2:1</td>
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<tr>
<td>5th</td>
<td>3:2</td>
</tr>
<tr>
<td>4th</td>
<td>4:3</td>
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<tr>
<td>6th greater</td>
<td>5:3</td>
</tr>
<tr>
<td>3d greater</td>
<td>5:4</td>
</tr>
<tr>
<td>3d lesser</td>
<td>6:5</td>
</tr>
<tr>
<td>6th lesser</td>
<td>8:5</td>
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</table>

"And so the order here is the same as formerly determined;
but we are left to the same difficulties and uncertainty as
before; . . ." 53

Finally, he lists Mersenne's proposition which states that the
"more simple and agreeable consonancies are generated before the more
compound and harsh." 54

51 Ibid., p. 74.
52 Ibid., p. 76.
53 Ibid., p. 78.
54 Ibid., p. 80. Cf. Marin Mersenne, Traité de l'Harmonie
Example let 1, 2, 3, be the lengths of three chords, 1:2 is an octave, 2:3 a 5th, and it is plain 1:3 is an octave and fifth compounded or a twelfth. But the vibrations of chords are reciprocally as their lengths, therefore the chord 2 vibrates once while the chord 1 vibrates twice and then exists an octave; but the twelfth does not yet exist, because the chord 3 has not vibrated once, nor the chord 1 vibrated thrice (which is necessary to a 12th); again for generating a 5th the chord 2 must vibrate thrice and the chord 3 twice which cannot be unless the chord 1 in the same time vibrate 6 times, and then the 12th will be twice produced, and the octave thrice, as is manifest; for the chord 2 unites its vibrations sooner with the chord 1 than with the chord 3, and they are sooner consonant than the 1 or 2 with 3. Whence many of the mysteries of harmony, viz. concerning the preference of concords and their succession may be deduced, by the sagacious practiser. Thus far Mersennus; and Kircher repeats his very words.

But when we examine the proposition by other examples, it will not answer; and we are as far as ever from the universal character sought.55

After his detailed analysis, Malcolm suggests a definition for concord which combines the various hypotheses.

... concord is the result of a frequent union and coincidence of the vibrations of two sonorous bodies, and consequently of the undulating motions of the air, which being caused by these vibrations are like and proportional to them; which coincidence the more frequent it is with respect to the number of vibrations of both bodies performed in the same time, cæteris paribus, the more perfect is that concord, till the rarity of the coincidences in respect of one or both motions become discord.56

Roger North and Prencourt

The manuscripts on music by Roger North, written between the years 1710 and 1726, contain statements on consonance and dissonance. It is pointed out in Chapter II (supra, pp. 104-109) that in several of these manuscripts North discusses in detail the theory of consonance and dissonance based on coincidence of pulses. He favors the coincidence of pulses theory, but also he advances ideas on the role of

55Malcolm, op. cit., p. 80.
56Ibid., p. 84.
memory and perception. He questions that any unchanging norms for consonance or dissonance exist.

North's comments on manuscript instructions for thorough bass by Prencourt define his ideas about consonance and dissonance. Prencourt presents the traditional approach in which intervals are viewed as unchanging entities capable of simple definition. North's view, on the other hand, is complex: to him a musical sonority is a human experience with dynamics in a physical world of vibrating forces given a temporal dimension by memory. The quotations and comments which follow illustrate the two points of view.

P. These intervals are divided into concords or consonances and discords or dissonancies. The concords or accords, which is the same thing, are divided into perfect and imperfect. The perfect concords are the 5th and 8th. The imperfect concords are the 3d and 6th. The discords are the 2d and 7th.

N. NB. Here we are got into the hackney road of our descant writers, but in truth the partition here is absolutely false. For if there be perfect and imperfect, we must assign all the notes of a full accord, independent of any thing that goes before or is to follow, that is, the 3d, 5th and octave, and all the octaves of them to perfection, and those accords that are good be relation only, or quasi in symbusa, such as the 2d and 7th to the imperfect. For I deny utterly the 2d and 7th to be discords but ascribe them as high a relish of harmony as any other notes whatever, and that point blank, without the sincopes and preparations the masters make such a time with. Nor do I allow almost any intervall of the scale to be perfect discord, at least not such as when notes of one scale and another sound together, yet are untuned or have no relation to each other; thereby the perfection of discord, scarce knowne in the compass of any one scale. It's true, there are all degrees of better and worse in harmony, from the unison, 5, 3, 6, 2, 7, 4, 4 or 5°, 7§ and 2°: or in a commixture of these, till the sound comes to be harsh and bad but not like out-of-tune sounds. Therefore I must differ in this whole scheme, and for a more explicate declaration of my reasons, be referred to the
following essay on the subject of the key and its scale. But in the meantime, for the learners sake, I shall comply with the author in the method he has taken, for whether critically true or not according to nature, it is a specious analogy that serves for teaching such as know no better.\textsuperscript{57}

At this point Roger North has rejected completely the system in which an interval is considered an entity with a definite and unchangeable index of consonance or dissonance.

P. And the fourth is also taken for a discord since it is played with a 2d as you'll see hereafter. But it could be taken justly for an imperfect concord, since it is not only played with a 2d but with the 6th also. And this is the reason I would rather have it neuter.

N. NB. This is a musico-grammatical duelism of no signification at all. For the 4th is never an ill sound, and often an haut heast in the harmony, as either with the 2d or 6. It is the sound of the 5th and 8th when the base note is silenced. And that which was harmony in the full accord, cannot be discord in part of it: nor yet is it a complete accord because the want of the base note (which) is its full complement) renders it less satisfactory.\textsuperscript{58}

According to North, the fourth is the inversion of the fifth, and that fact, rather than its innate harmonic sonority, defines its harmonic role. The following dialogue regards the third. North emphasizes the importance of harmonic context.

P. This interval is one of those that does help to make the accord, and as it must be considered several ways, so take notice that we have 2 sorts of thirds, viz. the sharp and the flat third.

N. NB. The accord is a terme of art in musick, and means the full and standing harmony of the key, which is the 3d, 5th, and 8th and all their superior eighths. This is an accord complete of itself, without relation or dependence on any sound that comes before or after it, which cannot be sayd of the 4th and 6th, or indeed any

\textsuperscript{57}Roger North, 32511, \textit{op. cit.}, fol. 30.

\textsuperscript{58}\textit{Ibid.}, fol. 31.
other consonance. And one thing must not be forgot, which is that every tone whatever that is by it self, unrelated to others, bears well this accord, that is a 3d and 5th to it, and it is so natural, as to be, as it were included in the sound of it.\textsuperscript{59}

In further comments about the fourth, North emphasizes that the interval fills a functional harmonic role and reaffirms his point of view regarding "dissonant" structures.

\textbf{P.} This interval being a dissonance is never played or it must be set above the note in the base, which is either with the 2d or with the 6th and then the 3d is left out.\textsuperscript{60}

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{fourth.png}
\caption{Use of the fourth.\textsuperscript{61}}
\end{figure}

\textbf{N. NB.} The 4th doth not sound well alone because it wants its base, but yet it is no dissonance. And in its right use, it hath an excellent sound, as in the instances given, especially the latter which is so distinguishing in the harmony, that the accord is as useful in tuning an instrument as the best of all. But the beauty of these come chiefly out of a dependance on the key, which is not a subject of this place.

\textbf{P.} I told you in the article of the second that always a concord must be played after a discord; I' ll give you two examples which will serve you once for all and a little practice will do the business.\textsuperscript{62}

\textsuperscript{59}Ibid. \textsuperscript{60}Ibid., fol. 32r. \textsuperscript{61}Ibid. \textsuperscript{62}Ibid.
Fig. 27.—Progressions with the fourth\textsuperscript{63}

N. NB. Any of our masters would say this were false musik not allowing a point blank discord not brought off with a binding and would enjoin the coming off thus. But we must now by authority declare that discords as they call them, stand naked and unbound in the musik, if in due place, as well as concords. And as the author says, almost any consonance coming after a dissonance is well, as in his instances.\textsuperscript{64}

North writes in detail about the harmonic role of the fifth.

Consecutive fifths are bad, he states, because they imply a continual change of key.

P. The fifth is one of those intervals that do help to form the accord, but you must have an especial care that you don't make 2 fifths one after another not by degrees ascending or descending nor by rising or falling by intervals, that's to say when both hands are in the same position.

N. NB. Our teachers in print have a chapter they title consecution, to show what consonant notes may succeed each other, and what not. All thirds in the first place, and sixths may succeed in any manner, continually ascending or descending may but 5th and 8th they say may not because they are so luscious and sweet as must be tempered with thirds and sixths, to prevent clogging, as sweet meats must have some sauce then which reason I think few more impertinent have been met with. The true reason as to fifths, is that

\textsuperscript{63}\textit{Ibid.}

\textsuperscript{64}\textit{Ibid.}
being the very consonance that composeth the full accord
(for thirds go to sixths) where the fifth sounds, a full
key note is declared. And then a continual succession of
fifths, is a continual change of the key, . . . And yet, to
a distant auditing, I cannot say, but it is almost all one
where the fifth is put, for in a coalition of the sound, it
is the whole united harmony is perceived, and the conduct
of the several parts there is not well to be observed. Now
it is not the matter; but the manner and consequences makes
a consecution of fifths intollerable. That is when it
dislocates the key and superinduces another improperly
which in the fullness of the musick will have that effect,
for a slight fifth may go on in perpetual counterpoint,
with the other musick regulated apart, and instead of a
solescisme, makes a brightness in to sound, as would sur-
prise one, which is the case of the stop in an organ called
the twelfth, which is in effect, a perpetual fifth, for
that makes the sound metaleine and sprightly, and hath not
force to stand up against the other accords. So in a word
this faulty consecution of fifths chiefly concerns the
management of one part, or in many, of each, which must be
made to counterchange the fifth neatly, so as one part may
not carry it twice together.65

North is not at all certain that the rule against consecutive fifths
is always necessary. Indeed he suggests that the use of the organ stop
of the twelfth is evidence in favor of parallel fifths for purposes of
sonority. In concluding comments about the fifth North emphasizes
again the harmonic role of the fourth.

Before I leave the fifth, I must prepare for what is to
come by remembering shortly that all accords whatever, that
have any good sound are finally resolvable into the grand
accord of one or more notes, as the sequel must show. But
at present observe the fifth is part and a principal one of
it, and the fourth is the sound made between the fifth and
the octave above, so that in the accord when full you have
the sound of the fourth as well as of the fifth, and the
producing the fourth is done by silencing the base note, and
then the fourth sounds alone, and then sounding the base
note again, and the fifth takes the chief place in the
accord.66

65Ibid., fol. 33r.
66Ibid., fol. 34r.
Similarly, North holds that the sixth is the full accord with the bass note omitted.

P. This interval is never played, except it be marked above the note in the base, which is in three different ways.
1. With a fourth under it.
2. Alone, or with a 3d under it.
3. Or with an eight above it.

N. NB. And in the plain sixth with the third it is the full accord with the base note left out and for that reason a sixth always admits the 3d below to be put in by the thro base man or left out ad libitum without any change of the air or harmony. Only the putting it in makes it more full and sonorous, as here is in two instances demonstrated, and so it is universally.  

\[ \text{Fig. 28.--Optional use of the chord root.} \]

For this reason it is that the use of the sixth maintains the key which a fifth would loose. For in the first instance, the E. and C. being a sixth maintains the air of the key, c, as if that were the base note, but if instead of c. you put H. the fifth, then c. key were lost and the E. key took place, as who will may prove by the ear upon an instrument, but of this more discussed elsewhere.

The other case, is of a 6. with a 4. and that is resolved into a mixture of the accord of the key and of its fifth (which is next to it) or the fourth below, which is

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67 Ibid., fol. 34r.
68 Ibid., fol. 34v.
69 Ibid.
the same thing. For it is an holding the accord of the key, and at the same time the key changed to the fourth below.70

Fig. 29.—The six-four chord71

As here be F. the key and A. and c. the accord. Let those stand, and put down the c. below, and then the accord is or 64. Now I am bold to say here that if with a sort of discretion the accord to c. were put to sound with that of F. which together makes manifold discord, it would not be intollerable, but capable to be brought off well, which notion I will not prosecute here, because it is reserved to a fitter place. In the mean time it is enough to remark, that upon this accord it is, that the 6. and 4. sound so well together, but yet require to be fetched off, as the author will shew, coming to his cadences.72

Turning to the seventh, not only does North accept this interval as a consonance, but to him it is a "noble accord." From the seventh he finds an explanation for the harmonic function of the tritone.

P. This interval being a discord is never played except it be set above the note. Then you do always play a 3d to it let it be marked or not. These following examples will shew you how it must be.73

70Ibid.
71Ibid.
72Ibid.
73Ibid., fol. 35v.
In making closes or cadences (which is all one) the 7th is all ways used but then it is the flat 7th as you will see more of it in the article of closes.

N. NB. He affords us too little remarks on this noble accord (so I must call it) the 7th which in its place hath a sound more noble than any other, so that the grace of all full cadences depends almost entirely upon it. The example of it full is in the last of these instances. For joined with a 3d and fifth, there is a composition of 3 3ds sounding together a rare mixture, besides the harmony of all with the base, with which this injured seventh (mis-called a discord) hath an elegant sound.

There is resulting from the composition of this full seventh an accord, which the author medles not with. And by it self, without relation to its place, is the worst sound can be made between any 2 notes in the scale, and in its place, it is exceeding good. And this is the tritone or fals fifth, as it is called, that is a flat 5th or sharp fourth. It is made by the notes F above and H underneath as in the foregoing examples. The first and the 3d of them, and in the second example, it is B♭ and E. And as the sixth is the full accord of 3d 5th and 8th with the base note silenced, so is the tritone the full accord of 3 5 and 7th with the base note dropped, so that when you hear a full seventh, you hear the tritone in the composition and base when denuded of the base note thus.75

74 Ibid.
75 Ibid., fol. 36r.
The first note is the full seventh, the second, a tritone with the 3d interposing, and the last the bare tritone. And as the seventh is always proper upon cadences, all which are to bear, so the tritone is admitted in the same case, only as part of the seventh, when the rest is left out, and will be thus.\(^77\)

Hereby it appears that the universall rule, that if a full accord be well, upon what accord soever it is, the parts of it will be also well, in like circumstances, is by this case of the tritone confirmed.\(^79\)

In his other manuscripts, North expresses similar ideas relative to consonance and dissonance. By concord and discord he means something quite different from what was meant by earlier theorists. No note of the scale is discord, in his opinion. Rather, discord occurs when a pitch has no orientation to a key or to an accord to a key!

\(^{76}\text{Ibid.}\)

\(^{77}\text{Ibid.}\)

\(^{78}\text{Ibid.}\)

\(^{79}\text{Ibid.}\)
1. It is a vulgar mistake that 2ds and 7ths are discords for in truth they are a true and good harmony, and are concords, but not to that degree of holding perfection as 3ds, 6ths, 5s.

2. It is another error that discords as they call 'em must be brought off with concords as 'f without that proceeding they were faulty, for 7ths, 2ds, false 5ths and many other passages beside all rule of harmony and in meer counterpoint with long (almost any) continuance will be good.

3. The proper harmony to the key can scarce be called discord. I mean the scale notes. But the scale notes of another key are termable discord. So that we can find little discord while we keep the key. Therefore such passages as these are most frequent with Italians as is well known to those who are conversant with their recitative musick.\(^{80}\)

\[\text{Fig. 33.—Example of an "Italian" passage}\] \(^{81}\)

But if you would make a noise insupportable, so as to give true discord, it may be thus, as any may please to prove by an instrument. For here the key of the base is G and the sound above is in E with 3\(\sharp\) which is certainly most insufferable.\(^{82}\)

\[\text{Fig. 34.—North's example of discord}\] \(^{83}\)

4. It is to be observed, that in passing thro the notes which are harmony to the key, or to the notes which are the

\(^{80}\)Roger North 32532, \textit{op. cit.}, fol. 2.

\(^{81}\)\textit{Ibid.}, fol. 2v.

\(^{82}\)\textit{Ibid.}

\(^{83}\)\textit{Ibid.}
harmony of those, there can scarce be any error in harmony committed, for the tendency of the sound falling hard upon the coincidency's or chief concords, that which is between hath not such an emphasis, as holds the ear. But you go on as with the eye upon who walks a stage to musick observing that his principal stops are in the line, and the intermediate one not so much heeded as.

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And consequently, the thirds above added to these notes, for the same respects; but mend the musick because, the charges and mixture of flatt and sharp 3ds adds extremely to the gusto of the sound. And tho they fall blunt seconds and 7the flat as sharp to the key yet the passing to and from, stamps their allowance, tho the half notes are to account discord, as not to bear long continuance, with phatic dwelling upon them.

In another manuscript North distinguishes between two kinds of discord. One of these is discord that occurs when various melodic parts do not agree. The other is out of tune playing, observed as beats when pulses do not coincide.

And of these we make distinction, (1) when the tones are all scalar, and (2) when not. The first part of this distinction may be understood as when 2 persons design sound the same notes do not coincide, but one comes before or after the other, and what will be consonances seem dissonances: this is rather a disorder, than discord: and so long as the sounds do not deviate from the scale or key they are not only well endured but (under some rule) the greatest ornaments of musick are acquired by such disorders.

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84 Ibid.
85 Ibid.
86 Ibid.
and of that kind are the ordinary embellishments musicians continue by mixing discords, as they call 'em, with their harmony. 87

As for the other part of the distinction, which is of isochronic sounds such as may be found by stopping the monochord in any non- aliquot part, and that will be such discord, as will not reconcile with any concord of that key, nor with any note of its scale. But by the ordinary means of tuning or varying the sound more or less sharp, or flat, it may yet be found that by degrees such a sound may be wrought to fall into a conjunction with the key or some of its accords, and a skillful tuner by the manner will guess whereabouts it is, and when it falls into any accord, and what accord that is. As for experiment let the string be tuned to an unison with any other, and hold it fast there, and then loosen it gradually by sharpening its tone, and it will be found that the joint sound will make long swellings and remissions, like gusts of wind, and as the process goes on, the swellings will hasten, and become like wallowing about, and then be more like rolling and so on, till it falls to beating and chattering very fast, and turning back, by a reverse process it will, thro the same sort of action, fall into unison again and then all is quiet. 88

This is similar to the theory of consonance and dissonance developed in detail approximately 150 years later by Helmholtz. 89

Since the beating is predictable, rather than random, it occurs to North (c. 1715-20) that the beats may form musical sounds which might be useful in musical composition. This parallels the work of Tartini of c. 1714, 90 and may be the earliest written mention of combination tones.

87Roger North, 32535, op. cit., fol. 115r.
88Ibid., fol. 115v.
90Giuseppe Tartini, Trattado di Musica Secondo la Vera Scienza dell'Armonia (Padova: Giovanni Manfre, 1754).
I have already shewed that the regular concords, arising by the sextuple division of the monochord, have a formed character, which as the divisions fall upon smaller aliquot parts, is more expressly distinguished by a slight purle in sound, which was ascribed to the nearer perception of the coincidences and separations of the pulses. Now we are to consider that as those coincidences and separations become wider, that is one after the other in time less frequent, those incidents will be more grossly perceived, and by the artists are termed beats. And those are always an indication of disagreement between the pulses. For as the $3^{rd}$ is coincident upon every fourth part of the base, there may be sounds that shall not coincide but upon the 40th, 50th, or the 100th pulse of the base, and so in variety to infinite. And then the extremes of coincidence and separation are grossly distinguishable by the beats and such sounds having so much more of disagreement then of agreement; are justly termed discord, and the more importunate and frequent the beats are the discord will be found more fierce and disagreeable.

It would be thought a strange attempt by a composition of discords, to create a new order of harmony. And I shall not undertake it further than to explain my thought, and show some probability of it. And perhaps if the exceeding difficulty in making the experiment were not very discouraging, make some advance that way. ... I would take a discord regularly beating and combine it with another discord by its beats, setting them down together. And if the beats prove as $2/3$ why should not that yield one common sound, like the knowne concord called a fifth. So of the 3ds, 8ths, etc.

A criticism of the theory of consonance or dissonance by coincidence of pulses was leveled by Newton. It was quoted and answered by Roger North. North introduced the criticism in this way.

It is not to be expected that this hypothesis of harmony founded upon analogy and mentally formed should be entertained without various objections...

He quotes the text of Newton's letter of disagreement in detail.

The essence of the letter, quoted in part below, is that the hypothesis

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91 Roger North, 32534, op. cit., fol. 38r.
92 Ibid., fol. 45r.
93 Roger North, 32535, op. cit., fol. 46.
breaks down because it does not consider phase relationships of the
sounding waves. His explanatory diagram is shown on Plate XIV.

... pulses are after the manner of undulations from the
center continually succeeding, as by throwing a stone into
water. Let therefore A. and B. represent 2. sounding body's
of like tones, c. d. e. f. the pulses propagated from A and
k. l. m. n. the pulses propagated from B, and if the ear be
placed at x, or y or z or any place where the pulses at any
time intersent, they will strike the ear at the same time,
but if it be placed between x and y, suppose at v, the pulse
which comes from body B will strike in the interval of the
pulses which come from the body A. And the like will happen
if the ear be placed in any pulse of one body, and between
two pulses of the other; so that the ears of 2. men, or the
2 ears of one man according to their position from the sound-
ing bodys may be struck one at a time, and the other succes-
sively by the pulses; and yet in all positions of the ear the
sounds and their harmony are heard the same, the sound of the
body's tuned to a fifth or any other concord. Seeing there-
fore that the same time strike one ear both together and the
other ear alternatively, and yet do exhibit the same concord
to all ears, it follows 1. that concords arise not from the
coincidences of pulses at the ear, nor have any dependence on
such coincidences; and 2dly that unisons are rather an har-
mony of like tones than a single tone made more loud and full
by the addition as the author would have it.94

North's response is that the mechanics of vibration cause the pulses
to be in phase, and that even if this were not true, human perception
of sound would make an "in phase" interpretation.

To this I answer. 1. That all unison tones however the
bodies are scituate with respect to each other, pulse equally
and at the same moments of time, for the force of each other
upon the respective springs reduce all to that state. This
the curious objector doth not gain say, but seems to allow
it. 2. Whither the pulses strike the ear edem instante or
not, the memory joins sensation and thereby the mind judges
the consonance alike; for it is the syncronism of each course,
and not the exact time of the touch, that makes the conso-
nance. ... 3. The mind judgeth of place from whence sound
cometh by the manner of its centration. ... 4. The objector
is in an error saying that a single tone is not made more
loud by the addition of an unison, which supposed so near
as to strike together, is undoubtedly false, as 2 candles

94 Ibid., fol. 46-47.
THE COINCIDENCE OF PULSES\textsuperscript{95}
set together tho neither hath more light than a plain candle, shall give a stronger light than either alone, or both divided wide from each other and so unisons together augment the sound.

5. He says that unisons are rather an harmony of like tones,—by which he seems (after his way) to decline the mechanic, for he says not how, or in what respect like; and so to set up qualities in harmony which we wholly decline as an asylum of ignorance. 6. He eludes the whole scheme by a disguised expression,—that concords do not arise from the coincidence of pulses at the ear, and have no dependence thereon. But he says not that they do not depend on the equability or order of pulses from divers body's of which the ear is sensible, and thereby judgeth of concords.96

So the final explanation for consonant and dissonant meanings, according to North, is in the interpretation the mind makes of the pulses of sound.

The consonances or dissonances of sounds reside not in the body's that emit the tones or in the order of pulses with respect to each other, for harmony is an idea of an interior result of the mind and not pure sensation, altho we cannot by any gross corporeal means distinguish the same, that is mental ideas, from motive agents.97

Attitudes similar to those of Roger North are reflected in other treatises of the early eighteenth century, specifically those of Turner (1724),98 Fond (1725), and Lampe (1740).

William Turner

Turner's list of concords and discords is similar to those by theorists of the early seventeenth century. However, he raises questions regarding the dissonance of the fourth, second, and seventh which are very like the questions raised by Roger North.

96Ibid., fol. 47-48r.

97Ibid.

And here I hope I shall not incur the displeasure of any, if I crave leave to throw in an objection against the common notions of most of (if not all) our modern musicians, who look upon the fourth as a discord, the definition of a discord being a sound which is ungrateful to the ear; and whether the fourth be so or not, the ear must be the judge: and I never yet heard any one pretend that it is disagreeable; nay, rather the contrary, for that the fourth is concern'd in the resolution of all cadences; it being directly contrary to the nature of musick to close with any sound that's disagreeable: wherefore, 'till I can see some satisfactory reason to the contrary; I hope I may, without a breach of modesty, assume the liberty of ranging the fourth in the number of concords; which are the third, (major or minor) the fourth (perfect) the fifth, (perfect), the sixth (major or minor) and the eighth: so that the concords are (not four only, but) five in number, viz. the third, fourth, fifth, sixth and eighth; the second and seventh only, being properly termed discords, from their jangling with the basis. And even these, when artfully introduced, yield a most agreeable harmony, as well as some others; which may not be properly discords, although it be the third, fourth, fifth or sixth etc. when they are occasionally extended or contracted, according to their capacity.\(^99\)

Apparently, the last sentence of the quotation refers to augmented and diminished intervals. In Turner's opinion the second and seventh are called discords because of the discomfort occasioned by the close approximation to the unison and octave.

The only satisfaction I can give such curious enquirers . . . is, that it may probably be; because the sound being but one degree from its basis, may create such a disagreement from its lying so near to its center; for where there is any appearance of uneasiness, the closer the object presses, the greater will the grievance be; from whence naturally ariseth the following paradox, viz. the nearer they meet, the farther they are asunder; for it is not good to be too familiar.\(^100\)

John Fond

Fond (1725), in his *New System*, offers little that is new to the understanding of intervals but he does suggest a consistent terminology. Other authors called the interval of two full steps the ditone, third, major third, and sharp third; the interval of three and one half steps has been called tritone, false fifth, diminished fifth, and enlarged fourth, and so on for other intervals—some of these names reflecting tuning systems. Fond's suggestion is to give each interval the Latin name which expresses the included number of equal tempered semitones: unison or prime, second, terce, quart, quint, sexte, septime, octave, none, decime, undecime, duodecime, tredecime, quatordecime, and quindecime.101 He attempts no explanation of why sounds please.

And as for accounting for the natural cause of sound, whether pleasing or displeasing, that's the province of a natural philosopher. A treatise of those things, might indeed entertain a few curious persons, but I am sure the same would lead a lover of music out of his way.102

Some indeed pretend to teach how sounds do please; they attempt to show the immediate manner of the sound's pleasing: But I am afraid they had better rank this among impossibilities; for if neither music, nor mathematics, nor even natural philosophy can account for this, as certainly they cannot, we may safely pronounce that nothing can: and it is no wonder we cannot account for this particular thing, since we know not how anything at all either pleases or displeases us.103

John Christopher Pepusch

Pepusch (1730, 1731, and c. 1750) tended to be retrospective in his statements on consonance and dissonance but was unusual in certain respects. One unusual aspect is his terminology.

Concords are when two or more consonants are played together. They are five, viz. the unity or the 1, the 3, 4, 5, and 6th. These are again either perfect or imperfect concords. The perfect concords admit no alteration, neither in ascending for sharps, nor in descending for flats, and are three, viz. the unity, or 1, the 4, and the 5th. But the imperfect concords admit the alteration of a minor semitone, either upwards for sharp or downwards for flat, viz; the 3d and 6th. Ex. gr. 3♭ or 3♯, the 6♭ or 6♯. Of these two sorts of concords, viz. the perfect and imperfect arise two other kinds of concords, viz: the common concords out of the perfect concords, and the uncommon concords out of the imperfect concords.

The common concords are of the same harmony as the perfect concords in any key-note, viz. the 1, 3, & 5 or 3, 5, & 8, etc.

Note. To these might not improperly be added the 1, 4, & 6, because they are neither common chords nor discords; being composed of 2. perfect cords and one imperfect cord, like the common cord, only having, instead of the 5th the 4th, and instead of the 3, the 6th.104

Pepusch means more by the terms concord and discord than simply a combination of two tones. Apparently the terms "perfect concord" and "imperfect concord" refer not only to intervals but also to degrees of the scale and the terms "common concord" and "uncommon concord" refer to positions of a triad. Thus the common concord, 1, 3, 5; 3, 5, 8 or 8, 3, 5 should be used above the first, fourth or fifth degrees of the scale and the uncommon concord, 1, 3, 6 or 3, 6, 8 or 6, 8, 3 should be used above the second, third, and sixth degrees of the scale. This system limits harmonizations to three basic triads in

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104 Pepusch, 29429, op. cit., fol. 2v.
root position or inversion, except for the 3, 6, 8 structure above the leading tone.

The perfect concords, viz. the unison, the fifth, the fourth, and the octave of the key, do in all keys (as well flat as sharp) require the common cords, that is to say, their 3d, 5th, and 8th for their harmony or accompaniments, excepting the fifth of E key which has its sixth major instead of its fifth, . . .

The imperfect concords of the key, viz, the third, and the sixth; and the discords of the key, viz. the second, and the seventh, do in all keys require the uncommon cords for their harmony, that is to say, their 3d, 6th, and 8th, except the seventh of E key, which has its fifth in lieu of its sixth: . . . 105

Pepusch asserts that both the imperfect consonances and the dissonances of the second and seventh may have one factor altered chromatically without losing harmonic identity. According to this rule, he considers the augmented sixth a consonance. If the chromatic change is such that the interval loses its identity Pepusch terms it a "false relation." The most common false relation is the tritone.

True relations are those wherein the two notes which make the terms of the relation have a certain proportion of agreement which is agreeably sensible to the ear.

False relations are those wherein the agreement is so distant and so small, that it is not sensible, at least not obvious or agreeable to the ear.

According to the degrees of agreement, the intervals have the denomination of concord or of discord, or perfect or less perfect.

The greatest agreement is found in the concords which are distinguished into perfect and imperfect.

The discords might be distinguished in the same manner, and so might also the false relations, that is to say into the nearer to, or farther from perfection; but as use has not occasion to carry this distinction to so great a nicety, we shall say nothing of it; . . . 106

105 Pepusch, 1730, op. cit., p. 6. This is discussed in more detail in Chapter V, (infra, pp. 296-301).

106 Ibid., p. 2.
Pepusch, like earlier theorists, requires discords to be prepared and resolved. However, he mentions one exception: the minor seventh or diminished seventh leading to dominant harmony.

Fig. 36.--Example of note against note dissonance

John Frederick Lampe

Lampe did not use the terms consonance and dissonance, but his Art of Music (1740) is discussed here because in it are expressed harmonic developments which have been noted in other works. Lampe is critical of Malcolm (1721), Pepusch (1730 and 1731), other theorists, and the ancients, for they failed to consider "that the knowledge of the nature of all sounds depend upon the sense of hearing," and they did not know "the true operations of nature." The true rule of nature is seen, according to Lampe, in the vibrating string.

By striking one of the biggest or longest strings on a harpsichord or spinnet, and carefully listening to it, we may hear different harmonious sounds, during the vibration of that string, this nature freely gives us; and were not the modification of those united sounds we hear on one string different, we could not distinguish any more than one sound, nor can they

107 Pepusch, 29429, op. cit., fol. 18.
108 Lampe, 1740, op. cit., p. 3.
109 Ibid., p. 9.
be conveyed to the mind, but by the help of the ear, and as this is more or less perfect, the mind more or less perceives the truth, beauty, nature, and variety of the produced sounds; and whatsoever sounds a nice ear is either uncapable of hearing, or bearing, cannot regard musical harmony.110

Nature in her free operation, by one pulse of a string in the pitch of AA, gives the following combined sounds, AA, A, E, a, c♯, e.111

No other sounds "should be brought into a composition when a full harmony is required."112 Later Lampe adds "another species of perfect harmonics," the minor triad. He does not explain how these "come from nature" other than that they "derive their being from the harmonious sounds of the first relative species, taken from the free operation of nature."113

Robert Smith

One of the most detailed statements on the subject of consonance and dissonance for the time was made by Smith (1749). Smith suggests that consonance is physically caused by a mixture of pulses in a cycle of times.

Such a mixture of pulses, succeeding one another in a given cycle of times, terminated at both ends by coincident pulses, and sufficiently repeated, is the physical cause that excites the sensation of a given consonance ... 114

This being premised, one consonance may be considered as more or less simple than another, according as the cycle of times belonging to it, is more or less simple than the cycle of times

110Ibid., p. 18.
111Ibid., p. 20.
113Ibid., p. 52.
114Smith, op. cit., p. 15.
belonging to the other. And upon this principle all consonances may be ranged in due order of such simplicity . . .

Smith is convinced that coincidence of pulses is part of consonance, but does not accept a theory of beats alone as definitive. Rather, he includes also the numbers in the constituent proportional terms.

One consonance is simpler than another in the same order, as the sum of the least terms, expressing the single vibrations, is smaller than the like sum in the other consonance; and when several such sums are the same, these consonances are simple in the same order, as the lesser terms of their ratios are smaller. For the simplicity of a consonance or cycle of times, consists partly in the number of times contained in the cycle, and partly in the proportions they bear to one another.

Smith's order of simplicity of the consonances, based on his application of these criteria, is given on Plate XV, page 217. The proportions are placed in an order of simplicity according to the numbers in the ratios, in general, the smaller the numbers the simpler the consonance. The ratios 1:1, 1:2, 1:3 have orders of simplicity of 1, 2, and 3. The ratio 1:4 has the order of simplicity of 4. At this point, Smith inserts the ratio 2:3, because the two digits of both these latter proportions also total 5. The order of simplicity of the ratio 2:3 is $4\frac{1}{2}$, the fraction being obtained from the number of proportions having numbers totaling 5. By this method the proportions 1:10, 2:9, 3:8, 4:7, and 5:6 have respectively the orders of simplicity 10, 10 1/5, 10 2/5, 10 3/5, 10 4/5. However, the ratio

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115 Ibid., pp. 15-16.

116 Ibid., p. 16.
PLATE XV

SMITH'S TABLE OF THE ORDER OF SIMPLICITY OF CONSONANCES OF TWO SOUNDS

<table>
<thead>
<tr>
<th>Ratios of the vibrations</th>
<th>Order of the simplicity of the sounds</th>
<th>Intervals of the sounds</th>
<th>Continuation of the table</th>
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<td>2</td>
<td>VIII</td>
<td>1 : 16 16 4VIII</td>
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<td>3</td>
<td>VII</td>
<td>2 : 15 16 1/3 2VIII VII</td>
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<td>1 : 18 15 4VIII T</td>
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<td>3 : 16 15 18 2/9 2VIII 4th</td>
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<td>45 : 64 108 22/27 5th</td>
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117 Ibid., p. 18.
4:7, with the order of simplicity 10 3/5 is omitted from the table because the number 7 is not available to "perfect ratios."

This series increases from unity in several arithmetical progressions, except that a term or two is here and there omitted, where ratios occur which being reducible to simpler terms have been considered before, or else are not perfect ratios, which are such only whose terms are 1, 2, 3, 5, with their powers and products.118

The effect of this rule is to exclude the number 7 and its multiples, which neatly avoids considering as possible consonances intervals related to the seventh harmonic. Smith gives no reason for this exclusion, other than the arbitrary statement regarding the availability of only the numbers 1, 2, 3, and 5 for "perfect ratios."

There are other singular features in Smith's system. The perfect fourth, 3:4, has an early place in the consonances, with an order of simplicity of 6 2/3, placing it between the tenth (2:5 with order of simplicity of 6 1/3) and the sixth (3:5 with order of simplicity of 7 2/3). Smith includes the fourth as a consonance because it is the complement of the fifth to the octave.

Though nature has appointed no certain limits between concords and discords, yet as musicians distinguish consonances by those names for their own uses, I may do the like for mine; calling unisons, IIIds, Vths and VIths and their complements to the VIIIth and compounds with the VIIIths concords, and all other consonances, discords.119

Smith's ordering of the intervals includes intervals larger than the octave. For example, the tenth, 2:5, with an order of simplicity of 6 1/3, is considered more consonant than the third, 4:5, with an order of simplicity of 8 3/4.

118 Ibid., p. 19.
119 Ibid., p. 21.
The computations involved in Smith's system lend an aura of objectivity and precision to his treatise. According to Smith,

... simpler consonances affect the ear with a smoother and pleasanter sensation, and the less simple with a rougher and less pleasant one. And this analogy seems to hold true according to the order in the table, as far as the ear can judge with certainty. 120

Later, Smith attempts to show that tempering "can produce no sensible difference in the harmony."121 In other words, Smith offers his system as definitive to all cases in ordering consonances and dissonances. In fact, his selections of certain number techniques are arbitrary and offer little that is new or more successful than earlier similar systems. For example, the position of the fourth high in the table of consonances is contrary to the general understanding regarding this interval.

Giorgio Antoniotto

Antoniotto (1760) used the terms consonant and dissonant in a sense somewhat different from earlier English authors. To him the term "consonant" meant "with-sounding." By this definition, the two pitches of a consonant interval are perceived as one sonority but in a dissonant interval, the pitches are perceived as separate sounds.

The thirds, and sixths, the fifths and octaves, have been, and at this very time are, reciprocally called consonant or harmonic; only with the distinction of calling the thirds and sixths imperfect consonant, not in regard to the degrees of consonance, but because they may be altered into major and minor; and the fifths and octaves perfect consonant, because they cannot be altered. It seems very clear, that the term consonant signifies two sounds, which resemble each other,

120 Ibid., p. 21
121 Ibid., p. 85
and being sounded together, can scarcely be distinguished, as it is demonstrated by experience, in the introduction: for which reason a progression made with a combination of two octaves, or two fifths following each other in a composition of two, or three parts, are justly forbidden in practice, because they are considered as simple sounds, without harmony.

Harmony must be considered as the union or combination of dissonant sounds which word dissonant signifies, that there is heard two distinct sounds, as above said, or, in vulgar terms, a combination of dissonant sounds, distinguishable by the ear, as has been defined in the fourth article of the first chapter, for which reason the simple fifths and octaves cannot be harmonic, particularly the octaves, which being the more perfect consonant, is always absorb'd and confounded with its grave sound; and, on the contrary, the other intervals cannot be consonant, as mentioned in the antecedent chapters; but the fifth, when divided into two parts by a middle sound, it becomes harmonic, being distinguished in and by two successive thirds, consequently if all the sounds which compose their general system, were disposed in successive thirds, all the same sounds would become consonant and harmonic, respectively from one fifth to another; and in this manner will be formed an harmonic system... 122

Antoniotto equates the terms "dissonant" and "harmonic." By his definition, not only seconds and sevenths, but also thirds and sixths are dissonant. His compositional problem is to understand dissonant or harmonic sounds and to manage their organization into musical structures.

Summary

The uses of consonance and dissonance and even the meaning of the terms underwent extensive change during the post-restoration period. At least part of this change was due to the change from a horizontal to a more vertical point of view in harmonic thinking, that is, from a contrapuntal to a homophonic harmonic idiom. Other changes were corollary to developments in the natural sciences and to

122 Antoniotto, op. cit., p. 31.
the growth of empiricism in philosophy. Possibly the most that can be said about this change is that in the period and geographic area studied it had not yet in the early eighteenth century resulted in a consistent meaning for the technical terms. Four schools of thought conditioned the thinking relative to consonance and dissonance of the early seventeenth century English theorists. One of these was number symbolism which traced its history back at least to Pythagoras and which found renewal in seventeenth century England, especially relative to proportions of intervals. A second was the senario from Zarlino (1562), which was a variation of Pythagorean proportions in which proportions up to the number six were used to compare lengths of vibrating strings. A third came from Benedetti (1585), and later Galileo Galilei (1638), who suggested a hypothesis for consonance and dissonance based on the coincidence of motion of vibrating strings. This developed in three channels; one considered the total number of concurrences between strings without regard to time; a second, developed by Mersenne (1636-7) and Kircher (1650), placed intervals in an order of consonance based on the time required for the consonance to achieve full cycle; the third, developed especially by Francis North (1677), Holder (1694), and Roger North (c. 1700-1726), was concerned with the coincidence of pulses in the air and as perceived by the mind. The fourth school of thought was that which looked to sense perception for musical meanings.

The early seventeenth century counterpoint treatises, exemplified by Bevin's Brief and Short Instruction (1631) and Butler's Principles (1636), listed intervals in categories of consonance and dissonance without explanation. Descartes (1622, trans. 1653) provided similar listings but stated justifications for consonances.
First he justified all the consonances except the minor sixth by proportions from senary division of the vibrating string. The minor sixth he explained as a consonance because of its quality, which he asserted was similar to the quality of the minor third. Later in his treatise he stated justifications based on the observation of sympathetic vibration of fifths and dittones.

Birchensha's translation (1664) of Alsted's "Musica" provided another similar list in which intervals are categorized. However, Alsted stated that fourths, sixths, and sevenths are obtained between respectively the fifth and octave, third and octave, and second and octave.

Simpson (1667) presented a list of concords similar to that of Alsted. Likewise, Blow (c. 1680) and Keller (1707), in their thorough-bass treatises, provided lists in which the intervals are divided into consonant and dissonant categories.

Francis North (1677) was the first of the English theorists to state a theory of consonance by coincidence of pulses. This theory was also stated by Holder (1694), but he was uncertain whether the true reason for consonance was in coincidence of pulses or perfection of proportions.

Malcolm (1721) investigated the theories for consonance from proportions, from number of vibrations per unit of time, from number of coincidences per unit time, and the theory that the more simple and equable consonances are generated in time before the more compound and harsh. He suggested a definition for consonance which combined these theories.
Roger North (c. 1700-1726) rejected traditional definitions for consonance and dissonance. He used the term "discord" in two ways: one to refer to the effect that occurs when simultaneous melodic parts do not agree and the other to refer to out of tune sounds. He held that consonance is the result of coincidence of pulses. However, he rejected the idea that coincidence provided any unchanging norms for consonance and dissonance. He asserted that any interval which the mind could accept as harmonically functional was consonant to a degree, and discord occurred only when a pitch had no orientation to a key or to an accord to a key.

Turner (1724) presented a list of concords and discords similar to that of earlier theorists, but he suggested that discords as well as concords were capable of yielding agreeable harmony.

Fond (1725) suggested a consistent terminology for intervals, giving each interval the Latin name which expresses the included number of equal tempered semitones.

Pepusch (1730, 1731, and c. 1750) used the terms "perfect concord," "imperfect concord," and "discord" not only to apply to specific intervals but also to characterize degrees of the scale. He used the terms "common concord" and "uncommon concord" to refer to the root position and first inversion of the triad.

Lampe (1740) did not use the words consonance and dissonance, but he asserted that perfect harmony could be observed in the co-sounding harmonics of the vibrating string.

Smith (1749) held that consonance is physically caused by a mixture of pulses in a cycle of times. Using the number of
coincidences in a cycle of times and the proportions of intervals, he listed the consonances in order of simplicity.

To Antoniotto (1760) the term "consonant" meant that the two sounds of an interval could scarcely be distinguished. The term "dissonant" he equated with "harmonic," meaning that distinct sounds could be heard. By his definition not only seconds and sevenths but also thirds and sixths are dissonant, though in different degrees.

In the writings of Francis North (1677) and the later theorists can be seen the dissolution of the idea that intervals should be viewed as stable harmonic entities apart from context. Rather, in the later writings, the idea is stated that individual sounds function relative to a chord root and within a tonality. Specifically, Roger North (1726) discarded completely the categorical point of view and asserted that interval sonorities were relative notions within a musical context. The development of this tonal harmonic awareness is similarly detailed by the theorists' statements about harmonic vocabulary, which is the subject of the following chapter.
In the previous chapters, the theorists' writings about reason and sense, theories of sound, scale, and consonance and dissonance have been discussed. The writings on these subjects not only provide insight to the theoretical thinking of the time but also they are resources from which the harmonic systems are formulated.

It is the purpose in this chapter to describe the harmonic ideas and to list the harmonic possibilities found in the treatises. The following subjects are recurring ideas and are used as centers of focus in the discussions which follow.

1. The basis and point of view for the harmonic system.
2. Distinguishing characteristics of the system.
3. Available chord structures.
4. Cadence structures and harmonic idioms.
5. Systems for harmonic progression.
6. Use of non-harmonic tones.
7. Principles for chord and interval inversion.
8. Affective ideas.

Treatises that included information relative to homophonic harmonic practice are discussed in chronological order. Because each
of the writings illustrates particular purposes and points of view, the discussion which follows is written as a series of brief descriptive essays.

**Matthew Locke**

Arnold (1931) wrote that Matthew Locke's *Melothesia* (1673) was the "first extant English treatise upon the art of playing from a figured bass."¹ Arnold quoted the treatise in detail and added some commentary. The commentary is descriptive of the treatise but does not deal specifically with the relationship of the work to musical thought on the English scene.

*Melothesia* is one of three similar early treatises on the subject of figured bass by English composers. The other two are a small manuscript treatise by Blow (c. 1680)² and Keller's *Compleat Method* (1707).³ Later treatises on figured bass were written by Lampe (1737)⁴ and Pasquali (1754).⁵ The harmonic vocabulary expressed by Locke in *Melothesia* is summarized here for purposes of comparison with the other sources.

**Ten general rules.**—*Melothesia* is a concise work. In ten paragraphs Locke gives the "general rules" for figured bass. The "general rules" are followed by descriptive examples. Following is

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¹Arnold, op. cit., p. 154.

²Blow, 34072, op. cit.

³Keller, 1707, op. cit.

⁴Lampe, 1737, op. cit.

a summary of the ten rules.

1. Where the rules do not instruct otherwise, harmonize with thirds, fifths, and octaves. Avoid parallel fifths and octaves.

2. On the third, sixth, and seventh degrees of the scale, and on any "sharp notes out of the tone"—bass notes sharped with accidentals—use thirds, sixths, and octaves.

3. On the first of the two bass notes of a cadence "play either a fourth and third with a fifth against them, or a third, fourth, and third, with a seventh, sixth and fifth (or a sixth and fifth) against them; making the fourth as long as both thirds and the fifth as long as the seventh and sixth." The thirds are "third majors." The bass rises a fourth or falls a fifth to the second chord of the cadence.

4. The seventh resolves to the sixth; if the sixth is major, add also a major third; if the sixth is minor, use with it a minor third.

5. "Omit a third when a fourth is figur'd; a fifth, when a sixth is figur'd; and a sixth when a seventh is figur'd."

6. Ascend by step in the bass with the intervals five, six above each bass note; descend using six, five or seven, six.

7. In bass movement by thirds, one of two adjacent chords should use the sixth.

8. In "running" basses it is necessary to harmonize only important notes.

9. Avoid close spacing in low registers.
10. Moving the left hand in contrary motion to the right is an aid in avoiding successive fifths and octaves.6

The rules are explained and the basic ideas are expanded by Locke's examples.

Rules one and two provide triads or six-three chords above bass notes.

Rule three emphasizes the importance of the four-three suspension as part of the cadence structure. In each of three examples, Locke uses the fourth speaking against the fifth, followed by a resolution to the third, as illustrated in Figure 37.

Fig. 37—Use of the four-three in cadence7

The effect of Locke's fourth rule is to assure the resolution of the seventh scale degree in the key and mode implied by the sixth scale degree. Rule five is to avoid the construction of extraneous dissonances in the upper parts.

Rule six provides a system for harmonizing a bass which ascends or descends by degrees. Apparently Locke found it acceptable

6Matthew Locke, op. cit., pp. 5-8.

7Ibid., pl. 1. Locke uses a six-line staff with a C clef on the fourth line of the upper staff and an F clef on the fourth line of the lower staff.
to avoid parallel fifths by anticipating a factor of the second chord, or suspending a factor of the first chord, as illustrated in Figure 38.

![Figure 38](image)

**Fig. 38.**—Examples of Locke's sixth rule

Rule number seven is illustrated in Figure 39 which shows the sixth used on one of two adjacent chords, with the bass skipping a third. Apparently, to Locke the leaps in similar motion to the fifth were acceptable.

![Figure 39](image)

**Fig. 39.**—Bass movement in thirds

**Transition.**—In addition to the harmonic possibilities available by the ten rules, Locke mentions in his conclusion the possibility of "transition, or passing from one key to another." One of the

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examples in Locke's treatise illustrates some possible transient modulations which are accomplished with cadential progressions at various pitch levels. This example is shown in Figure 40.

Fig. 40.—An example of transition

John Blow

The small manuscript treatise by Blow (c. 1680) is similar in a number of respects to Locke's Melothesia (1673). In his opening sentences, Blow, like Locke, lists the consonant and dissonant intervals and establishes the combinations three, five, and eight; and three, six, and eight as basic harmonic entities. Like Locke, Blow emphasizes the use of the suspended fourth in a $\frac{5}{4}$ progression in cadence formulae; however, Blow presents a larger number of cadence idioms. Like Locke, Blow avoids parallel fifths in "common chords" ascending or descending by degrees by anticipating a factor of the second chord, or suspending a factor of the first chord. Like Locke, Blow shows that in a rapidly moving bass line only the important notes need be harmonized.

However, the analysis below will show that Blow adds three suggestions for harmonic possibilities to those given by Locke: (1) In a bass ascending by degrees, one of two adjacent notes is generally

11 Ibid., pl. 2.
12 Blow, 34072, op. cit., fol. 1.
harmonized with the sixth; (2) the seven, nine combination is possible
as a suspension resolving on eight, six; and (3) the flat fifth, flat
seventh combination above a leading tone the diminished seventh chord
may precede the cadential formula.

Blow's little treatise suffers from a lack of consistent
organization, a problem which might have been corrected had the work
been brought to publication. However, the harmonic possibilities
listed by Blow can be grouped into the following categories: (1) bass
movement by step; (2) functions of the common chord; (3) cadence
formulae; (4) rapid bass movement; (5) treatment of the ninth, fourth,
and other dissonances; and (6) the chord of the flat fifth and flat
seventh.

Bass movement by step.—Blow lists three harmonic possibilities
for bass movement by step. The first is motion in parallel six-three
structures.

![Parallel six-three structures](image)

Fig. 41.—Parallel six-three structures, bass movement by step\(^{13}\)
Another possibility is the mixing of five-three and six-three struc-
tures, illustrated in Figure 42. "One may observe generally that when

\(^{13}\)Ibid., fol. lv.
2 notes ascend or descend, one of them requires a 6th.  

Fig. 42. — Bass movement by step, five-three and six-three structures

The third possibility for bass movement by step requires the alternate use of sixths and fifths as anticipations or suspensions or, in descending motion, of suspended dissonant intervals. Bass movement by step is illustrated in Figures 43 and 44. 

Fig. 43. — Fifths and sixths ascending gradually

Figure 45 illustrates the use of the seventh and ninth as suspensions resolving on the sixth and octave. In this progression, Blow and later Keller (1707) omit the third above the bass. 

\(^{14}\) Ibid., fol. 2r. 
\(^{15}\) Ibid., fol. 3v. 
\(^{16}\) Ibid., fol. 2r. 
\(^{17}\) Arnold (1931) mentions the omission by Keller but not by Blow. Cf. infra, p. 240.
suggests the possible use of a ninth and fourth—the eleventh—resolving on the eighth and third, but no example is given.

Fig. 44.—Sevenths and sixths, the bass descending

Fig. 45.—Ninth and seventh, the bass ascending

Functions of the common chord.—Alternating five-three and six-three structures in close position in the right hand with bass movement by skip in the left hand provides another possible harmonic progression. The fact that Blow illustrates this idiom, Figure 46, with examples in four parts rather than three emphasizes the similarity of this progression to that of the fifths and sixths in step-wise motion, Figure 43.

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18 Ibid., fol. 2rb. Due to an error in numbering there are two second folios.

19 Ibid., fol. 2r.
Rapid bass movement. -- Blow suggests that a rapidly moving bass may be accompanied in the right hand with notes of longer duration.

If your bass move by quavers or semiquavers, you need not play with your right hand more than once to four quavers, or once to two quavers, being the same as if your bass had been minims or crochets. 21

Treatment of the ninth, fourth, and other dissonances. -- Blow's rule for treatment of dissonances is that they must be prepared by repetition from a concord and must be resolved.

Chord of the flat fifth and flat seventh. -- Blow suggests the use of the chord of the flat fifth and flat seventh -- the diminished seventh chord -- on the raised fourth degree directly preceding a cadential progression. Inasmuch as the minor seventh was considered the "normal" seventh (supra, p. 172), the interval Blow calls the flat seventh is the diminished seventh. Figure 47 illustrates the diminished seventh followed by dominant harmony.

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20 Ibid.
21 Ibid., fol. 3r.
Cadence formulas.—Blow's typical cadence formula is similar to that of Locke; the suspended fourth speaks with the fifth and resolves on the third. Following the resolution to the third, Blow uses the eighth descending to the flat seventh—the dominant seventh chord. If it is in the highest voice, he has the seventh progress downward; in an inside voice he allows upward progression of the seventh. Figures 48 and 49 are explanatory.

22 Ibid., fol. 4v.

23 Ibid., fol. 2bv.
Blow concludes his treatise with the figured bass illustrated in Figure 50, which he presents without explanation.

The bass is similar to the example of "transition" which Locke uses to conclude *Melothesia* (supra, p. 230). The final cadence is the only example Blow gives of a cadential six-four, rather than five-four progression.

Godfrey Keller

Arnold (1931) discussed the thorough bass treatise of Keller (1707) and pointed out some of the features, including faults. Arnold noted that the book was published posthumously, and that had Keller lived, the faults might have been corrected.

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26 *Arnold, op. cit.*, p. 248.
Chord structures. — Keller, like Locke (1673) and Blow (c. 1680), conceives his harmonic structures as combinations of intervals above a bass. In presenting harmonic structures, he lists three possible organizations above the bass for "common chords" and five possibilities for "sixes," illustrated in Figure 51.

\[
\begin{array}{ccc}
\text{common chords} & 8 & 3 \\
5 & 8 & 3 \\
3 & 5 & 8 \\
\text{sixes} & 6 & 3 \\
3 & 6 & 8 \\
6 & 3 & 6 \\
\end{array}
\]

Fig. 51 — Keller's possible positions for triads²⁷

Later, he suggests inversion of the triad as a device to aid the memory in recalling the various intervallic possibilities.

To make some cords ease to your memory you may observe as follows. A common cord to any note makes third, sixth and eighth to the third above it or sixth below it. A common cord makes a fourth, sixth and eighth to the fifth above it and a fourth below it.²⁸

Division. — Non-harmonic possibilities described by Keller can be obtained by the process known as "division." His examples show the addition of passing notes and auxiliaries to both bass and upper parts. Division of a bass is illustrated in Figure 52.

Fig. 52 — Keller's example for "division" of a bass²⁹

²⁸Ibid., p. 7.
²⁹Ibid., p. 2.
Scale.--Keller's scale possibilities include the major and minor modes, which he presents with key signatures to five sharps and five flats. He uses the terminology "flat" and "sharp" keys to refer respectively to the minor and major modes. Each of his "flat" keys uses the same key signature as the "sharp" key a third higher.

Cadence formulae.--Keller provides detailed instructions for cadences. In his "common cadence," the key note is suspended into dominant harmony. In his examples there are singularities in the resolution of what later theorists called the dominant seventh chord, for the seventh resolves upward—a convention also observed in the examples of Blow (supra, p. 235.)

![Diagram of cadence](image)

Fig. 53.—Keller's "common cadence" 31

The "sixth and fourth" cadence described by Keller is the cadential six-four formula, illustrated in Figure 54. In another cadence structure, Figure 55, the suspended tonic is joined with the seventh above the fifth scale degree. Keller terms this the "seventh and fourth" cadence.

30 Ibid.
31 Ibid.
In connection with the discussion of cadence possibilities, Keller, like Blow, suggests the possibility of a "flat fifth and flat seventh" above the raised fourth degree, preceding a chord on the fifth scale degree. Inasmuch as it is a minor seventh which is to be flatted, the result is the interval of a diminished seventh which progresses to dominant harmony, illustrated in Figure 56.

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32 Ibid., p. 2.
33 Ibid.
Fig. 56.--Chord of the flat fifth and flat seventh

Other harmonic possibilities.—Figure 57 illustrates Keller's use of the ninth and the fourth.

Fig. 57.—Keller's use of the ninth and fourth

Each use of the ninth and fourth is prepared by repetition and the resolution is downward. Referring to the ninth, Arnold (1931) points out that when Keller employs the ninth in three part writing, he omits the third.

A curious feature in Keller's harmony is the regular omission of the third (instead of the fifth) when a suspended ninth is taken in three parts . . .

\[ \text{34 Ibid.} \]
\[ \text{35 Ibid.} \]
In only two cases in the entire work is a suspended ninth taken in four parts $9_5^3$, and in every other case the 3 is omitted. 36

The omission of the third emphasizes the contrapuntal function of the ninth.

Arnold also notes Keller's use of consecutive fifths and octaves and an augmented interval. 37 Figure 58 is illustrative.

![Crescents and Measurements]

Fig. 58.--Keller's use of direct fifths and an augmented interval 38

For harmonization of ascending step-wise motion in the bass, Keller, like Locke (1673) and Blow (c. 1680), suggests alternate fifths and sixths.

He also suggests chordal structures which later theorists call "secondary dominants." These are constructed by adding a "flat fifth"--diminished fifth--to any "sharp note"--bass note followed by the pitch a half step higher--if the latter is harmonized also with a sixth. This results in passing or momentary modulations, as in Figure 60.


37 Ibid., p. 249.

38 Keller, op. cit., p. 3.
Keller presents combinations of intervals to be used in harmonizing a bass and rules for connecting these sonorities. He suggests that six-three and six-four structures may be interpreted as positions of a common chord. However, his systems for chord progression are cadence formulae or harmonic idioms rather than comprehensive systems. His harmonic vocabulary includes what are later called secondary dominant chords.
Francis North

The basis of North's system.--The Essay of Francis North (1677) presented a theory of harmony developed from a theory of sound. The basis for the system is the theory of consonance by coincidence of pulses. North illustrates this rationale with a table showing the coincidence of pulses of various intervals with the following explanatory note.

It is worth observing, that the close in musick, being the most pleasing, and full sound, which comprehends the fifth and third sharp, and eighths, hath the pulses in the proportions $\frac{4}{1}$ of these numbers, 1, 2, 3, 4, 5, 6; as appears by this figure.

Fig. 61.--The most pleasing and full sound

The numbers have for North more than only arithmetic meaning. They refer to the number of coincidences of pulses of the vibrations of the higher pitches with the lowest, and so are used by North to support a physical justification for the importance of this "most pleasing and full sound."

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41 Francis North, op. cit., p. 27.
42 Ibid.
43 Ibid.
The perfection of the full accord, which Descartes (trans. 1653) justified from observations of sympathetic vibrations of strings tuned to higher fifths and ditones (supra, p. 180) is given added acoustical justification by Francis North—in the same year that Wallis (1677) writes of the sympathetic vibration of string partials.44

In the Essay, Francis North presents no comprehensive harmonic system. His intent is only to make known the reason on which the rules of other theorists are founded.

... I am only in the part of a philosopher, to show what is allowable musick, in order to make the reasons upon which their rules are founded understood.45

He does not limit his statements to explanations of a mechanical system. Rather, he is also concerned with meanings to the listener of the physical motions. He asserts that these meanings include three ideas: harmony, formality, and conformity.

Harmony.—"Harmony is the grateful sound produced by the joining of several tones in chord one to another." Tones in chord "join and give one entire sound, whereas discording tones will jar; ... 46

By the principal of perfection in coincidence of pulses, North explains three harmonic ideas: (1) the fundamental importance of the bass, (2) the identity of octaves, and (3) the function of chord tones.

In the principal of perfection by coincidence of pulses, the bass is the norm with which the pulses coincide.

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44 Wallis, 1677, op. cit.
45 Francis North, op. cit., p. 36.
46 Ibid., p. 28.
In all conjunct sounds the bass is according to its name the foundation, and all the upper chords are grateful as they have relation to that, because it comprehends all the rest, and its pulses are according to nature bigger and stronger than those of the other parts, and so of more effect to maintain the coincidence; and for this reason, where a tune begins with conjunct sounds, the bass is always the key note. 47

The pulses of octaves coincide perfectly with those of lower octaves. They differ from unisons, "yet as to appearance, they are the same, in respect of such difference as there is between other sounds." 48

From the principle of coincidence of pulses, North finds the meanings he has attached to the chord tones above the bass. The fifth "is the principal chord [harmonic] in which there is an acquiescence." 49 A fourth, "because its octave below the base mends the harmony so much," is "subservient to change" and "strongly induces a close in the fifth below." 50 Similarly, sixths are the inversions of thirds. 50

Formality.--North does not define this term, so its meaning can only be inferred from the context. It is a "requisite which every part ought to have." 51

And there are allowances which the nature of the parts require; the formality of the treble must be airy and brisk, that of the base slow and robust, the inner parts are generally employed to fill the musick with chords, and have little curiosity of formality, except upon following a point; [imitation] but these allowances considered, an expert musician will give a competent share of formality and sweetness to every part, making

47 Ibid., pp. 28-29.
48 Ibid., p. 29.
49 Ibid.
50 Ibid., p. 30.
51 Ibid.
the treble move in a grave pace, and the base rest, that the
beauty of the inner parts may be discerned.52

Apparently, by the term "formality" North refers to the rhythmic and
melodic contours of the various voice parts.

**Conformity.**—The principle of conformity requires that regard
be given to the melodic tendencies resulting from both key and chord
structures.53

Discords are allowed in musick upon this score, and they
are also in other respects of excellent use; as when the mind
is to be carried from any particular note, it may be affronted
by a discord; or if a note in small esteem be to be favoured,
some other note may come in that agrees with that, and in dis-
cord to the rest, and so may draw the mind to the regard of
that note which it strengthens and supports.54

Apparently the principles of formality and conformity are
aesthetic principles which North believes underlie the rules of musical
composition.

Arthur Bedford

**A retrospective point of view.**—Bedford (1705 or 1706) was cri-
tical of contemporary theory. In his opinion, abuses had crept into
music, and these abuses needed to be corrected.

It is certain that the abuse of a thing ought not to take
away the lawful use thereof; but it is also certain, that the
abuses ought to be taken away, that so the scandal may be re-
mov'd and a science so noble may recover its ancient glory.
It is true, that of late musick hath grown into contempt by
such as have not distinguished between the mechanical and the
mathematical part; . . . 55

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52 Ibid., p. 31.
53 Ibid.
54 Ibid., p. 32.
What is needed, writes Bedford, is a return to the principles of
counterpoint. First of all, the young musician should learn thoroughly
the gamut and "how to keep true time." In this regard, the scale sys-
tem Bedford advocates is the movable system of four syllables.
Bedford recommends that after gaining these skills the student study
Playford, Simpson, and Campion.

When a scholar hath proceeded so far in the practical part, it
is time to proceed to the speculative, that so he may know the
reasons of what he doth, and heareth; and may be able to give
a good account thereof; and this is learnt by reading such
authors as treat of the science of musick, and following their
directions. The authors which I shall recommend, are Playford's
Introduction to Musick with Henry Purcell's Additions at the end
thereof and also Symson's Compendium of Musick; and tho it
must be granted that in some cases they are defective, yet I
hope their defects will be supplied by the following discourses;
and Dr. Campion's Treatise concerning the passages of the con-
cord's printed at the end of an old edition of Playford's
Introduction to Musick, though of late it is little minded,
yet I think ought not to be wholly neglected; especially in
plain counterpoint, by a very young composer. 56

He suggests the study of older contrapuntal music because the
modern songs "are much shorter, and composed only for a single part,
or two parts at most to a thorough-bass; in which the passages of the
concords, the chief thing which young composers ought to mind, are
not so discernable." 57 He states that one wishing to compose instru-
mental music should study scores by Purcell and music from other
nations, especially the sonatas of Bassani and Corelli. 58

Simpson, op. cit. Campion's treatise is in Playford's 3d ed., 1660,
and other eds. until replaced by Purcell's additions in the 10th ed.,
1683.
57 Ibid., p. 17.
58 Ibid., p. 18.
After asserting and illustrating his retrospective point of view, Bedford emphasizes two aspects of harmony: structures built on the 7th degree of the scale and cadence structures.

**Clarification of terms.**—To understand the areas of emphasis, it is necessary to understand Bedford's use of the terms "flat" and "sharp." He uses "flat" and "sharp" in four different ways: (1) for key signatures, (2) for accidentals, (3) to refer to the notes of the tritone, and (4) to refer to mode.

From hence it may be observed that there are several sorts of flats and sharps: namely, a flat or sharp in the beginning of a tune; and a flat or sharp in the middle of a tune; the flat or sharp note of a tune; and also a flat or sharp key.

A flat or sharp in the beginning of a tune, makes the whole line or space either flat or sharp throughout the whole tune; a flat or sharp in the middle of a tune affects only the note before which it is set, or those which immediately follow in the same line or space. In musick the key is the note, in which the bass always concludes; and if the third note above is a greater third, the musick is said to be set in a sharp key; but if the third note above is a lesser third, the musick is said to be set in a flat key. The flat or sharp note hath been spoken to already.

In a sharp key, or cadence the sharp note is always the note under the key, or cadence; and consequently, the flat note is the fourth above the key or close; but in a flat key or cadence the sharp note is always the note above the key or cadence; and consequently, the flat note is the sixth above it, the reason whereof will appear hereafter: and therefore from the alteration of the flat or sharp note in the tune by an accidental flat or sharp proceeds the alteration of a tune from one close or cadence to another, and the method of preparing for the same.59

**Harmonic structures on the seventh scale degree.**—Bedford's harmonic structures are similar to those of Locke (1673), Blow (c. 1680), and Keller (1707) in spite of the fact that he espouses the contrapuntal point of view; that is, he conceives chords as

combinations of consonant intervals above a bass. He makes the following statements about the chord structures above a "sharp note."

There is one thing more, which I must observe, that if you reckon from the bass, every note hath a perfect fifth above it, except there happen an accidental flat in the upper part to turn it into a lesser fifth, or there happen to be an accidental sharp in the bass which also turns it into a lesser fifth by raising the bass a semitone higher. But the minor sharp note hath properly a lesser fifth above it in a key either flat or sharp; and therefore the sharp note in a bass will either bring in relation enharmonical [tritone] to the key or prepare it for another cadence; in which case the said note ceases to be a sharp note. Besides, there is another reason; a fifth is a perfect concord, and therefore more apt to clog the Ear; and though, when naturally introduced, it makes an excellent harmony, yet being brought in after such a manner, seems more starch, and forc'd than natural, and hinders us from that variety, which through such discords is introduced into musick. And as the sharp note or accidental sharps will not bear a fifth, so neither will they bear an eighth without an offence to a critical ear. And therefore, when such notes are used in a bass, even in many parts, the upper parts do usually consist of a lesser sixth, a lesser fifth, and a lesser sixth, and a third; and any other composition cannot, I think, be allowed of; and the most proper motion of the bass is by ascending to the half note immediately above the sharp note, or accidental sharp.60

Thus speaks the arch conservative! According to Bedford, bass notes progressing upward by a semitone should be harmonized with a diminished fifth, rather than a perfect fifth. In addition, they may have a minor sixth and a third. In the examples that Bedford gives to illustrate structures above "sharp notes," not only are the diminished fifth, sixth, and third used, but also there are examples with the diminished fifth of the perfect fourth and diminished fourth. Apparently, Bedford will allow any interval to sound above a leading tone except the perfect fifth and the perfect octave.

60 Ibid., pp. 89-90.
By the use of accidental "sharp notes" in the bass, these structures are available to resolve on other chords in the key. Harmonic possibilities above a sharp note are illustrated on Plate XVI, page 251.

Cadence structures.--Bedford approaches his discussion of cadence after mentioning the use of accidental sharps and flats in music. Accidentals are used melodically "to affect the passions," to avoid the tritone, harmonically or melodically, to form the leading tone in minor, to avoid the melodic interval of augmented second in the minor mode, and to avoid the harmonic interval of the augmented fifth.

First, it is usually for a composer in rich chains as are designed greatly to affect the passions of love, sorrow, he either in the upper part, or in the bass, to ascend or descend by three, four, five, or six half notes, according as his fancy shall lead him; and in such a case there is a necessity of inserting such flats, or sharps accordingly.

2dly. It is usually to insert one or more flats, or sharps on a particular line or space, to introduce another cadence, or close, in order to prevent relation inharmonical in the intended key.

3dly. There are some composers, who insert an accidental flat or sharp, only to prevent relation inharmonical in a single part; but this must be done with care and judgment; and in such a case it is better afterward to alter the key to such a place, as required such a flat and sharp. This is a . . . soft way of stealing into another key, . . . before the hearer can seem to be aware thereof, by which means he is the more surpris'd and diverted.

4thly. Since every full close of the bass is made from a greater third, and not a lesser, therefore even in a flat key, the note immediately under the key affects always to be sharp, in every part of the strain, as well as near the close.

5thly. Since between a line and its immediate space there ought not to be the distance of more than a full note, therefore the note immediately under the aforementioned note, or the third note under the key, affects to be sharp also. . . . It must be observed that these accidental sharps are always placed in a part when it riseth either to, or above the key; that the hearer may have the true key in his mind: but they are never placed, when the part descends any lower; . . .

6thly. Between a note and its fifth, either above, or below, there ought not to be above the distance of a full fifth. . . .
PLATE XVI

EXAMPLES OF BEDFORD'S STRUCTURES ON "SHARP" NOTES

Ibid., fol. 48r.
Therefore the bass in a flat key naturally affects to be sharp the third above the key, that is, if it riseth afterwards into the fourth or next note above.\textsuperscript{62}

The use of accidentals is important to accomplish cadences or closes, especially those which occur within a composition and conclude interior strains. Bedford suggests that these may be either momentary closes on chords other than the tonic of the key or they may be more extensive sections. The cadence may take place on chords closely related to the key or distant from the key, depending on the length of composition and the mood it is expressing, and it may close on a minor triad or a major triad. Following are Bedford's nine rules for cadence structure.

The closes or cadencies in a key, are such different notes, either above the key or in the octaves below, wherein it is proper to conclude a middle strain in the same manner, as the bass concludes the whole tune.

First, the closes which are most proper, may be more freely us'd and longer dwelt upon; especially, the three best: the rest must be more cautiously handled; and such as require two accidental flats, or sharps, are hardly to be touch't without great judgment, design, and caution, and in a long piece of musick.

2dly. Besides the key it self, which is the best close of all, there are two good closes, three others which may be used for variety, and three others, which must not be used, except by an eminent master.

3dly. The next in dignity to the key is the fifth above; first because it concludes either flat or sharp, like the key itself; and secondly because it is a perfect concord to the key it self. I have seen a flat close in a fifth, tho the key is sharp, as in a set of musick by Mr. Toilet called the Country Wake; and a sharp close in a fifth above, tho the key is flat; as in the first hymn of the second part of the Harmonia Sacra, by Mr. Henry Purcel.

4thly. The next in dignity to the fifth, is that, which may be taken without the inserting of any accidental flat, or sharp, and then in a sharp key, this close is always flat, and in a flat key it is always sharp.

\textsuperscript{62}Ibid., pp. 96-100.
5thly. The next keys in dignity to those above mention'd are such closes, which can be taken, only with the addition of one flat or sharp.

6thly. Tunes in a flat key do best affect flat closes; and tunes in a sharp key do best affect sharp closes as most agreeable to their own nature.

7thly. That close is so much the worse whose sharp note bears relation inharmonical to the key; or, if the sharp note in the key bears relation inharmonical to such a close.

8thly. It is bad to close in the sharp note, because it requires two sharps to make it proper, even for a flat close:

Lastly; there are some, but very few instances of closes, in the flat note of the key sharpt, or the sharp note flatted; but this is not to be attempted by any, but with wonderful judgement, care, and caution. However, he who is willing to see any instances of this nature may find every one of these closes mention'd in an hymn set by Mr. Henry Purcell in the first part of the Harmonia Sacra, beginning with these words, Awake and with attention hear.63

An application of Bedford's nine rules leads to the results summarized in the table, Figure 62, providing a system for achieving coherent tonal relationships within a composition.

<table>
<thead>
<tr>
<th>Flat note</th>
<th>Key above gamut</th>
<th>Sharpe note</th>
<th>Key above gamut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key G</td>
<td>1</td>
<td>Key G</td>
<td>1</td>
</tr>
<tr>
<td>Key D</td>
<td>2</td>
<td>Key D</td>
<td>2</td>
</tr>
<tr>
<td>Key B</td>
<td>3</td>
<td>Key E</td>
<td>6</td>
</tr>
<tr>
<td>Key C</td>
<td>4</td>
<td>Key A</td>
<td>4</td>
</tr>
<tr>
<td>Key F</td>
<td>5</td>
<td>Key C</td>
<td>5</td>
</tr>
<tr>
<td>Key E</td>
<td>6</td>
<td>Key B</td>
<td>6</td>
</tr>
<tr>
<td>Key A#</td>
<td>7</td>
<td>Key F#</td>
<td>7</td>
</tr>
<tr>
<td>Key E#</td>
<td>8</td>
<td>Key C#</td>
<td>9</td>
</tr>
</tbody>
</table>

Fig. 62.—Bedford's table of interior cadences

63 Ibid., pp. 102-107.
64 Ibid., p. 112.
In summary, in the opening pages of his manuscript Bedford states a retrospective point of view. He suggests that harmonic and compositional skills be learned by study of counterpoint treatises. However, his examples of harmonic structures above the leading tone are homophonic and illustrate unprepared dissonances and unusual resolutions. His statements regarding cadence structures suggest a method for achieving tonal organization of a composition.

Roger North

Roger North (c. 1700-1726), in his harmonic system, emphasized the following areas: (1) justifications from natural phenomena and from effects on the hearer; (2) concepts related to the bass; (3) insights related to tonality, including "key" and "syre"; (4) basic harmonic structures; (5) available harmonic progressions; and (6) nonharmonic tones, including dissonances, "elegances," and "breaking." Each of these is discussed below.

Justifications from natural phenomena and from effects on the hearer.--Roger North held a theory of consonance based on coincidence of pulses similar to that of Francis North (1677) (supra, p. 243). His "ocular demonstration" of the coincidence of pulses, illustrated in Figure 63, is similar to that of his brother in the Philosophical Essay.65

65 Cf. Francis North, op. cit., Pl. II.
Fig. 63.—Ocular demonstration of the perfection of the major chord

The ocular demonstration can be illustrated in notes by the overtone series GG, G, D, g, b, d, g'. "And this is found to consist in a combination of pulses as 2, 3, 4, 5, 6, 8 to 1, all sounding together, as this punctuation demonstrates which I have drawn in several ranges." North believes the representation in two dimensions to be descriptive of the beauty of the sounds.

But if all lay in one range in proper distances and proportion, according to the condition of the sounds, the beauty would be no less ... It was observed before that objects exposable to the sense, as well of seeing, as of hearing, alike are delightful, or the contrary.

In addition to the perfection of the major chord, North demonstrates, from the coincidence of pulses between the fifth and seventh harmonics, the harmonic importance of the tritone.

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66 Roger North, 32534, op. cit., fol. 37r.
67 Ibid.
68 Ibid.
69 Ibid., fol. 35r.
However mechanistic the theory of perfection by coincidence of pulses may seem, it is not correct to attribute to North a strictly mechanically determined system of musical harmonic meanings. From the coincidence of pulses, he justifies the major chord as a standard of perfection, but he moves beyond this to discuss the effects of aural stimuli on relative human meanings. Specifically, he refers to the effect of music on the emotions, including the feelings aroused by the scales. "For the \( \text{major} \) expresseth joy, triumph, and prosperity, and the \( \text{minor} \) sorrow, dependence, and misfortune."\(^7^0\) He mentions other factors that contribute to musical meanings.

It were endless to enumerate all the circumstantialls that call for a masters regard; some we shall mention, and perhaps the chief. The first is the magnitude of what his art in its utmost energy can produce. He ill applies to do any thing, that knows not the most of that kind, which by any possibility may be done. And that in musick is the moving affections and exciting passions in men, joined (it may be) with an excess of pleasure. This (in the proposal) sounds great, and the peculiar means tending to it is magnitude of sound: other circumstances, as the quality of the composition, the ability of the performers, species of instruments, and the like, are common to other, and lesser undertakings.\(^7^1\)

Concepts related to the bass.—In the theory of coincidence of pulses, the bass is the normative sound in determining the character of harmonic sonorities, for all the upper parts are more or less perfect as they have more or fewer pulses coincide with pulses of the bass. North writes about the bass in detail. He distinguishes between basses which are "proper" and those which are "improper."

\(^7^0\)Roger North, 32533, op. cit., fol. 142r.
\(^7^1\)Ibid., fol. 117v-118r.
And first of the base part, which I must distinguish into proper and improper, and explain it thus; if the 3. parts sounding, any other note in the scale underneath the base, without changing the accord that is an improper base, and is the case of every 6th, 4th, and tritone, or false fifth.\(^2\)

I make a distinction between a proper base and a consort base, the former is when no note can be subjoined without changing the scale or key, and the other is when there is room for sub-addition, without alteration of the harmony other wise than by making it more perfect.\(^3\)

The meaning of the two quotations is clouded somewhat by North's use of the term "key." One of his uses for this term is to refer to the lowest harmonic, or root, of the perfect accord. North states that addition of a third below a "proper base" would change the root of the chord, whereas addition of a third below an "improper base" would result in a closer coincidence of the chord with the perfect accord. More simply, with one exception, the bottom note of a chord rearranged so the notes occur as super-imposed thirds is always the "proper base."

The exception is the tritone. Inasmuch as the tritone can be expressed by the coincidence of pulses of the fifth and seventh harmonics, the key note of the tritone must be the note represented by the first harmonic—the third below the lower note.

\[^2\] Roger North, 32537, op. cit., fol. 36.

\[^3\] Roger North, 32533, op. cit., fol. 81v.
I shall only add how the tritone or $\text{b}5$th is detracted from the same full accord, supposing the $\text{b}7$th to sound with it, which is not amiss. Silence the key root and its fifth and it is done. Figure 64. 74.

The "proper base" of the example is G. For further clarification of "proper base," North points out that any note of a consort bass may be made a "proper base note" by constructing above it the full triad.

North also uses the terms "mixt" and "consort" to refer to basses. A "mixt" bass is a bass line composed of both proper and improper bass notes. A "consort" bass is the same as an improper bass; that is, a "consort" bass note is any chord factor other than "key," as illustrated in Figure 65.

![Example of proper and consort bass notes]

Fig. 65.—Examples of "proper" and "consort" bass notes 75.

In Figure 65, the proper bass is added below the consort with a shaded note.

North uses the term "basso continuo" to apply to a mixed bass.

The term basso continuo would serve well to denote a consort base with all the proper base notes filled in, which makes it a proper base. But it is used to signify any base continually attendant upon superior music. 76

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74 Roger North, 32533, op. cit., fol. 72v.
75 Ibid., fol. 81.
76 Ibid., p. 83.
In summary, North uses the term "proper base" in the sense that Rameau uses the term "basse fondamentale." The terms "improper base" and "consort base" refer to other chord factors than the root in the bass, and the terms "basso continuo" and "mixt bass" are both used for progressions which include both proper and improper bass notes.

_Insights related to tonality._—North uses the term "key note" in two ways: (1) to refer to key center, and (2) to refer to chord root. He defines the word "key" as the "lower or leading tone--tonic--of that scale, which is intended to divide the tones that follow into proper and agreeable harmony..." However, he views all chord progression as change of key; indeed, the best change of key is that which takes place in the perfect cadence.

The chief fund of variety in musick consists in changing the key... to do it properly is a principal virtue... the best change is that which least disturbs the note of the foregoing.... And that proves to be into the fifth rising or the fourth descending, which amounts to the same. And the next change will aptly fall back into the same again.... This passage of the key is the most celebrated of any, by the name of the cadence.

North expresses the notion of tonal center in a composition by the word "ayre." It is apparently an omnibus word, meant to include ideas of harmony, the subject or melody, and rhythm. Although he includes other ideas in the concept, North states that tonality is a constituent of ayre.

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78 Roger North, 32533, op. cit., fol. 67v.
79 Roger North, 32532, op. cit., fol. 16r.
80 Roger North, 32536, op. cit., fol. 27v.
First as for the word ayre, it was taken into the language of harmony from an analogy with the flow of a gentle well tempered air abroad, as if that yielded the sound. And from musick it hath been translated to the vulgar, who call air every singular disposition not literally expressible, as the air of a man's face and the like. Therefore, it is not to be wondered if air in musick be hard to be expressed. But by way of endeavor towards it, I shall first propose a plain key note taken ad libitum, with its full accord; as the mechanism, so the idea of this sound is distinguished from that of all other keys whatever, and this peculiarity of sound is called the ayre of that key, and being once heard dwells so strong in our minds, that whatever sounds succeed they must maintain an harmonious relation with the key or some of the accord of it, or be resented as no better than discord. Therefore it is not indifferently at liberty to change the harmony from the air of one key to any other but to prevent loosing the air of the key, it must be done with a connexion, as shall be demonstrated elsewhere.81

Ayre includes the sense of tonality, and maintaining ayre involves maintaining key-related tonal relationships. In florid melodic passages, for example, chord notes must be emphasized in order to maintain the ayre.

It is a chief care and indeed a rule in the practice of breaking, that the emphasis fall upon the accord notes, or their octaves. Otherwise the ayre will be bad, or rather false. 82

![Fig. 66. Examples of bad and good ayre in a melodic passage](image)

81 Ibid., fol. 20r.
82 Ibid., fol. 20v.
83 Ibid.
The first example, Figure 66, is the way "a novice is apt to begin."

The second example is "the true emphatick air of that key."\textsuperscript{84}

North's meanings for the terms "ayre" and "key" are further clarified in the following quotation.

Having shewed whence varieties may be introduced within the compass of the proper ayre of the key, satiety will grow, if we do not provide for a change of (or at least a departure from) the key. And it must be so done, to the end air may be conserved flowing in the best manner; for the base of key note may remove into any other tone whatever, and by sounding a fifth to it become a key, as the former was. But if that tone be dissonant with the former, as all contingent or out of the way sounds must be, then the connection of them, made by a remembrance of the former with the sense of the latter proves a false air, . . . Therefore it is required that the departure of the key note shall be into some place within the scale of the former key, and expedient that it should be into some note or sound which is in consonance nearest to it.\textsuperscript{85}

Harmonic structures.—Two premises are basic to North's harmonic structures. The first is his theory of chord structure from coincidence of pulses, which he cites as evidence of the fundamental nature of the major chord. The second, related to his tonal insights and his theory of consonance and dissonance, is the principal that all pitches in the scale of a key are relatively useful in creating chord structures.

Regarding the first premise, the major chord is basic to North's system, and he perceives six-three and six-four structures as inversions of this chord.

\ldots the major accord G-B-D-g has two thirds, a larger and a lesser, 1 fifth, 1 fourth, and 1 sixth, all sounding in consort together, without any inferior accords intermixed. \ldots Now let

\textsuperscript{84}Ibid.

\textsuperscript{85}Ibid., fol. 21v.
us be free and silence G, the key or proper base, and its fifth and there remains sounding B and G a member of the full accord that is a sixth, of which the lower B is a consort base note and cannot be a key.86

North provides examples of various positions of the triad, and shows by shaded notes that the same pitch is the "proper base" of all positions.

By which it appears that every musically harmonious accord is comprised in and may be detracted from the full accord, 3d, 5th, and 8th.

And it appears also that of all these G is the only proper bass, but the rest may be consort basses.87

North points out that the major triad with minor seventh can be formed by adding the seventh harmonic to the major chord. He considers the seventh an elegance which need not be prepared, progressing with the seventh falling one degree.

Fig. 67.—Resolution of the major chord with minor seventh88

But the tone is an elegant note, and bears a direct stroke in many cases [appears in a relatively strong rhythmic position] without the ceremony of preparation or syncopation, for some notes of the full accord ring with it.89

He mentions again that this chord shows the proper base of the diminished triad to be the third below the lowest note.90

86 Roger North, 32533, op. cit., fol. 71r.
87 Ibid., fol. 72v.
88 Ibid., fol. 73.
89 Ibid., fol. 73v.
90 Ibid., fol. 88v.
Other "harsher accords" are available by the "conjunction of accord keys." This is done by combining triads in a key or by adding other chord notes in the same key. It is North's opinion that so long as the added notes are in the same scale as the key note, the added pitches do not make dissonances but harsher chords. In other words, basic triads are formed by the addition of thirds and fifths to a key note. If, however, the chord notes conjoined are interpreted in turn as keys, the chord may have added to it additional related chord notes. Thus a ninth chord is available by conjunction of the keys of a note and its fifth.

The chief in accord together, the key and its fifth either ascending or descending, either of which doth sound exceeding well with the key note, and very lofty one with another, and this makes the 2d so elegant, as by musicall experience it is found to be, as thus.

![Fig. 68.---North's conjunction of keys](image)

Fig. 68.---North's conjunction of keys

The C and D may also be adjunct, which is more harsh... but then the composer must have in his mind the scheme upon which it depends, that is fifth upon fifth, or else it may prove not so well; but when it hath a regard to the accords, underneath, it cannot be amiss.

Hence we derive the noble accord of the 4th or 4 5th, the former together and the other successive.

... [in the 4-5 structure] the key is dropt, and the rest left to sound, which being heard by a skillful ear, a change is called for, and that is to be of course into the fifth as

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91 [Ibid., fol. 90r.]
92 [Ibid., fol. 90v.]
93 [Ibid.]
here from G to D. . . . And after that no less easily, the former key G, by falling back a 5th, thus returns. 94

Fig. 69. --Common cadence from conjunction of keys 95

The intervals of the fourth and second in Figure 69 are not held to be dissonant by North. Rather, this chord is an elegance made possible by conjoining chords on G and D. Any such combination is possible, so long as the combination of notes is within the scale.

. . . And to say the truth, within the proper scale of a key, we may make confusion, but it is not easy to make a bad sound, but the least step into other keys, is resented at the very first touch; . . . 96

The combination of chords results in what North terms "harsher accords." In addition to the ninth or second already mentioned, which are available by combining triads a fifth apart, North lists several other combinations. One of these is the chord of the major seventh. North calls this the "beat-up," pointing out that the usual movement is for the seventh to move upward to the octave. The seventh is available by combination of chords, as the third above the fifth. However, if the duration of sound is continued too long, the "relation will be lost." 97

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94 Ibid., 32533, fol. 90v-91r.
95 Ibid.
96 Roger North, 32536, op. cit., fol. 22v.
97 Ibid.
Another harsher combination is that which North has heard performed by organists who achieve great sonority by sustaining all the notes of the chord on the fifth degree of the scale with those notes of the chord on the first degree of the scale.

![Musical notation](image)

*Fig. 70.* "Harsher accords" by combination

The close relation of those two chords makes such combinations possible.

... I must observe that the affinity, of these 2 keys, that is the close note (now to call it so) and its fifth, or cadence note, is such that they bear each othersaccords almost promiscuously, ... 99

Sustaining these chords into each other provides a sound of great "lustre."

... and this lustre is given to musick chiefly in organ's upon which a master will crowd downe all the keys of accord to those two sounds he can, so that the hearer shall be amazed at the noise, not fit to continue long, such is the confusion and blast of the notes, but an artificiall [artistic] dropping away divers harsh notes one after another, and so falling into a full accord render it infinitely more acceptable than other noise it would have bin.100

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98 Roger North, 32533, *op. cit.*, fol. 92v.


100 *Ibid.*
North recommends resolution of the "harsher accord" by release of the notes until only the tonic chord is left to sound.

**Harmonic progression.**—Roger North's rules for harmonic progression also result from his theory of harmony based on the relationships found by coincidence of pulses. The best chord change is that "which least disturbs the note of the foregoing." By this North apparently means that the best progression is that of the proper base moving in fourths or fifths—the most consonant intervals.

And that proves to be into the fifth rising or the fourth descending, which amounts to the same. And the next change will aptly fall back into the same again.

![Fig. 71.](image)

... this passage of the key is the most celebrated of any, by the name of the cadence.

The first chord of the example North calls the "preparation," the second chord is the "cadence," and the third chord is the "close note." If the progression goes no farther than the second chord, "it is a semicadence."

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101 Ibid., 77r.
102 Ibid.
103 Ibid., 77v.
104 Ibid.
105 Ibid.
The continued motion of the proper base in skips of fourths and fifths provides ways to "change the key round the scale and not to break the harmony."¹⁰⁶ This movement of the proper base is shown in Figures 72 and 73. Figure 72 illustrates proper base movement in fourths and fifths, remaining in one tonality.

Fig. 72.—Proper base movement in fourths and fifths¹⁰⁷

Fig. 73.—Proper base movement in perfect fourths and fifths¹⁰⁸

In Figure 73, North shows that movements from a given proper base note may be made into tonalities related to that note, rather than necessarily to the original key.

¹⁰⁶ Ibid.
¹⁰⁷ Ibid., fol. 78r.
¹⁰⁸ Roger North, 32536, op. cit., fol. 28. (28r-28v).
It is ever to be observed that after some length of time, the note into which a change is made, becomes as it were primary, and from thence other changes may be made ad infinitum.

So the proper base may either remain in an original tonality or pass into keys related to the original tonality by way of consonant motion. North adds that "it may be observed that those notes which accord best with the key, are aptest to receive the change, . . . "

Other intervals of close accord to the key found in the "full accord" include thirds and sixths. The thirds and sixths may be either major or minor, for both kinds of thirds and sixths can be found in the inversions of the major chord. Since the harmonic structures above the proper base also may be major or minor, North has available already at this point a variety of harmonic progressions.

... by these instances it may appear that the proper changes of the key are made into the notes of the full accord, either ascending or descending, so that with and after the change, the key note may continue to sound in consort with a notable variety of flat and sharp keys. And thus by step one after another, the change of keys in admirable concatenation [in great variety] may be carried on properly thro the whole scale, a track well known to composers. And it plainly shows how much variety these changes yield.

North states that the progression of the proper base in "2ds or 7ths or semitones out of order, or the like," is improper because "the key continuing to sound with its accords shall make with the other the worst sort of discord." The example in Figure 74 is given, but

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109 Roger North, 32533, op. cit., fol. 78r.
110 Ibid., fol. 78v.
111 Ibid., 79v.
112 Ibid., 80r.
the explanatory information in the manuscript has been crossed out.

Fig. 74.--Example of proper base movement by a second

Following is the statement which has been crossed out.

In the mean time take the scheme of a prolonged cadence, out of which very good, if not the best, harmony is found.

In another manuscript North offers the following proper base, Figure 75, without explanation for the movement by seconds.

Fig. 75.--Proper base combining skips with movement by seconds

The following figures illustrate some of the harmonic possibilities of North's system. Figures 76 to 79 show possible harmonic interpretations of ascending and descending mixt base lines. The shaded notes are the proper bass. In these examples, the proper base of the diminished triad is a third below the lowest note when the triad is rearranged into thirds.

\[ ^{113}\text{Ibid., fol. 78v.} \]

\[ ^{114}\text{Ibid.} \]

\[ ^{115}\text{Roger North, 32536, op. cit., fol. 29r.} \]
Fig. 76.--Harmonization of a mixt base ascending\textsuperscript{116}

Fig. 77.--Harmonization of a mixt base descending\textsuperscript{117}

Fig. 78.--A mixt base descending "with another air"\textsuperscript{118}

Fig. 79.--Harmonization of a mixt base descending\textsuperscript{119}

\textsuperscript{116}Ibid., fol. 88r.

\textsuperscript{117}Ibid., fol. 88v.

\textsuperscript{118}Ibid.

\textsuperscript{119}Ibid.
Figure 80 illustrates the harmonization of a mixt base. Here, North shows how the music would appear in a full score.

A sequence of seven-six suspensions in two parts with the bass moving on the resolution results in a continuous succession of seventh chords. Such a progression is illustrated in Figure 81. The passage in which the proper base continuously rises a fourth or falls a fifth North terms a "consort of cadences." The passage is used by North to illustrate that "a b7th is of itself a noble accord."\(^{121}\)

\(^{120}\)\textit{Ibid.}, fol. 89.

\(^{121}\)\textit{Ibid.}, fol. 100v-101r.
Fig. 81.—Consecutive sevenths with a consort of cadences\textsuperscript{122}

Alternating thirds and sixths, with a proper base skipping up a fourth and down a fifth, results in the following passage, Figure 82.

Fig. 82.—Proper base of cadences, alternating thirds and sixths\textsuperscript{123}

According to North, this pattern was used by Corelli.

The great Corelli hath spun out of this a more complex webb, which I never saw in any other author, and is put together thus.\textsuperscript{124}

\textsuperscript{122}\textit{Ibid.}

\textsuperscript{123}\textit{Ibid., fol. 101v.}

\textsuperscript{124}\textit{Ibid.}
Alternate proper base skips of thirds and either fourths or fifths provides a possible harmonization for a chromatic mixed bass. Figure 84 illustrates such a progression in an ascending passage.

The progression is similar to Rameaus's "chromatic genus," illustrated in Figure 85.

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125 Ibid.
126 Ibid., fol. 102.
With his theory of harmonic progression from the movement of the proper base, Roger North states ideas of chord progression similar to those of Rameau. The proper base functions in the same way as Rameau's "basse fondamentale." North emphasizes proper base movement in fifths and fourths—Rameau's "triple progression," and in thirds and sixths—Rameau's "quintuple progression." 128

There are differences in the theories of the two authors, of course. An example is in the approach to seventh chords. In the Traité, Rameau constructs dissonances larger than the octave by "supposition," that is, additional thirds are added below the fundamental chord. North justifies such harmonic structures by the principal of "conjunction of accord keys," that is, they are accomplished by joining two related chords. 129

Nowhere does North mention the work of Rameau. Musical ideas expressed by the two authors are similar, but terminology is different. Manuscripts containing North's harmonic ideas pre-date the Traité (1722), and most of them pre-date the Nouveau Système (1726).

**Non-harmonic structures.**—The term "non-harmonic" is used here to mean tones sounding with, but not a basic part of the chord structure. However, North rejects such terminology for describing sounds that are so important to good composition. To him, tones outside the normal harmony are not non-harmonic, nor are they dissonant, rather they are "consonant elegances." By this, North seems to mean that

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129 Cf. Roger North, 32533, op. cit., fol. 90v-91r and Rameau, Traité, op. cit., pp. 73-77.
such tones are ornaments that sound appropriately with the basic harmony. The elegances are of several kinds, including "playing on each side of a note," "intermixture," and "artificial gracing."

According to North, "playing on each side of a note" is a device used by the best composers. In this elegance, one or more of the voices sound tones on either side of the basic harmony as in Figure 86. "Playing on each side of a note" is especially appropriate, according to North, to express passion, sighing, or quarreling.

"Intermixture" is the term used by North to refer to the elegances made by having one or more parts ornament the basic harmony in syncopations or with arpeggios, passing tones, and auxiliaries in rapidly moving passages. The suspension syncope North calls "intermixture by halving." Arpeggiating, filling between chord tones with scale passages, and adding auxiliary notes he terms "intermixture by breaking." Figure 88 illustrates "mixt breaking." It includes arpeggios, passing tones, and auxiliaries.

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131 Ibid., fol. 96v.
This is a mixt breaking, because some accords are found as principals in it. But for this whole matter, nothing can be more cusulent than Mr. Symson's discourse and examples, who hath treated it ex professo.\textsuperscript{134}

In addition to "intermixture," non-harmonic tones are possible by "artificial gracing." The term "artificial gracing" refers to the various idiomatic ornaments added to upper parts which are not notated, but left to the performer's discretion. North mentions the "beat-up" -- an upward resolving appogiatura, the "back-fall" -- a downward resolving appogiatura, "shaking graces" -- trills, and "slurs by a third or fifth" -- rapid passages of passing notes.\textsuperscript{135}

\textsuperscript{132} Ibid., fol. 97v.
\textsuperscript{133} Ibid., fol. 99r.
\textsuperscript{134} Ibid.
\textsuperscript{135} Ibid., pp. 106-115v.
In summary, North's system grows from a theory of sound which finds relative perfection in the coincidence of vibrations observed in the overtone series. He uses this theory both to justify harmonic structures and to form a system for harmonic progression. Important to the system are his concepts of key, ayre, proper base, and chords by conjunction. But the system is no neat package: coincidence of pulse justification is only a starting point for North's conversation on compositional possibilities and performance practices of his time.

Alexander Malcolm

The compendious Treatise of Music by Malcolm (1721) has one chapter on homophonic harmonic practices. Whereas there is much information on consonant and dissonant intervals, the section on harmonic practice is limited in scope and some of the information was given to Malcolm "by a friend, whose modesty forbids me to name." Malcolm attempted to state only principles.

What I proposed was, to set forth the principles of composition in two parts, by way of institution only, not daring to proceed any further than the small knowledge I have of musick would lead me with safety. Facets of harmonic practice which he treats in detail include: (1) a system for ordering chords according to their perfection based on harmonic arithmetic, (2) rules for melodic and harmonic progression, (3) non-harmonic tones, and (4) modulation.

Harmonic arithmetic.—Malcolm goes into great detail in attempting to quantify musical sonorities using harmonic arithmetic. From

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137 Ibid., p. 450.
proportional relationships of the intervals, he constructs an order for the perfection of chords.

Harmony is a compound sound consisting (as we take it here) of three or more simple sounds; the proper ingredients of it are concords; and therefore all discords in the primary relations especially, and also in the mutual relations of the several acute terms are absolutely forbidden.

Now any number of concords being proposed to stand in primary relation with a common fundamental; we discover whether or no they constitute a perfect harmony, by finding their mutual relations.\textsuperscript{138}

Not only must the harmonic relationships of all intervals be consonant, but also the relative perfection of the constituent intervals determines the degree of perfection of the chord. The relations are of three kinds: primary, secondary, and mutual.\textsuperscript{139} The primary relationships are the proportions of upper notes to the bass. The secondary relations relate the factors of a chord by coincidence of vibrations, and the mutual relations are the proportions that exist between the upper voices.

1st. The primary relation of every simple sound to the fundamental (or gravest) whereby they make different degrees of concord with it. 2dly. The mutual relations of the acuter sounds each with another, whereby they mix either concord or discord into the compound. 3dly. The secondary relation of the whole, whereby all the terms unite their vibrations, or coincide more or less frequently.\textsuperscript{140}

For example, in the chord with major third, fifth, and octave, the primary relations are 4:5, 2:3, and 1:2, which are all concords. The mutual relation of the upper factors, lesser third, lesser sixth, and

\textsuperscript{138}ibid., p. 205.
\textsuperscript{139}ibid., p. 201.
\textsuperscript{140}ibid.
fourth, are 5:6, 5:8, and 3:4, which can be expressed as 30:24:20:15, and which are also consonant. The secondary relation of this group of intervals is $\frac{4}{1}$, obtained in the following manner.

Lastly, to find the secondary relation of the whole, find the least common dividend to all the lesser terms or numbers of the primary relations, l. 3. the least number that will be divided by each of them exactly, without a remainder; that is the thing sought, and shows that all the simple sounds coincide after so many vibrations of the fundamental as that number expresses.\textsuperscript{141}

Here, Malcolm is using the word "fundamental" not to refer to the bass of the chord, as in the primary relations, but rather to a fundamental which is computed by figuring the least common denominator to the lower terms of the primary relations.

The order of consonance of harmonies is determined from the three types of relations, according to rules which Malcolm lists.

Now upon all the three things mentioned, viz. the primary, secondary, and mutual relations, does the perfection of harmonies depend; so that regard must be had to them all in making a right judgment: it is not the best primary relation that makes best harmony, for then a 4th and 5th must be better than a 4th and 6th, yet the first two cannot stand together because of the discord in their mutual relation: nor does the secondary relation carry it; for then also would a 4th and 5th, whose secondary relation with a common fundamental is 6, be better than 3d l. and 5th. whose secondary relation is 10; but here also the preference is due to the better mutual relation of the 3d. l. and 5th., which is a 3d g. and a fourth and octave would be equal to 6th g. and octave, the secondary relation of both being 3, which cannot possibly be, the ingredients being different. As to mutual relations, they depend altogether upon the primary, yet not so as that the best primary relation shall always produce the best mutual relation; for 'tis contrary when two terms are joyned to a fundamental; so a 5th and octave contain betwixt them a 4th; and a 4th and octave contain a 5th. But the primary relations are by far more considerable, and, with the secondary, afford us the following rule for determining the preference harmony, in

which that must always be taken for a necessary condition, that there be no discord among any of the terms; therefore this is the rule, that comparing two harmonies (which have an equal number of terms) that which has the best primary and secondary relation, is most perfect; but in two cases where the advantage is in the primary relations of the one, and in the secondary of the other, we have no certain rule; the primary relations are the principle and most considerable things, but how the advantage here ought to be proportioned to the disadvantage in the secondary, or contrarily, in order to judge of the comparative perfection, is a thing we know not how to determine; and therefore a well tuned ear must be the last resort in these cases.\textsuperscript{142}

So when this number system fails to work, resort is had to the judgment of the senses!

In Figure 89, ways the seven simple concords can be combined are listed, along with the resulting secondary relations.

\begin{tabular}{|c|c|c|c|c|c|}
\hline
interval & 2dry rel. & interval & 2dry rel. & chord \\
\hline
5th & 8th & 2 & 3d g. & 5th & 4 & 3d g. & 5th & 8ve \\
4th & 8ve & 3 & 3d l. & 5th & 10 & 3d l. & 5th & 8ve \\
6th g. & 8ve & 3 & 4th & 6th g. & 3 & 4th & 6th g. & 8ve \\
3d g. & 8ve & 4 & 3d g. & 6th g. & 12 & 3d g. & 6th g. & 8ve \\
3d l. & 8ve & 5 & 3d l. & 6th l. & 5 & 3d l. & 6th l. & 8ve \\
6th l. & 8ve & 5 & 4th & 6th l. & 15 & 4th & 6th l. & 8ve \\
\hline
\end{tabular}

Fig. 89.--Malcolm's table of harmonics\textsuperscript{143}

There are problems in his system of quantifying harmonic values, and Malcolm is aware of some of them. For example, the fourth appears high on the list of consonances, yet it fulfills a harmonic function which is different from the other consonant intervals.

\ldots since all the rest of the concords in musick are only useful for varying of the 5th, certainly the 4th which does not so is useless, which is plain from this, that if we put it next the bass, the acuter 5th will resound, and there the

\textsuperscript{142} Ibid., pp. 206-208.

\textsuperscript{143} Ibid., p. 208.
ear will observe it out of its place, therefore the 4th would be very displeasing, as if we had the shadow for the substance, an image for the real thing.\footnote{\textit{Ibid.}, p. 213.}

The system of secondary relations is impressive by the quantity of calculations, but it is based wholly on number proportions already used to describe the primary relations and so adds no new information to the understanding of a chord. The only advantage would seem to be the use of only one number to describe several proportions. Malcolm calls the secondary relation a "fundamental" but he uses it as a number rather than a pitch.

Malcolm applies his system only to "consonant" structures of no more than three different notes. The system could only function as introductory to greater harmonic complexities.

Voice leading.--Malcolm lists five rules for the succession of intervals "in the several parts."

(1) The treble ought to proceed by as little intervals, as is possible consistent with that variety of air which is the distinguishing character.
(2) The bass may proceed either gradually or by larger intervals, at the will of the composer.
(3) The ascending by the distance of a false fifth is forbid, as being harsh and disagreeable; but descending by such a distance is often practised especially in the bass.
(4) To proceed by the distance of a spurious 2d, that is, from any note that is $\#$ to the note immediately above or below it that is $b$; or from any note $b$ to the note immediately above or below it $\#$, is very offensive.
(5) The proceeding by the distance of a 7th $l$, in any of the parts is very harsh.\footnote{\textit{Ibid.}, p. 421.}

Rules for harmonization.--After discussing the movement of the parts, Malcolm discusses the motion of the harmonies.
First, he writes about perfect and imperfect harmony in terms similar to those later used by Pepusch (infra p. 296). Perfect harmony he defines as the bass, third, fifth, and octave--root position triads. Imperfect harmony he defines as the bass with the third and sixth--first inversion triads.

To apply first the preceding distinction of perfect and imperfect harmony, take this general rule, viz. to the key f. ["f." refers to the fundamental, or bass octave] to the 4th f. and to the 5th f. a perfect harmony must be joined. To the 2d f. to the 3d f. and to the 7th f. an imperfect harmony is in all cases indispensably required. To the 6th f., a perfect or imperfect harmony is arbitrary.146

By these rules the following are possible: a triad on the key note, six-three chords on the second and third scale degrees, triads on the fourth and fifth scale degrees and a six-three chord on the seventh scale degree. Either a triad or six-three chord is possible on the sixth scale degree. The effect of these rules is to emphasize tonic, sub-dominant, and dominant chords in root position or first inversion.

Malcolm lists rules for harmonization in two parts. In spite of the existence of only two melodic lines, the rules indicate that the second part is harmonically constructed above a base which is conceived tonally as the foundation of a compound harmonic structure.

1. The key f. may have either its octave, its 3d or its 5th.
2. The 4th f. and 5th f. may have either their respective 3ds or 5ths; and the first may have its 6th; as to favour a contrary motion, the last may have its octave.
3. The 6th may have either its 3d, its 5th or its 6th.

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146 Malcolm, op. cit., p. 423.
4. The 2d f. 3d f. and 7th f. may have either their respective 3ds or 6ths; and the last may, on many occasions, have its false fifth.\textsuperscript{147}

**Non-harmonic tones.**—Under the subject "discords, or figurate counterpoint," Malcolm presents two kinds of non-harmonic tones.\textsuperscript{148}

One kind of "figurate counterpoint" is that "of the transient discords that are subservient to the air, but make no part of the harmony."\textsuperscript{149}

Another kind is "that wherein the discords are made use of as a solid and substantial part of the harmony; . . . "\textsuperscript{150}

Regarding the first kind of non-harmonic tones, Malcolm makes this statement.

The harmony must always be full upon the accented parts of the measure, but upon the unaccented parts that is not so requisite: wherefore discords may transiently pass there without any offence to the ear: this the French call supposition, because the transient discord supposes a concord immediately to follow it, which is of infinite service in musick, as contributing mightily to that infinite variety of air of which musick is capable.\textsuperscript{151}

He lists four kinds of discords by "supposition."

1. Passing tones, "when the parts proceed gradually from concord to discord, and from discord to concord."\textsuperscript{152}

2. Discords which resolve by the skip of a third downward,\textsuperscript{153} illustrated in Figure 90.

\textsuperscript{147}Ibid., pp. 423-24.  
\textsuperscript{148}Ibid., p. 433.  
\textsuperscript{149}Ibid.  
\textsuperscript{150}Ibid., p. 435.  
\textsuperscript{151}Ibid., pp. 433-34.  
\textsuperscript{152}Ibid., p. 433.  
\textsuperscript{153}Ibid.
Fig. 90.—Discords resolved by skip of a third downward\(^1\)

3. Discords resolved by leap of a fourth downward.

Fig. 91.—Discords resolved by leap of a fourth downward\(^2\)

4. Discords which fall on the accented parts of the measure.

These must be followed by a step-wise resolution downward.

Fig. 92.—Accented discords\(^3\)

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\(^1\) Ibid., Pl. 6.

\(^2\) Ibid.

\(^3\) Ibid.
The second kind of "figurate counterpoint," includes suspension structures. The requirement is that the discord be prepared by the same note in the preceding chord and resolved by step downward to a consonance in the following chord, as in Figure 93.

![Figure 93](https://example.com/figure93.png)

**Fig. 93.**—Suspension structures

**Modulation.**—The final harmonic subject which Malcolm treats in detail is modulation.

Altho' every piece of musick has one particular key wherein it not only begins and ends, but which prevails more through the whole piece; yet the variety that is so necessary to the beauty of musick requires the frequent changing of the harmony into several other keys; on condition always that it return again into the key appropriated to the piece, and terminate often there by middle as well as final cadences, especially if the piece be of any length, else the middle cadences in the key are not so necessary.

Keys available for modulation are those which do not use any of the "five extraneous notes" of the key for either the first or third degree. In other words, a key is closely enough related to be used in modulation if its root and third are included in the seven natural notes of the original scale of the composition. According to this rule, the following possibilities exist.

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Malcolm suggests an order for using these keys in constructing a composition.

In a sharp principal key, the first cadence is upon the principal key itself often; then follow in order cadences on the 5th, 3rd, 6th, 2nd, 4th, concluding at last with a cadence on the principal key. In a flat principal key the intermediate cadences are on the 3rd, 5th, 7th, 4th, and 6th. Now, whatever liberty may be taken in varying from this order, yet the beginning and ending with the principal key is a principle never to be departed from; and as far as I have observed, it ought to be a rule also that in a sharp principal key, the 5th, and in a flat one the 3rd, ought to have the next place to the principal key.  

To complete a summary of Malcolm's comments on modulation, it is only necessary to add his six rules "to guide the beginner" in his first attempt at modulation. The rules state that modulation is accomplished by introducing the leading tone of the new key. Figure 94 is illustrative.

1st. The 7th g. [seventh greater, or leading tone] of the key into which we intend to lead the harmony, is introduced into the treble either as a 3rd g. or 5th g. or as a 4th g. with its supposed accompaniments of 4th and 6th; and as 3rd g. or 6th g. it is commonly the resolution of a preceding discord. 

2do. When this 7th g. comes into the treble in what quality soever, as 3rd g. 7th g. etc. it is either succeeded immediately by that note which is the key where to it immediately leads, or immediately preceded by it, and most commonly the last; in which case the treble must of consequence descend to it by the distance of a semitone. Thus, when we are to change the harmony from the sharp key c to the flat key a, that is, from a sharp...
principal key into its 6th, we use it in the treble as the 6th to the principal key c, or as the 5th to d, or as the 3d to f; and being once upon the note which we design to be the key, the falling half a note to its 7th g. for fixing the harmony fairly in the key, is most easily performed; thus were we to go from a principal key into the 3d, we should use a 6th on the 5 f.; or were we to go into the 2d, we should use a 6th on the 4 f. and the rather, because in the key whereto we design to go, a 6th is the proper harmony, for that 5th f. of the principal key becomes the 3d f. of the 3d, when it is constituted a key; and so does the 4th f. of the principal key become the 3d f. of the 2d, when it is constituted a key.

3nd. When the 7th g. of the key, into which we design to change the harmony, is introduced in the bass, it is always immediately succeeded by the key; and then the transition to the 7th g. is most part gradual, by the interval of a tone or semitone, or by the interval of a 3d f. But most commonly it is introduced into the bass, by proceeding to it from the natural note of the same name, that is, from a note that is natural in the key, as from f to f♯ in the sharp key c, or from b to b in the flat key d.

4th. When the 7th g. of the key to which we design to lead the harmony, is one of the seven natural notes of the key wherein the harmony already is, the introducing it into the bass is most natural, as being of course; this happens when we would modulate from a sharp key into its 4th, or from a flat key into its 3d. In which cases the 7th g. is introduced into the bass, and in the treble the false 5th is applied to it, which resolves into the 3d g.

5th. When this 7th g. comes into the bass, it must of necessity have either a 3d f. 6th f. or false 5th in the treble; if a 3d f. it resolves into the 8ve, if a 6th f. it commonly passes into the false 5th, and from thence resolves into the 3d of the key.

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Fig. 94.--Example of modulation

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161 Ibid., Pl. 7.
6to. By applying the 6th to any note of the key, to which the 5th is a more natural harmony, as for example, to the key itself, to the 4th f. or 5th f. a preparation is thereby made for going into another key, viz. into that note which is so made use of, as a 6th to any of these fundamental notes, as in the examples. 162

Similarities to the theories of Pepusch. —Based on evidence in format and terminology, it is possible that the friend, whom Malcolm credited with giving him much of his harmonic information, may have been Pepusch or someone familiar with the work of Pepusch. Malcolm's terminology is similar to that of Pepusch (infra, p. 296). Both works use the terms "perfect harmony" and "imperfect harmony" to refer respectively to chords with bass, third, fifth and to chords with bass, third, sixth. Both use the terms "perfect" and "imperfect" harmony to emphasize chordal structures with roots on the key note, fourth, and fifth scale degrees. They are similar in using the term "supposition" to refer to non-harmonic tones, although they do not agree on the meaning of this term. Malcolm adds an observation on use of the term by the French; however, his use of "supposition" is different from that of Rameau. 163 Finally, both Malcolm and Pepusch present rules for achieving tonal interest within a composition by means of modulation.

But the works of Pepusch and Malcolm are not identical in all respects. Malcolm's "perfect and imperfect harmonies" are Pepusch's "common and uncommon concords." In regard to the subject of modulation, Pepusch limits the keys of modulation to the various modes.

162 Ibid., pp. 448-50.
163 Cf. Rameau, Traité, op. cit., pp. 73-77.
Malcolm mentions the modes but suggests modulation into closely related "sharp" and "flat" keys. With reference to "perfect" and "imperfect" chords, Pepusch says that the second, third, and sixth scale degrees may introduce new harmonies by being used as the bass of either "perfect" or "imperfect" chords; Malcolm mentions only the latter.

Summarizing Malcolm's harmonic vocabulary, his chord structures are defined and placed in order of perfection, according to proportions within the chord, by a system of proportions which is detailed but arbitrary and limited. Malcolm's systems of chord progressions and tonal organization are oriented toward functional relationships to a unifying key or tonality. His system emphasizes triads in root position and first inversion built from the first, fourth, and fifth degrees of the scale. He calls non-harmonic tones "figurate counterpoint," and includes in this category passing tones, escape notes, appoggiature, and suspensions. He provides instructions for modulating to closely related keys, suggesting that modulation is accomplished by introducing the leading tone in the new key.

John Fond

The New System of Fond (1725) is included in the discussion of harmonic vocabulary not because of the harmonic resources described in the work but because of his harmonic ideas. Indeed, no detailed descriptions of harmonic possibilities or instructions for composition are included in the work. Rather, Fond seems to assume that a commonly accepted system of harmony exists, and the New System is both critical and corrective of the commonly accepted system.
Fond's approach.—Fond suggests a change in notation to a system in which all twelve pitches of the chromatic scale are identified by the symbols 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, u, d, with t, q, and Q identifying the thirteenth, fourteenth and fifteenth semitones. ¹⁶⁴ A second suggestion is that a new and consistent tablature for the system of cleffs be established. ¹⁶⁵ In the textual material relating to the discussions on scale and cleff Fond's harmonic ideas are stated. Specifically, two subjects are mentioned: (1) the importance of "passion" to "harmony," and (2) the relationships of "air," "harmony," and "compound bass."

Fond's technique is to select a term or notion in common use and hold it for scrutiny in order to discover new shades of meaning. At its worst, the technique bogs down in a mass of words and minor technical inferences; at other moments the descriptions reveal sensitive musical insights. For example, he lists three meanings for the word "key." The first meaning is "the pieces of wood or ivory by which the strings of a harpsichord are struck." ¹⁶⁶ The second is "the note in which an air ends," ¹⁶⁷ and the third is "the general humor or mode of an air." ¹⁶⁸ Fond's discussion of these ideas requires fifteen pages of his text. ¹⁶⁹ Included in the discussion is his suggestion that

¹⁶⁴ Fond, op. cit., p. 113.
¹⁶⁵ Ibid., p. 142.
¹⁶⁶ Ibid., p. 45.
¹⁶⁷ Ibid., p. 53.
¹⁶⁸ Ibid., p. 55.
¹⁶⁹ Ibid., pp. 45-60.
the term "soft" rather than "flat" be used in referring to a minor key, and "gay" rather than "sharp" be used in referring to a major key.\footnote{170 Ib.\textit{,} p. 50.}

Passion and Harmony. -- "Harmony is the pleasing effect of the compound or joint sound of two or more particular notes without passion."\footnote{171 Ib.\textit{,} p. 5.} To Fond, harmony has only temporary meaning apart from passion. Just what "passion" is, Fond does not make clear, other than that it equates with melody or "air." Passion and harmony Fond calls the two "integrary" as well as the two "integrant" parts of music.

Integrary parts of any whole, are barely parts of that whole; but integrant parts of a whole, are all the parts of it considered as joined together, and making up that whole.\footnote{172 Ib.\textit{,} p. 6.}

Having the proper mixture of these two components was "the characteristic of the late glorious Corelli."\footnote{173 Ib.\textit{.}}

Air, harmony, and compound bass. -- In a similar way, air--melody, harmony, and compound bass--figured bass, are inter-dependent.

The most elaborate and the most curious compound basses, which is that treasure itself, will not entertain so well nor so long as the best airs will. They cannot do it, even joined to a good deal of air, as indeed they cannot exist without some: In short compound bass, which is harmony, cannot exist without air or passion; whereas passion exists without harmony.\footnote{174 Ib.\textit{,} p. 7.}

At this point, Fond seems to use the terms "harmony," and "compound bass" synonymously. However, later he distinguishes between the two terms.
compound bass cannot exist without passion, and it is certain that harmony does sometimes exist without it; but when it does, as exemplified above, it does not make anything of a bass, nor indeed of a treble. It does please indeed, but the pleasure it affords, ends almost as soon as it begins; and that pleasure cannot be lengthened but by the addition of a little air.\textsuperscript{175}

Whatever the technical relationships of the various constituent parts of music which Fond is struggling to describe, it is clear that he is emphasizing the emotional and affective meanings of musical structures.

**Johann Christopher Pepusch**

Pepusch's point of view.--The writings on harmony of Pepusch (1730, 1731, and 1746 and c. 1750) offer a system of chord progression using a fundamental bass, but suggest nothing in the way of harmonic sonorities not available in the treatises already discussed. Pepusch was familiar with the writings of the ancients, and his preoccupation with Greek theory, as well as the hexachord system, permeates his theoretical writings. Apparently his knowledge of the older theorists was highly regarded by his contemporaries, for his reputation as a theorist was mentioned by Hawkins (1776)\textsuperscript{176} and it was after presenting a paper on the topic of Greek theory to the British Royal Society that he was made a member of that august group. However, from the point of view of harmonic idioms, his writings are a curious blend of the old and the new. The first aspect of harmony in Pepusch's works to be treated here is cadence, followed by his principles for chord progression and his approach to non-harmonic tones.

\textsuperscript{175}Tbid.

\textsuperscript{176}Hawkins, \textit{op. cit.}, Vol. II, p. 884.
Cadence structures.—Pepusch equated the various cadences with punctuation in language.

A cadence is in musick, the same as a period or full stop is in speaking or writing; that is to say, it is a termination or ending either of a part, or of the whole piece of musick; as the full stop is either of one sentence only, or of the whole speech.

For which reason cadences are distinguished into full cadences, and into middle cadences; these last like commas and semicolons, never making so full a stop as the others, so that more is expected to follow; whereas after a full cadence, we are sensible that we are come to a conclusion.\textsuperscript{177}

He cites the following examples in two voices. These include the 2-3 and 7-6 suspensions, followed by the unison or octave, typical of earlier two-voice contrapuntal style.

\begin{center}
\begin{tikzpicture}
\end{tikzpicture}
\end{center}

\textit{Fig. 95}.—Pepusch's cadence structures\textsuperscript{178}

\textsuperscript{177}Ibid., p. 5.

\textsuperscript{178}Ibid., pp. 39-43.
Cadences two and four on E show cadence possibilities in the Phrygian mode. This differs from all other keys,

... for they are introduced or brought in by the semitone below them, but this key is by the semitone major above it, that is to say, from F downwards to E.

It is because of this difference and peculiarity, that the key of E is as it were dedicated and appropriated to church musick, this difference in its modulation, making what is composed in it the most solemn, and therefore the Italians call it tuono di chiesa.179

The last cadence above, which Pepusch calls the "grand cadence," is to be used only in writing more than two parts.180

Pepusch suggests some rules for tonal organization of cadences within a composition, but his statements in this regard are not as complete as those of Bedford (supra, pp. 250-53).

The cadences that finish or end in the unison or in the eighth, are only proper to finish a full sentence, and as has been said answer to the full stop in writing, and therefore are called final cadences.

All other cadences beside these mentioned are middle cadences; that is to say, they are to be used in the middle of a piece of musick, but not at the end of it.

The best or fullest of these is the fifth; it answers not only to the colon, and to the semicolon, but also to the interrogation, and to the admiration stops in writing.

The middle cases in the sharp third or in the flat sixth are the next best; these also serve for a weaker kind of interrogation . . .

The last and worst middle cadences are in a flat third, or in a sharp sixth; they are unfit for finishing a piece, since they answer to a comma only in writing.181

The concluding statements on cadence by Pepusch in the 1730 and 1731 treatises, deal with the deceptive cadence.

179 Ibid., p. 54.
180 Ibid., p. 43.
181 Ibid., p. 45.
We will conclude the subject of cadences, by mentioning what is called the flying or avoiding cadence; what is meant hereby is that when after having prepared and resolved the discord which precedes the cadence, instead of using or falling a degree, we skip upwards or downwards, insomuch that after having done what is requisite for a cadence, instead of finishing and completing it, we break off by going somewhere else.\textsuperscript{182}

The cadence structures in the two published treatises seem to be contrapuntally conceived except for the "grand cadence." However, the British Museum manuscripts by Pepusch (c. 1750) suggest other homophonic structures in preparing for cadence; specifically, the use of what later theorists term the leading tone seventh and diminished seventh of the dominant. Pepusch mentions the minor seventh or diminished seventh being "prepared," but in the examples both voices move both to and from the dissonance.

However, in the preparing for a cadence, both the flat and the deficient 7th, may be prepared in both the treble and bass together, and struck at the same time, without holding--or keeping--on either.\textsuperscript{183}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig96}
\caption{Fig. 96.--Examples of preparation for the cadence\textsuperscript{184}}
\end{figure}

\begin{footnotesize}
\begin{enumerate}
\item\textsuperscript{182}\textit{Ibid.}, p. 46.
\item\textsuperscript{183}\textit{Pepusch, 29429, op. cit.}, fol. 3v.
\item\textsuperscript{184}\textit{Ibid.}
\end{enumerate}
\end{footnotesize}
The first example is not allowed because "it makes a tritone to the next following note."\textsuperscript{185} The second example illustrates the leading tone seventh of the dominant and the third example illustrates the diminished seventh of the dominant. Further examples, Plate XVII, page 297, illustrate similar progressions in other keys. At the bottom of the folio, Pepusch indicates that the minor seventh may be used in place of the diminished seventh. No examples are given of cadences on the seventh scale degree although cadences are suggested on B with a key signature of one sharp. Key signatures for the "flat keys" reflect modal thinking, and the fact that Pepusch does not always indicate a leading tone in the chord preceding the final is another evidence of his bias toward the modes.

Bass progression on perfect and imperfect concords.—Pepusch's uses of the terms "common chords," "uncommon chords," "perfect concords" and "imperfect concords" are as follows. A "common chord" contains the intervals 3, 5, and 8 above the bass, whereas an "uncommon chord" contains the intervals 3, 6, and 8 above the bass. The "perfect concords" are the key note, fourth and fifth, illustrated in Figure 97.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure97.png}
\caption{Example of the "perfect concords of C key"\textsuperscript{186}}
\end{figure}

\begin{enumerate}
\item \textsuperscript{185}\textit{Ibid.}
\item \textsuperscript{186}\textit{Ibid., fol. 14v.}
\end{enumerate}
PLATE XVII

EXAMPLES OF CADENCE STRUCTURES BY PEPUSCH

187

Ibid., fol. 18r.
The imperfect concords are the third and sixth of the key.

![Image of imperfect concords in C key]

Fig. 98.—Example of the "imperfect concords in C key"\(^{188}\)

The "discords" are the second and seventh of the key.

![Image of discords in C key]

Fig. 99.—Example of "discords in C key"\(^{189}\)

The perfect concords of a key form the fundamental bass to all melodies in that key. To avoid the skips which are inherent in

![Diagram of treble, fundamental, and supposed basses]

Fig. 100.—Example of supposed and fundamental basses\(^{190}\)

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\(^{188}\)Ibid.

\(^{189}\)Ibid.

\(^{190}\)Pepusch, 1731, op. cit., p. 117.
fundamental bass movement, another bass, or "supposed bass" may be contrived.

All melodies have the perfect concords of the key they are in, for their fundamental bass.

As those melodies are most agreeable that go least by leaps and most by degrees, and as the fundamental bass's being only made use of, would occasion many leaps in the melody, we may therefore use other notes for basses, which are then called supposed basses.

These are necessary on many occasions, for besides that they do not in reality change the harmony, they make the melody receive the benefit of being capable of great variety; for by making use of the fundamental and of the supposed basses as occasion requires, we are enabled to make the parts move the more by degrees, and consequently the melodies will be the more agreeable and sing the better.\(^91\)

Figure 100, page 298, illustrates the fundamental bass and a bass which combines fundamental and supposed basses.

Figure 101, page 300, illustrates additional possibilities for bass movement. Normally, in such progressions, the fundamental bass carries the "common cord" and the supposed bass carries the "uncommon cord."

Every note in the bass which has a sixth upon it, is a supposed bass.

The key note, and its fourth, and its fifth, which are the fundamental basses of the key, have their sharp thirds for their supposed basses [in a major key], that is to say, these may be used in their stead as basses, and only the fifth of the key has the privilege of having also its fifth for a second supposed bass to it.\(^92\)

This limits harmonizations to root position or first inversion chords built in thirds from the first, fourth, and fifth degrees of the scale. Although he does not use the term "inversion," Pepusch is aware of this function.

\(^{91}\)Pepusch, 1730, op. cit., p. 7.

\(^{92}\)Ibid., p. 10.
From hence, it is to be observed, that the harmony of the third of the key, is a harmony borrowed from that of the key note.

And that the harmony of the sixth of the key, is a harmony borrowed from that of the fourth of the key.

Also that the harmony of the ninth of the key, is a harmony borrowed from that of the fifth of the key, to which it is a second supposed bass, and as such must have its flat third, fourth, and sharp sixth for its accompaniments; that third being the seventh to the fifth of the key, from whence the second or ninth is the supposed bass; and the fourth to it is the octave of the fifth of the key, and its sharp sixth is the third to the said fifth of the key, which as has been said is the fundamental bass, to which the said second or ninth serves for a supposed bass.\(^{193}\)

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Fig. 101.—Examples of supposed and fundamental bass movement\(^{194}\)

\(^{193}\) Ibid., p. 10.

\(^{194}\) Pepusch, 1731, op. cit., p. 115.
Not only does Pepusch assert that the harmony of "uncommon cords" on the third, sixth, and seventh degrees of the scale is "borrowed" from respectively the key note, fourth, and fifth, but also he holds that the proper harmony on the second degree of the scale is a 6-4-3 position of the chord on the fifth degree of the scale. These tonal ideas are strengthened by his rules for doubling.

There are three ways of accompanying or making parts upon the third, and upon the sixth of the key, when they are supposed basses.

And but two ways of bringing in the parts or accompaniments, upon the second of the key, when it is a supposed bass.

The first and best way, is by doubling the sixth to that bass.

The second and best way, is by doubling the third to that bass.

And the third but worst way is by taking the octave to that bass.

The second or ninth of the key has but the two last ways.¹⁹⁵

Other possible progressions.—Progression of the fundamental bass and supposed bass and their concords Pepusch terms "modulating."

Up to this point the harmonies available have been triads and inversions built on the first, fourth, and fifth degrees of the scale. Additional harmonic resources are available by treating the supposed bass as a fundamental bass.

By this it is evident, that the mixing of the fundamental and the supposed basses of the perfect, and of the imperfect concords of the key; affords an infinite variety both in the melody, and in the harmony.¹⁹⁶

Pepusch uses the fundamental bass in both "sharp" and "flat" keys. In the flat keys the seventh degree should always be raised to

¹⁹⁵Pepusch, 1930, op. cit., p. 11.
a leading tone but not doubled.\textsuperscript{197} To stay in one key, the rules are:

(1) The fourth of the key must always have the same kind of third that the key note has; (2) The second of the key must have a sharp sixth; that is, the seventh degree must be sharpened; (3) The fifth of the key must have a sharp third; that is, again the seventh degree must be sharpened; and (4) The seventh of the key must have a flat sixth, "except in E key" --Phrygian mode.\textsuperscript{198}

Avoiding these four rules accomplishes the second kind of modulation mentioned by Pepusch, that which results in a "transition from one key to another."\textsuperscript{199} Pepusch lists the recommended modulations, Figure 102, page 303.

In plate 2. [Figure 102] we have put figures as 1. 2. 3. 4. etc. over some of the letters in every key which denotes the notes in the harmonic scale of each key, the figures denote the cadences in their order, and which are proper to each key, and also show thereby what other keys we may properly modulate into from it; that is to say from the original key.

For instance, in the key of C, over C which is the unison or octave of the key, we have put 1; whereby it is meant to say, that in the unison, or in the octave of the key is the first or chief cadence.

And over G which is the fifth of the key we have put a 2, which denotes that the second cadence ought to be in G, and also that the key of G is the best to modulate next into.

Over E which is the third of C key we have put a 3, which shows that we are to make the third cadence in E; and also that E is the key we ought next to modulate into.

Over A which is the sixth of C key we have put a 4, to denote that the fourth cadence is in A, and also that we may modulate in A key as being the next best.

And over F which is the fourth of C key is a 5, which shows that the fifth cadence is in F, and also that we may modulate in F key, before we return again to the key of C, which is that

\textsuperscript{197}Ibid., pp. 14-15.
\textsuperscript{198}Ibid., p. 18.
\textsuperscript{199}Ibid., p. 47.
we began in, and in which must be the last as well as the first cadence.200

<table>
<thead>
<tr>
<th>Key</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>A</th>
<th>Key</th>
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<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>Uni</td>
</tr>
<tr>
<td>son</td>
<td>C E G C</td>
<td>D F A D</td>
<td>E G B E</td>
<td>F A C F</td>
<td>G B D G</td>
<td>A C E A</td>
<td>son</td>
</tr>
<tr>
<td>2d</td>
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<td>E 3 6 8</td>
<td>F 3 6 8</td>
<td>G 3 6 8</td>
<td>H 3 6 8</td>
<td>B 3 6 8</td>
<td>2d</td>
</tr>
<tr>
<td></td>
<td>F B D</td>
<td>G C F #</td>
<td>A F D</td>
<td>B G E G</td>
<td>C A F # A</td>
<td>D G B # B</td>
<td></td>
</tr>
<tr>
<td>3d</td>
<td>E 3 6 8</td>
<td>F 3 6 8</td>
<td>G 3 6 8</td>
<td>H 3 6 8</td>
<td>I 3 6 8</td>
<td>J 3 6 8</td>
<td>3d</td>
</tr>
<tr>
<td></td>
<td>E G C E</td>
<td>F A D F</td>
<td>G B E G</td>
<td>A C F A</td>
<td>B D G B</td>
<td>C E A C</td>
<td></td>
</tr>
<tr>
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<td>3 2 5 8</td>
<td>B b 3 5 8</td>
<td>3 3 5 8</td>
<td>4 3 5 8</td>
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</tr>
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<td></td>
<td>F A C F</td>
<td>G B D G</td>
<td>A C E A</td>
<td>D F B b</td>
<td>C E G C</td>
<td>D F A D</td>
<td></td>
</tr>
<tr>
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<td>2 3 5 8</td>
<td>3 2 5 8</td>
<td>2 3 5 8</td>
<td>2 3 5 8</td>
<td>2 3 5 8</td>
<td>5th</td>
</tr>
<tr>
<td></td>
<td>G B D G</td>
<td>A C F # E</td>
<td>B D C # E</td>
<td>C E G C</td>
<td>D F A D</td>
<td>E G B # E</td>
<td></td>
</tr>
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<td>4 3 6 8</td>
<td>3 3 6 8</td>
<td>4 3 6 8</td>
<td>4 3 6 8</td>
<td>5 3 6 8</td>
<td>6 3 6 8</td>
<td>6th</td>
</tr>
<tr>
<td></td>
<td>A C F A</td>
<td>B b 3 6 8</td>
<td>D G B b</td>
<td>C E A C</td>
<td>D F B b D</td>
<td>E G C E</td>
<td>F A D F</td>
</tr>
<tr>
<td>7th</td>
<td>B 3 6 8</td>
<td>E C A C F</td>
<td>E 3 6 8</td>
<td>F b 3 6 8</td>
<td>G E C E A F</td>
<td>G B C E #</td>
<td>7th</td>
</tr>
<tr>
<td></td>
<td>D G B</td>
<td>E D A C</td>
<td>E A D F</td>
<td>G E C E</td>
<td>F B B D</td>
<td>E G B # C #</td>
<td></td>
</tr>
<tr>
<td>8th</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>1 3 5 8</td>
<td>8th</td>
</tr>
<tr>
<td></td>
<td>C E G C</td>
<td>D F A D</td>
<td>E G B E</td>
<td>F A C F</td>
<td>G B D B</td>
<td>A C E A</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 102.—Diagram of possible modulations201

By this system, in order to change keys rather than "modulate" in one key, it is only necessary to introduce the leading tone of the new key.

The way of going out of one key into another, except into the key of E is by introducing the note or sound that is sharp seventh to the key we would go into; that is to say, that is but a semitone major below that key note.202

Again, the keys available for modulation are the modes, or those keys available through the hexachord system. The attachment of

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201Ibid., p. 103.
202Pepusch, 1730, op. cit., p. 51.
Pepusch for the hexachord system is deep. His theories seem to attempt to merge the theories of his day with those of the ancients. For example, it is the suggestion of Pepusch that Guido added two notes to the Greek tetrachord in order to achieve a fundamental bass to every note in the hexachord.

Guido of Arezzo finding that the Greeks in their scale of musick used b, c, D, E for the first tetrachord, and e, f, G, A for the second, and that they also used a third tetrachord accidentally, viz, a, b♭, C, D.

And observing that the first note of the first tetrachord could not be a fundamental bass, it having but a semidiatonge for its fifth; he added two notes of a full tone each to this tetrachord, by placing them before it thus, G, A, B, C, D, E, for he found that the first, the fourth, and the fifth notes in this order would one or other of them be a fundamental bass to every note in this hexachord, which he called durum because B is natural in it. etc.203

Pepusch illustrates this theory in his manuscript. In the manuscript he has examples of the gamut, in "the acumen," or ascending, and in "the gravitas," or descending. All of this he has underscored with fundamental basses, with the ambiguous notes between fundamental basses carefully delineated, modulating from hexachord to hexachord! The examples are shown on Plates XVIII and XIX.

To complete the description of the harmonic vocabulary of Pepusch it remains to mention his system of non-harmonic tones.

Non-harmonic tones.--In his comments on "descant," Pepusch treats of passing notes and discords by "supposition," "anticipation," and "postposition."

The description of passing tones is as follows.

The notes in the accented part of the bar must be concords, and those in the unaccented parts of the bar may be discords,

203 Ibid.
PLATE XVIII

PEPUSCH'S GAMUT IN ACUMEN, WITH FUNDAMENTAL BASS

204 Pepusch, 29429, op. cit., fol. 10v.
PLATE XIX

PEPUSCH'S GAMUT IN GRAVITAS, WITH FUNDAMENTAL BASS

\[\text{\cite{Ibid., fol. 11r.}}\]
provided we come to them by degrees upwards or downwards, and that we likewise afterwards proceed farther by degrees upwards or downwards to a concord.\footnote{206}

Discords by supposition are those which occur on the accented part of the measure, for they are "supposed to be a note higher or lower."

There is a way in division of making use of discords upon the second accented part of the bar, which way is called supposition, because that discord so brought in is supposed to be a note higher, or a note lower.\footnote{207}

The following rules apply.

But if the discord by supposition descends to the concord, and we have a mind to go by skip to the note that follows that concord, it must be by ascending to it.

And if the discord rises to the concord, we must afterwards descend if we will go by leap to the note that follows the concord.

We must here observe that we cannot end with a note that is preceded by a discord by supposition, \ldots\footnote{208}

Besides using discords by supposition in the second half of the bar, we may also use them in the first half; but then if we make use of them in the first accented part of the bar, we are obliged to use them upon the second accented part, also; This can't be done but by descending.\footnote{209}

This method provides a descending melodic line. The melodic line starts with a "supposed" dissonance and fills in an interval with passing tones. In the case of a third, "if our skip of a third descends from the third to the unison, we make it by supposition \textit{4th, 3d, 2d, ln}.\footnote{210} And the

\footnote{206}{Pepusch, 1730, \textit{op. cit.}, p. 28.}
\footnote{207}{Ibid., p. 29.}
\footnote{208}{Ibid., p. 30.}
\footnote{209}{Ibid., p. 31.}
\footnote{210}{Ibid., p. 32.}
same may be done on other intervals. Figure 103 illustrates dis-
cords by "supposition."

Fig. 103.—Discords by supposition

Discords by anticipation occur by "bringing a note upon the
unaccented part of a bar in such a manner as that it has not yet its
right harmony."  

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211 Ibid.
212 Pepusch, 1731, op. cit., p. 175.
213 Ibid., p. 175.
Discords by postposition include the suspension or retardation.

Postposition in rising is when a discord, as for instance, a second being taken on the accented part of the bar, will become a third on the unaccented part following, by rising one degree whilst the note in the bass holds on.\footnote{Pepusch, 1730, \textit{op. cit.}, p. 37.}

Postposition in descending is when a discord on the accented part of the bar becomes a concord on the next unaccented part, by the treble's falling one degree, whilst the note in the bass hold on. As for instance, a fourth will thus become a third.\footnote{Pepusch, 1731, \textit{op. cit.}, p. 49.}

The theoretical writings by Pepusch are disappointingly brief, in view of the high esteem with which he was held as a teacher and theorist. In spite of limited quantity and scope, however, his treatises illustrate chord inversion and harmonic structures in the functional relationships which were later to become known as tonic, sub-dominant, and dominant. He presents a system for harmonic progression, using a fundamental bass. His theories of fundamental bass and supposed bass make no claim to foundation in either the laws of proportion or nature as did those of Rameau; neither are they worked out in as great detail. Together with his methods for cadence, the theories of Pepusch provide for tonal organization of musical structures, both within the phrase and for combining phrases into larger units. In his system of harmony, it appears that he attempted to bring theories of his time into harmony with systems of the past.

John Frederick Lampe

Lampe published two works which stated his ideas on harmonic vocabulary: \textit{A Plain and Compendious Method of Teaching Thorough Bass}
(1737) and The Art of Musick (1740). The earlier treatise lists a system of harmonic practices, and the second work provides rationale and framework for the harmonic practices. The two works form a complete harmonic system.

Justifications from the vibrating string.—Lampe claims to form his harmonic system from natural principles, a point made clear in the first paragraph of the preface of The Art of Musick.

These few sheets have been the labour of years, and I hope not ill bestowed, if my endeavours have succeeded to form rules for music from the principles and dictates of nature accomplishing her own work.216

The ancients erred, according to Lampe, in taking their principles from mathematics. It is not enough "... to know only the right use of concords, the preparations and resolutions of discords, or to make subject upon subject, without knowing how to touch the passions, ..."217 The "... knowledge of the nature of all sounds depend upon the sense of hearing, ..." and "... nature has given us musical sounds by which the soul of every thinking creature must be touched."218 Knowledge of the techniques of counterpoint is not enough.

But by fixing our thoughts on the before mentioned principles, inspired by fancy, and reason assisting to keep due order and method, we shall discover infinite beauties, and vast variety of expressions in musick, the more we know, the more we shall wish to know, as perceiving tho' knowledge be gained every day, yet the boundless prospect of fancy and invention lies open, reflection will branch out variety of beautiful images, which if disposed in a proper manner, must produce

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216 Lampe, 1740, op. cit., p. 3.
217 Ibid., p. 5.
218 Ibid., p. 3.
the desired effect, by a regular and nervous \[\text{sensitive}\] performance to instruct and please.\(^{219}\)

The harmonic relationships perceived in the sound of the vibrating string are the resource from which Lampe develops his harmonic system. His statements are similar to those of Rameau in the *Nouveau Système* (1726).

By striking one of the biggest or longest strings on a harpsichord or spinnet, and carefully listening to it, we may hear different harmonious sounds, during the vibration of that string, this nature freely gives us; . . .

How this experiment may be looked upon at first sight I know not, but I am sure as simple as it may seem, the curious and attentive experimenter will find this leaves nature to her own free operation, and by the motion or vibration of one single string gives a perfect connection, or chain of harmony: and from this great original of musical sounds, as from the fountain head, all practical harmony is naturally and truly derived.\(^{220}\)

In the harmonics of the vibrating string Lampe finds the chord of nature, for example, the chord AA, A, E, a c\#.

What art or invention could otherwise have attained to what nature has given us? Could all the rules of the mathematicks by numeration, measuring, etc. have given us such delightful and compleat impressions of harmony? Or would not such mathematical principles have destroyed the peculiar niceties, fine touches, or master strokes of nature, and the piece appear without any spirit or life?\(^{221}\)

From the chord of nature he gets his guidelines for spacing notes of chords, relative movement of various voice parts, range, and chord progression.

Regarding the spacing of notes, the lower harmonies of the chord of nature are spaced by larger intervals than the upper factors.


Similarly, lower parts of a musical composition should consist of relatively larger melodic skips and wider harmonic intervals than upper parts.\(^{222}\)

Turning to principles for doubling, as there is only one c\(^#\) in the chord of nature, so this pitch—the third—relative to the fundamental, should not be doubled in harmonizations.\(^{223}\)

The upper factors of the chord may be disposed either in close or open position, that is, "within the compass of an octave," or "with a vacancy between each beyond the compass of an octave." The result, without the bass, is shown in Figure 104.

\[
\begin{align*}
\text{Close position:} & \quad c & a & c \text{ sharp} \\
& \quad c \text{ sharp} & c & a \\
& \quad a & c \text{ sharp} & E \\
\text{Open position:} & \quad c \text{ sharp} & a & e e \\
& \quad E & c \text{ sharp} & a a \\
& \quad A & E & c \text{ sharp}
\end{align*}
\]

Fig. 104.—Possible positions of upper voices of the chord nature "... and this is to be done always keeping nature in view to imitate her delicacy."\(^{224}\)

At this point in his treatise, Lampe has written only of pitches relative to the fundamental A. However, the whole complex may be transposed to other pitch locations.

The impression of the harmony of the first species being fixed in the memory, they may be transposed (as I have said) compared, and the cords will be found to be of the same quality, with this distinction, that they are in a higher or lower pitch. One sound, tho of never so small a distance from the

\(^{222}\)Ibid.

\(^{223}\)Ibid., p. 23.

\(^{224}\)Ibid., p. 29.
other, has its species of the three principal sounds, but each harmony must be properly introduced, so as there may be harmonical relation and musical connection; therefore on the doctrine of harmonical relations (called modulation) depends the art of acquiring and changing the harmony, and forming the melodies.

If we keep close to nature, and proceed from the harmony of AA. to that of EE. that change has a melodious and agreeable effect, . . . provided the parts are moved regularly and conformable to one another, . . . 225

Lampe's principles for harmonic progression also come from the vibrating string. Harmonies can be connected with good effect if they are related as in the chord of nature.

Thus by continuing the transposition of the foregoing harmonies, so as not to break thro' the necessary connexion, one sound bears to another, from their natural order, and by a sufficient impression of harmony, the mind is capable to remove or transpose the order of these species of harmonies, by the melody taken from the same to another distance, and from hence I presume, a musical system of all the practical species of harmony taken from the first may be formed, because going from only one sound taken as first, and passing thro' all the others taken and transposed in the before mentioned relative manner, we come to the first again, . . . 226

In addition to the major chord, another species of harmony is available, which is formed by minor triads, "called cords with a lesser third, who derive their being from the harmonious sound of the first relative species, taken from the free operation of nature, . . . " These are formed when the third of a chord is used as the "natural base" of a related chord.

In his treatise of 1740, Lampe never goes beyond the major and minor triads in applying his justifications of harmonic practice from nature. However, the harmonic resources listed in the thorough-bass

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225 Ibid., p. 29.
226 Ibid., p. 51.
treatise include additional chords. In the thorough-bass treatise the following ideas are mentioned: (1) spelling of chords by superimposed thirds above a "natural bass"; (2) dominant relationships, without, however, using the term "dominant"; (3) non-harmonic tones as ornamentation of fundamental harmonies; (4) diminished-minor--leading tone seventh, and diminished-diminished--diminished seventh, chords as dominant functioning chords without a root; and (5) the augmented six-three chord, resolving on the dominant in the minor mode.

Natural bass.--Figure 105, from the thorough-bass treatise of Lampe, illustrates the concept of "natural bass" and shows that Lampe treats harmonic structures in six-three and six-four positions as inversions of a triad with its root on a natural bass.

![Fig. 105. --Natural bass and thorough-bass](image)

That sound, that gives the chord the name, is called the natural bass, which differs from the thorough bass in this, that the latter sounds any part or note of a chord as a bass,

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227Lampe, 1737, op. cit., Fl. 2.
but the former keeps its place as ground-note of the chord, as appears by the third example, plate 2.228

The next example, Figure 106, is given so "that a scholar may know what are the marks of a common cord, . . . "229 Bass B shows the ordinary figured bass. Bass A shows all the numbers implied by the figures of bass B. The natural bass is not shown in this example.

Fig. 106.—The marks of common chords230

Harmonic relationships.—After pointing out the harmonic relationships of the natural bass and thorough bass, Lampe lists rules for chord progression. A chord may be related to an adjacent chord by having as its natural bass either the fifth or third of the adjacent chord. Relationship by thirds is illustrated in Figure 107.

The procedure in voice leading, according to Lampe, is to hold the common note between chords in the same voice, "because it continues

228 Ibid., p. 18.
229 Ibid., p. 16.
230 Ibid., Pl. 2.
Fig. 107.—Chords related by thirds and unites the harmony of the other chord, ... If there are no similar notes, as in the progression from a chord on the fourth scale degree to one on the fifth scale degree, the upper parts should move in contrary motion to the bass.

Other harmonic possibilities.—Lampe's statements on chord generation and progression form a complete system for musical composition. It remains to show harmonic possibilities generated from this system.

Figure 108 illustrates several of Lampe's harmonic ideas. On the second quarter note of the first measure, the first inversion chord on the seventh degree of the scale is presented as having its root on the fifth degree of the scale; in other words, it is considered an incomplete dominant seventh chord. The parallel fifths and octaves in the treble are apparently acceptable to Lampe. Measures two and three are harmonic possibilities over a sustained bass on the fifth degree.

\[ ^{231}\text{Ibid., Pl. 4.} \]
\[ ^{232}\text{Ibid., p. 22.} \]
\[ ^{233}\text{Ibid., p. 26.} \]
The fifth note to the key, holding out in the second and third bars, has various accompaniments of figures as fifth note, because it is nearest related to the key chord; the chord of the key note and its own chord are alternatively sounded, as proved by the natural bass . . . 234

Fig. 108.—Other harmonic possibilities, showing relationship of the thorough bass and natural bass 235

The examples illustrate the harmonic importance of dominant relationships. Figure 109 illustrates dominant type chords, which Lampe terms "fifth chords," resolving on the first, second, third, fourth, fifth, and sixth scale degrees.

The second crotchet in the first bar is accompanied with its own chord, having the greater third with the seventh; the seventh being added to a sharp chord changes the chord from a key chord to a fifth chord, and the third crotchet in the first bar now becomes a key note itself to the foregoing note; a seventh being added to the chord of the fourth crotchet in the first bar, notes that are a fifth chord to the following key note or the first crotchet in the second bar; and the seventh being added to a chord with a greater third, has the same effect throughout the lesson.

234 Ibid., p. 41.
235 Ibid., Pl. 8.
And whenever the seventh is added to a chord with a greater third, the scholar may discover by that the natural bass note of that chord is the fifth note to the key, and by that he will more readily find what key he is in.  

Fig. 109.—Examples of "fifth chords"  

Lampe interprets chord structures on the seventh degree of the scale as incomplete chords with their natural bass on the fifth degree of the scale. Figure 110 illustrates this interpretation.  

Fig. 110.—Examples of the diminished seventh chord on the seventh degree of the scale as an incomplete ninth chord with a natural bass on the fifth degree  

... The thorough bass note is accompanied with the chord of the fifth note to the succeeding bass note, and by that means

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236 Ibid., p. 28.  
237 Ibid., Pl. 15.  
238 Ibid., Ex. XXV, Pl. 8.
introduces the latter as the key note, although the ground note of the fifth chord is not heard, . . . 239

Lampe presents what may be the first homophonic explanation in a theoretical treatise of the chord with an augmented sixth and third—the structure later called the "Italian sixth." This chord is presented, as well as the diminished seventh chord, as a possible harmony leading to the chord on the fifth degree.

The scholar should remember, that the sharp 5 is always sounded, to the third note of a flat key [augmented triad in minor], as the extreme sharp 6 is sounded to the flat sixth of the key, as shown by the minim in the first bar of the 21st lesson, the higher note being discordant to the thorough bass note, and of an absolute ascending nature, as being the higher sound of an extreme sharp interval. 240

Fig. 111.—The augmented sixth chord 241

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239 Ibid., p. 42.
240 Ibid., p. 43.
241 Ibid., Pl. 81.
Transient or passing notes.--Plate XX illustrates Lampe's use of "transient or passing notes"--non-harmonic tones.

Summarizing the harmonic vocabulary of Lampe, his two published theoretical works list harmonic possibilities generated from the chord of nature. His ideas have their parallel, or perhaps their source, in the works of Rameau. From the harmonics of the vibrating string, Lampe forms his theories for chord sonority and rules for progression of the "natural bass." He spells seventh and ninth chords by adding thirds above the basic triad. He emphasizes the importance of chords built on the fifth degree of the scale progressing to chords built on the key note, but he does not use the term "dominant." Chords of the minor seventh and diminished seventh above the leading tone he interprets as dominant type structures. He presents the augmented six-three chord as a harmonic possibility, resolving on dominant harmony in the minor mode. Non-harmonic tones he views as ornamentations of underlying harmonic structures.

Giorgio Antoniotto

The harmonic art about which Antoniotto wrote in L'arte armonica in 1760 was a complete system of tonal homophony with virtually all of the harmonic possibilities associated with eighteenth and nineteenth century harmonic styles, and with that harmonic vocabulary organized into musical structures based on expanding tonal relationships. In the pages which follow, discussion centers on Antoniotto's approach to harmony, his systems for harmonic progression and chord structure, and his harmonic vocabulary as described in harmonic "canons."
PLATE XX.

EXAMPLES OF "TRANSIENT OR PASSING NOTES" 242

Accompaniment varying the time of the parts with the 13 with passing notes.

Accompaniment varying the time of the parts moving with the 13 without passing notes.

Accompaniment without varying the time of the parts moving with the 13.

Thorough bass varying on the thorough bass with passing notes.

Thorough bass with passing notes varying on the thorough bass without passing notes.

Thorough bass varying on the natural bass without passing notes.

Natural bass.

242 Ibid., Pl. 9.
Antoniutto's approach to harmony. —Antoniutto (1760) defined harmony as the effect of the "progression of two, three or more different or dissonant sounds (distinctly perceived by the sensation) joined together and artificially combined." According to this definition, harmony is the effect of a progression, for a simple chord or combination of sounds is only a "beginning of harmony." The sounds must be different or dissonant. Harmony is of two types: fundamental and figurate. The "fundamental harmony" is the "only practical theory of the harmonic art," and the "figurate" is formed with "divers figures, movements, and times at pleasure." The fundamental harmony is the basic chord progression or harmonic formula; the figurate harmony is that basic progression or formula with the addition of melodic and rhythmic adornments.

Analysis of Antoniutto's musical bases and his harmonic idioms reveals vertical structures of almost all kinds built with superimposed thirds and fifths. He approaches musical composition as the horizontal expansion in time of a tonic by means of chord progression to dominant and sub-dominant and to dominant-associated or sub-dominant-associated chords, progressing finally back to tonic.

Harmonic progression and chord structures. —The secret of proper chord progression, states Antoniutto, is in a "fundamental counterpoint" by which all possible combinations and progressions of sounds can be known. This fundamental counterpoint "was never hitherto known, and consequently never used, ... 245

243 Antoniutto, op. cit., p. 22
244 Ibid., p. 23.
245 Ibid., p. 45.
In the counterpoint formerly, and now in the vogue, the bass and the parts move either gradually or skipping at pleasure: For this reason the composition of music cannot be learned otherwise than imperfectly and by a long practice.

But in the counterpoint here introduced, the motion of the bass and also of the parts, are limited; the bass moving only by its competent skips, and the other parts moving gradually, without skipping.

Of course, the idea of a fundamental bass was not new, having been used by Rameau (1722), Roger North (c. 1700-1726), and Lampe (1737 and 1740). However, there are distinctives in Antoniotto's system of fundamental counterpoint. He asserts that the principal and guide are the underlying basis of all progression.

Therefore all the art of combining the sounds, consists in keeping firm, one, two or three sounds, which composes the original, simple combination, in the antecedent combination simple, or compound, that may be, which sounds, by the succeeding motion of the fundamental bass are changed into the superior thirds (called false by the musicians) and afterwards in the subsequent motions of the same bass, they must be again introduced by a proper resolution into one of the three sounds of the accord with the third, fifth, or octave. This is all which may serve for a general solution of the mystery of the combination of sounds, so confounded and intricate, as commonly it is supposed to be.

Antoniotto uses the word "guide" to refer to the fifth scale degree—the dominant. The skip from key note to fifth he calls the

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246 Ibid.
247 Ibid., p. 46.
248 Ibid., p. 28.
249 Ibid., p. 33.
skip of guide, and the skip from the fifth to key note he calls the skip of cadence. Notes which indicate key—the leading tone and the seventh of a dominant chord—he calls "indicative" notes. In moving from the scale of guide to the principal, "the major third ascending, goes directly to the principal sound of the scale, and the indicative seventh minor descends directly to the major third of the principal."\(^{250}\) The following list summarizes the possible motions of the fundamental counterpoint.

1. Skip of a fifth downward or fourth upward.
2. Skip of a fourth downward or fifth upward.
3. Skip of a third downward or sixth upward.
4. Skip of a third upward or sixth downward.

The skips of the fundamental counterpoint may be in either of two systems: "general" or "natural."\(^{251}\) By the general system, Antoniotto means that in its movement the bass passes through any pitches of the chromatic scale. By the natural system, he means that the bass remains in the scale of the principal. Similarly, the upper parts may be in "simple" or "mixed" progression. Simple progression uses the "eight original sounds of the natural scale," and mixed progression passes through "all the semitones of the scale of transposition."\(^{252}\)

Regarding the intervals of fundamental counterpoint motion, the skip of a fifth downward or fourth upward is the most natural.

\(^{250}\) Ibid., p. 36.
\(^{251}\) Ibid., p. 28.
\(^{252}\) Ibid., p. 46.
progression.\textsuperscript{253} Antoniotto calls this the "terminate, perfect, consonant skip of cadence," because "by these skips the harmony cannot be terminated, except in some instances, for the sake of expression ... [and] from these skips arise all the imperfect irregulars and suspended cadences, with other imperfections, ... "\textsuperscript{254} Skip of a third downward is harmonically related to the skip of cadence and is called by Antoniotto the "perfect auxiliary harmonic skip of a third low." Similarly, the skip of a third upward is harmonically related to the skip of a guide, and is called the "imperfect auxiliary harmonic skip of a third high."\textsuperscript{255}

To complete the list of premises of Antoniotto's harmonic system it remains to mention the types of chord structures possible above the fundamental counterpoint. It was mentioned that these can be in simple or mixed progression (supra, p. 324). Harmonization can be at different levels of complexity: "simple" or "compound." In simple harmony only the basic triad is used in the harmonization. Compound harmony, on the other hand, uses sevenths, ninths, elevenths, and thirteenths at structures other than beginning and cadence positions.\textsuperscript{256} The premises of Antoniotto's harmonic system form the background for his harmonic vocabulary, which follows.

\textbf{Antoniotto's 80 canons}.—Antoniotto's 80 canons, or harmonic laws explaining the "fundamental harmony," are examples illustrating

\textsuperscript{253}\textit{Ibid.}, p. 27.  
\textsuperscript{254}\textit{Ibid.}, p. 29.  
\textsuperscript{255}\textit{Ibid.}, p. 29.  
\textsuperscript{256}\textit{Ibid.}, p. 32.
combinations of fundamental counterpoint with various levels of complexity in the upper parts. The possibilities include fundamental bass movement up a fifth, down a fifth, up a third, and down a third in natural and general progression with the upper voices in simple or compound harmony and in simple or mixed progression. Upon these possibilities Antoniotto imposes tonal musical limitations which unify them relative to key. Examples of his harmonic canons illustrate this point. Figure 112 shows simple harmony in simple progression. The skip of a diminished fifth Antoniotto finds acceptable because the f is prepared by suspension from the preceding chord.

Fig. 112.—Skip of cadence, natural progression; simple harmony in simple progression

The example shown in Plates XXI and XXII summarizes the harmonic possibilities with figured bass in natural progression in the skip of a cadence. Plate XXII is a lower continuation of Plate XXI. The bottom two staves, one and two, show the two "original and stable" sounds. The two staves above—three and four—show the fundamental bass. Staves five, six, and seven show the fundamental harmony in simple progression ascending. The top two staves with eight, nine,

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PLATE XXI

SKIP OF CADENCE, NATURAL PROGRESSION; SIMPLE AND COMPOUND HARMONIES IN SIMPLE PROGRESSION

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PLATE XXII

SKIP OF CADENCE, NATURAL PROGRESSION; SIMPLE AND COMPOUND HARMONIES IN SIMPLE PROGRESSION, CONT.

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Ibid., Pl. 20.
and ten show the compound harmony. Staves eleven, twelve, and thirteen show the simple harmony in simple progression descending.

Figure 113 illustrates how the skip of a third downward or sixth upward is harmonically derived from the skip of cadence.

![Musical notation](image)

Fig. 113.--Harmonic skip of a third low

Illustrated in Figure 114 is compound harmony in simple progression descending above a figured bass in skips of third descending or sixth ascending. In natural progression the skips will be either minor or major thirds as required by the tonality. Also illustrated is the fundamental bass in the skip of cadence from which the fundamental bass in skip of a third low is derived.

Other canons illustrate how the various skips of the fundamental bass may be combined. For example, Figure 115 shows the combination of skip of a third low with skip of cadence. The skip of a third low combined with the skip of guide, illustrated in Figure 116, Antoniotto finds less successful. It can be continued for only a few measures because the diminished fifth of the note b is unprepared. "Therefore it is evident, that this harmonic skip of a third low or a sixth high, can only properly be joined with the perfect consonant skip of

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[259] Ibid., Pl. 26.
Fig. 114.—Skip of a third low, natural progression; compound harmony, simple progression

Fig. 115.—Skip of a third low with skip of cadence, natural progression; simple and compound harmony, simple progression

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260 Ibid., PIs. 26-27
cadence, from which it derives, and to which it is its proper auxiliary skip. ²⁶¹

Fig. 116.—Skip of a third low combined with skip of guide, natural progression; simple harmony, simple progression ²⁶²

Figure 117 illustrates the "imperfect auxiliary harmonic skip of a third high." The upper voices are in simple harmony, simple progression descending. Included is a fundamental counterpoint in the skip of guide which shows that the fundamental counterpoint skipping upward a third is harmonically derived from the skip guide. Those movements are "very disagreeable to the ear; and if they can be suffered, must be only in quick movements as passing notes." ²⁶³

²⁶¹ Ibid., p. 58.
²⁶² Ibid., PI. 28.
²⁶³ Ibid., p. 59.
Fig. 117.—Skip of a third high, natural progression; simple
and compound harmony, simple progression. Using the fundamental counterpoint in general progression and
the upper parts in mixed or varied progression multiplies the available
harmonic formulas. The remainder of Antoniotto's canons show some of
the possibilities. The following illustrations are examples of the
remaining canons.

Figure 119 illustrates the kind of chromaticism possible with
general progression of the bass and mixed progression of the upper
voices. Major and minor chords alternate in this example.

Ibid., Pl. 29.
Fig. 118.—Skip of cadence, general progression; simple harmony, mixed progression

Fig. 119.—Skip of cadence, general progression; simple and compound harmony, mixed progression

265 Ibid., Pl. 33.
266 Ibid.
Figure 120 illustrates the skip of a minor third low combined with the skip of cadence. The canon progresses from the tonic by means of the fundamental counterpoint to the dominant and finally back to the tonic.

Fig. 120.—Skip of a minor third low, general progression; simple harmony, mixed progression

The skip of a major third upward combined with skip of guide in general progression with simple harmony in mixed progression gives the formula of Figure 121. This is similar to what Rameau calls "diatonic enharmonic products," illustrated in Figure 122.

\[267\text{Ibid., Pl. 38.}\]
Fig. 121.--Skip of a major third high combined with skip of guide, general progression; simple harmony, mixed progression

The final canon, Figure 123, combines various skips in the fundamental bass in general progression with compound harmony in mixed progression.

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268 Ibid., Pl. 46.

269 Rameau, Demonstration, op. cit., Pl. 5. Fundamental bass alternating between triple and quintuple proportion.
Other chromatic chords. — Not included in the canons but also of interest from the point of view of his harmonic vocabulary are Antoniotto's use of the "diminished seventh" chord, of an augmented sixth, of the augmented octave, and of cadence structures.

Antoniotto finds the diminished seventh chord in the compound harmony above the guide—dominant—in the minor scale. This provides a chord which may be respelled enharmonically with any of the chord factors becoming the leading tone or "indicative ascending 3d" in a new key.

From the explanation of the above article it is manifest that the compound combination with major 3d to the fundamental bass note, joined to the 5th, 7th and flat 9th in the artificial scale, when the fundamental bass note is abstracted, the

270 Antoniotto, op. cit., Pl. 46.
following four notes, namely the 3d, 5th, 7th and 9th make a combination of four successive flat thirds. ... Every note of the above combinations may be considered as fundamental indicative ascending 3d, ... from which it is apparent, that the combination composed by four successive flat 3ds, may pass into four different principal but artificial scales: Moreover—if these four artificial scales are changed into natural, namely, instead of giving to them the flat third, is given the major 3d, the same four scales are changed from being principal of their own scale into guides to four other artificial scales.271

Not only is the diminished seventh suggested in enharmonic use for modulation to a new tonic but also it is suggested for use as a "secondary dominant" to introduce the dominant of four other keys!

Figures 124 and 125 illustrate these constructions. The b9, b7 on the first note of the second staff of Figure 125 is probably an error, and should be b7, 5.

Fig. 124.—Enharmonic spellings of diminished sevenths to introduce new principal notes272

271 Ibid., p. 84.
272 Ibid., Pl. 51.
Another chromatic chord which Antoniotto suggests is the augmented sixth chord. It occurs in the minor scale, brought about by stepwise melodic movement in contrary motion resolving to the guide. Antoniotto asserts that the fundamental bass of this interval is the second degree of the scale—another secondary dominant relationship.

The superfluous 6th happens (supposing the same above scale A natural) when the common bass descends gradually from A to G natural, and successively from G to F also natural, G being the seventh note and F the sixth of the principal note in the scale, as may be seen in [Figure 126] in which the second part in the last measure but one having continued the antecedent measure in E, its fifth note of the simple accord, giving successively to the common bass the accord of 5th, 9th, and 7th, ast last it resolves the note E in D sharp, which is computed a major 6th to the bass note F natural, but the just interval between these two sounds D sharp and F natural, is a minor 7th, which interval respectively to the name is called sixth with the surname of superfluous; and the same D sharp being not composed in either of the two scales ascending or descending, consequently the false accord becomes of false relation; notwithstanding that the ear is not offended, for the reason of descending the common bass from the octave of the principal note A, in which is combined with the simple accord, passes gradually to F 3d below, which in the descending scale must be natural, and still remaining in the same F which belongs

\[273^{273}_{\text{Ibid., Pl. 51.}}\]
to the same artificial descending scale A with the rest of its accord, it keeps firm in the sensation the remembrance of the same scale; and the bass being in the basis of the above combination covers partly the harsh sound of the superfluous sixth in a manner that by following the resolution when all the parts are properly combined with the same superfluous sixth, it becomes extremely pleasant, for the same superfluous sixth ascending to the octave of the fundamental guide of the scale, and the bass descending into the same fundamental guide, both proceeding by semitones, which is the shorter way, always used by nature, and consequently the more agreeable. 274

Fig. 126.—The augmented sixth and augmented octave 275

274 Ibid., p. 87.

275 Ibid., Pl. 52.
The augmented sixth is between the second and fifth voices in the next to the last measure of Figure 126. An augmented octave is in the same measure between the third and fifth voices. The augmented octave occurs when a voice moves in parallel thirds with the voice which makes the augmented sixth.

As to the superfluous octave, it happens when the common bass descends in the supposed scale of A natural, from the octave of the same A to G natural, which G must be compounded with the octave for the preparation of the 9th to F, into which the same bass descends from G, and the same 9th is resolved into F sharp, which is the superfluous octave to F natural; this superfluous octave F sharp is a minor 3d to D sharp, which is the above explained sixth superfluous; . . . 276

Cadence structures. — Inasmuch as " . . . all progressions in music must be done by the harmonic combination of sounds belonging to the first principal notes of the scale, and to their fifth notes . . . "277 the result is continual cadences "as the harmonic code makes apparent. . . . Therefore, the composition of music may be defined as an harmonic progression of divers cadences, . . . "278

According to Antoniotto, cadences can be described as having different qualities: perfect or imperfect and terminate or indeterminate. The perfect cadence is distinguished by the skip of cadence, the imperfect is distinguished by the skip of guide. The terminate cadence is used to end a composition; the indeterminate is used within a composition.

276 Ibid., p. 87.
277 Ibid., p. 98.
278 Ibid.
Either the perfect or imperfect cadence may be a terminate cadence. If the imperfect cadence is terminate, it "is done ordinarily immediately after the perfect cadence, [and] must be in a very slow manner, by which is shown that it is a final cadence."279

Indeterminate cadences include perfect and imperfect cadences treated rhythmically to avoid a feeling of finality (flying cadences), cadences used in inversion, deceptive cadences, and cadences pausing on the skip of guide (suspended cadences). Antoniotto's cadences are illustrated in Figure 127.

![Figure 127: Antoniotto's cadences](image)

279 Ibid., p. 98.

280 Ibid., Pl. 52.
The deceptive cadence, with bass movement by step, is explained as follows:

[The deceptive cadence] ... instead of passing and making the principle cadence in its principal note C, passes, ascending a note to A, as a relative scale; but as a fundamental bass cannot proceed by joint degree, must suppose that the latter end of the bass note G is changed into a common bass, as being in the third note of the relative guide E to A, ... 281

Antoniotto's principles of construction for harmonic ideas are summarized on Plate XXIII. 282 Lines 1 and 2 show the immovable tonal foundation. Lines 3, 5, 6, 8, 10 and 11 show possible fundamental basses under the diatonic movement of lines 7 and 12, harmonized by the fundamental harmony in simple progression of lines 4 and 9.

The figured harmony.--Use of the "figured" harmony transforms harmonic idioms into musical composition.

Figured harmony is the usual and common music, which may be composed in two, three, four, to sixteen or more parts or voices with or without instruments. It is called figured music by musicians, because different figures are made use of, with variety to time and measure at pleasure; consequently it differs from the fundamental harmony, not only in the diversity of figures and time, but also in the combination of sounds, which becomes inverted by the arbitrary motions of the bass, and of the parts. 283

Antoniotto includes chord inversion as an aspect of figurate harmony. In the figurate harmony, melody in any or all of the parts is the goal. "Melody arises directly from nature," and is the "principal

281 Ibid., p. 97.
282 Ibid., Pl. 59.
283 Ibid., p. 77.
object in figured music, in which it may be introduced into any one of the parts, and bass." When melody is given to the bass, "the combination of sounds becomes less or more inverted." The bass, for example, may be made melodic by breaking it into shorter durations and using passing tones, arpeggio movements, neighbor notes, and syncopations. The result is that the chord may appear in original position or two inversions, the seventh chord in three inversions, and so on. The resulting bass is called a "common bass" to distinguish it from the fundamental counterpoint. If it is desired to know if a given bass note is common or fundamental, the answer is found by observing the "movement and situation" of the bass—that is, its function in the progression. Figure 128 illustrates this point. The second chord of the first brace is an eleventh chord with the fundamental bass C. In the second brace, the fundamental bass of the second chord is G, the common bass C being an inversion by syncope. The function of this C is made apparent by its resolution on the final chord.

But to dwell too long on the common bass would be to distort Antoniotto's meaning of the figured harmony. Motion to different factors of the fundamental harmony and creating melody by addition of passing tones and neighbor notes is possible for any part. A complete analysis of the Sonata Opus 5, No. 1 in D by A. Corelli is used by Antoniotto to illustrate how figuration works in composition.286

284 Ibid., p. 78.
285 Ibid., pp. 80-82.
286 Ibid., p. 88 and Pl. 34.
The following example, Figure 129, by Antoniotto, is used to illustrate how a melody is constructed from the fundamental harmony. The first staff shows the "supposed melody;" the second staff shows the "same melody, but varied by the diminutions of the principal notes"; the third staff shows the "principal notes of the proposed melody"; the fourth staff shows "the combination, which is compound, belonging to the fundamental bass"; the fifth staff shows the "fundamental bass."\(^{287}\)

Antoniotto's musical premises, his harmonic formulas, and his compositional procedures have been discussed above. His melody springs directly from the creator. It rests on a tonal basis established in experience and practice. This tonal basis includes chordal

\(^{287}\)Ibid., Pl. 51.

\(^{288}\)Ibid., p. 88.
Fig. 129.--The figurate harmony

structures built of super-imposed thirds which have their roots on a fundamental bass, which fundamental bass has as its source and foundation the stable and immovable principal and guide--tonic and dominant--of the key.

John Holden

Holden (1770), in his discussion of the theory of music, summarizes the current knowledge about sound, including harmonic theory, sound perception, the co-vibration of partials, and difference tones.

\[\text{Ibid., Pl. 53.}\]
The following ideas underlie his harmonic procedures: (1) the experience of sound accompanies vibration, (2) the principle of "isochronous parcels," (3) the importance of memory, (4) the notion of "modules," and (5) the primacy of the fifth.

The experience of sound accompanies vibration. — Vibrations that "succeed each other at equal intervals of time" produce musical sounds.\(^{290}\) Holden is not sure what vibrations are heard; it is enough for him that perceptions are caused in the mind.

It concerns us very little to enquire whether the vibrations here spoken of, which occasion each particle of air to move forward, and back again, through very small spaces, be the immediate cause of sound; or whether that cause ought not rather to be attributed to some more minute motion or trembling of the particles themselves. We have all the reason which the subject is capable of, for concluding from the analogy with our other senses, that sound is a motion of some kind, and that if it be not those very vibrations, yet it is some motion inseparably connected with them, and proportional to them; so that we may safely take the proportions of the vibrations as the proportions of musical sounds; especially when the conclusions drawn from thence are found agreeable to experience.\(^{291}\)

In addition, a musical sound is composed not only of the "principal or total vibration," but also "several other subordinate or partial vibrations existing along with it."\(^{292}\) This refers to the co-vibration of partials. In the co-vibration of the octave, twelfth, double-octave, and seventeenth, Holden finds support for the basic importance of the major chord.

\(^{290}\) Holden, op. cit., p. 110.

\(^{291}\) Ibid.

\(^{292}\) Ibid.
The principle of "isochronous parcels."—By this principle, Holden refers to the tendency of the mind in the process of perception to organize units into meaningful groups. A visual analogy is in the observation of a row of nine windows.

When we cast our eyes on nine equidistant windows in a row, they are no sooner seen than subdivided into three times three; eight appears at first sight to be two fours, and each of these fours, two twos.293

The principle of isochronous parcels is used by Holden to explain principles both of rhythmic and harmonic organization, as well as to justify a new emphasis on harmonic arithmetic.

The importance of memory.—When musical sounds appear in succession in time, memory functions to relate musical meanings. An evidence of this function is in tonal meanings of the key note.

... the faculty of remembering the key note, and the constant expectation of returning to it at the conclusion, which is so remarkably perceived by the musician resolves immediately into that of retaining the idea of a small portion of time, divided and subdivided in some eligible manner, by the vibrations of the same key, or its octaves; and agrees exactly with the remembrance of one bar or strain, and of the mood of time, in the timing of music.294

The notion of "modules."—Associated with the role of memory is the idea of modules. A module is the small portion of time into which the heard information is grouped. It is the information carrying unit by which isochronous parcels are judged.

To discuss this matter more distinctly, we shall in this treatise, give the name module to that small portion of time by which we suppose the vibrations not only of

293 Ibid., p. 111.
294 Ibid., p. 115.
the key, but also of every other sound which we admit into our music, while we retain that key, to be measured and distributed into isochronous parcels.295

The primacy of the fifth.--In the notion of modules, as well as in the co-vibration of partials, Holden sees proof of the importance of the fifth. "After the key note, the first and most natural change of sound is into the fifth of the scale, . . . 296

It will therefore be sufficient, in this place, that the preference due to fundamental cadences [fundamental bass skips of a fourth or fifth] is a necessary consequence of this new principle; for the regular cadence, in the fundamental bass, always implies a change from trisection to bisection, either of the whole module, or of some determinate part of it; and that, on the contrary, the irregular cadence up a fourth or down a fifth implies a change from bisection to trisection; and that to determine upon what degrees of the scale these cadences may fall it is necessary to what degrees can be formed by trisections only, and how oft this may be repeated; for all those sounds, whose parcels admit of another trisection, have their perfect fifths existing in the scale, and therefore may be made fundamentals; but that note where we can trisect no further, cannot have its perfect fifth, and therefore cannot be a fundamental.297

Difference tones.--Holden includes in his "Theory of Music" a discussion of difference tones.298 In difference tones he finds support for the importance of the chord of nature--the major triad. With the proportions of the chord of nature expressed as 1:2:3:4:5, Holden points out that the difference between any two harmonics is the same as another of the harmonics.299 From difference tones he suggests

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295 Ibid., p. 115.
296 Ibid., p. 117.
297 Ibid., p. 120.
298 Apparently Holden did not realize that combined sounds produce not only difference tones, but also sum tones.
299 Ibid., p. 137.
a system for finding the fundamental of an interval. The reasoning is as follows.

For example, the interval of a perfect fifth is expressed by the ratio of 2 to 3; and on account of the smallness of these numbers we may safely conclude that the terms of a fifth are concord to each other; but we cannot determine which of the two ought to be esteemed the fundamental without considering the formation of each parcel; from whence we immediately observe, that as 2 is simpler than 3, so the lower term of the fifth has always a simpler parcel than the upper term, because this latter involves 3 in place of 2 of the former, whatever by the other factors which enter equally into both parcels, therefore the lower term naturally takes place as the fundamental; and this is farther confirmed by observing, that the implied sound, represented by 1, is always the octave below the same lower term.300

By a similar sequence of reasoning, the lower term of the major third, 4:5, is the fundamental, and the upper term of the perfect fourth, 4:3, is the fundamental. The minor third, 5:6 is an example of a less perfect interval. Here, since the difference is 1, which is not the octave of either term, the difference tone is itself the fundamental.301

Holden's harmonic system.—In the opening pages of his Essay, Holden explains the notation of pitch and rhythm, lists scales, and explains Italian terms. In presenting his resources in scales, he charts the twelve major scales in the order of the circle of fifths, with key signatures to seven sharps and five flats.302 Turning to harmonic theory, he begins with definitions of chords and consonance and dissonance, and proceeds to outline a concise tonal homophonic system. Aspects of the system which are discussed here include:

(1) the approach to chords, (2) cadence structures, (3) the fundamental

300 Ibid., p. 139.
301 Ibid., p. 140.
302 Ibid., p. 17.
bass, (4) dissonant chords, (5) principles of progression, (6) chords by supposition, (7) chords by substitution, (8) the figurative melody, (9) affective ideals, and (10) other harmonic vocabulary.

The approach to chords.--Holden defines any combination of notes sounding together as a chord. Such combinations may be either consonant or dissonant.

A chord is a combination of various musical sounds, heard together. When the several sounds mix and unite, in a manner agreeable to the hearer, it is called a consonance or consonant chord; when they do not unite, but separately distract the attention of the ear, it is called a dissonance or dissonant chord. 303

The model of the consonant chord Holden finds in the major triad disposed in five parts, as sounded by the first five harmonics of the vibrating string. His statements in this regard are similar to those of Lampe (1740) (supra, pp. 309-314).

Along with the double octave the single octave may be joined, and also the fifth above the single octave, and the greater third above the double octave, without causing any distraction; and these five sounds properly constitute what is called the perfect chord. The lowest term is called the fundamental, and the others are called harmonics.

. . . the chord of the fundamental C is

\[ C - - - c - - g - - c' - e' \]

And that of the fundamental is

\[ F - - - G - - d - g - b' \]

The perfect chord of FF is

\[ FF - - - F - - c - f - d' \]

and so of others. 304

303 Ibid., p. 44.
304 Ibid., p. 44.
When the third or fifth of the chord is placed in the bass, Holden calls the chord an inversion. "These inverted chords are justly esteemed imperfect representations of the fundamental chord, but still they are representations of it."\(^{305}\) Holden supports the principle of inversion in two ways: from the perceptions of the human listener and by the principle of difference tones. ". . . we easily substitute the octaves above or below any sound instead of the sound itself, or we mentally carry any sound some octaves higher or lower, upon occasion; . . . "\(^{306}\) "The implied sounds arising from the differences of vibrations, do also contribute, in the most part of these cases, towards forming the idea of the perfect chord."\(^{307}\)

The minor chord Holden terms the "flat perfect chord." Justification for the major chord was found in proportions, harmonics of the vibrating string, and difference tones, but no such rational basis is expressed for the flat perfect chord. Rather, it is presented as similar to the major, but with the distraction of a minor third.

. . . the less third, in so far as we attend to it, causes a kind of distraction, and is an abatement to the perfection of the chord; so that the truest perfection of this chord is to omit the less third altogether, and take in only the fundamental, and its octaves and fifth.\(^{308}\)

In other words, he conceives the major chord as a reinforcement of the harmonics of the vibrating string, and the minor chord as a slight misplacing of the reinforcements.

\(^{305}\) Ibid., p. 48.
\(^{306}\) Ibid., p. 138.
\(^{307}\) Ibid.
\(^{308}\) Ibid., p. 48.
The conception of chords as reinforcements of the harmonics of vibrating strings is reaffirmed in Holden's principles for doubling.

... sounds unite better, and the effect is more satisfactory and conclusive, when the fundamental is rather stronger, or more distinguishable than the others; and the unity of the whole is destroyed when the third or fifth attracts too much of our attention.309

Reinforcing the third and fifth to too great an extent has the effect of giving the reinforced pitch the effect of the fundamental. Doublings should only "fortify the mutual consonances of the fundamental."310

Cadence structures.—To Holden, the cadence is the basic structural unit in chord progression. Its importance is proclaimed to him by experience, by the harmonics of the vibrating string, by proportions, and by difference tones.

In regard to fundamental progressions, it is of the greatest importance to understand well the passages called cadences in music, and therefore we begin with these.311

The cadence is composed of two chords, the first of which he calls the "leading chord." The cadence is said to be "made upon" the second chord, and so the second chord must appear in a relatively strong rhythmic position.312

Holden's cadences are similar to those of his contemporaries. They include the perfect regular cadence, the imperfect regular cadence, the irregular cadence, and the false cadence. In addition to

309 Ibid., p. 49.
310 Ibid.
311 Ibid., p. 64.
312 Ibid.
cadence structures, Holden lists another two chord progression, which he calls the "gradation on the fifth"—bass movement up a second.

The regular cadence is the progression with the bass skipping up a fourth or down a fifth. Holden points out the use of the terms "dominante" and "dominante-tonique" by the French for the chords of this cadence. If the regular cadence concludes on the major chord, it is a perfect regular cadence; if it concludes on a minor chord, it is an imperfect regular cadence.

![Fig. 130.--Holden's regular cadences](image)

The progression, in Holden's terms, is from the "five fundamental," or 5f to the "key fundamental," or Kf.

Holden's irregular cadence is the progression with bass rising a fifth or falling a fourth, as from the Kf to the 5f. It is a "regular cadence reversed."315

The false cadence is the progression with the bass moving from the fifth to the sixth degree.

313 Ibid., p. 64.
314 Ibid., Pl. 10, op. p. 66.
315 Ibid., p. 72.
The false cadence is a regular cadence disappointed, by the fundamental bass ascending only one degree, instead of a fourth, and thereby introducing a fundamental note, a third below that which would have taken place if the false cadence had not been admitted. 316

Holden calls the progression of the false cadence a "gradation." Such a gradation is also possible from the 4f to the 5f, "bringing the harmony to a kind of imperfect pause." 317 The harmonic structure on the fourth degree may be either a perfect chord or a six-five chord. In the latter case, either the fourth or second degree of the scale may be considered the fundamental bass.

In addition to perfect cadences concluding on the key note, Holden suggests that cadence structures may conclude on either the fourth, fifth, or sixth degrees of the scale.

Besides the perfect regular cadence upon the principal key, we can also admit the same passage to be made occasionally, upon the 4th, or the 5th, or the 6th of the natural scale, as dependents on the principal, without altogether adopting any of these for a new key, provided due care be taken not to dwell too long, or recur too often upon them, without a proper inter-mixture of other passages proper to keep the ear in suspense, or to renew the impression of the principal key. But we cannot make a regular cadence upon the 2d or 3d of the natural scale without previously adopting a new key, different from the key of the natural scale: and on the 7th we cannot make a regular cadence at all. 318

The possibility of cadences on the fifth degree above or fifth degree below the key note is in keeping with Holden's principal of the importance of the fifth. In addition, he finds the cadence on the sixth degree acceptable because the sixth degree substitutes for the key

316 Ibid.
317 Ibid.
318 Ibid., p. 68.
note. He calls the pitches used as the concluding notes of these structures the "adjunct 4th," "adjunct 5th," and "substituted 6th."  

The fundamental bass. —Holden's fundamental bass is the lowest sounding difference tone. This idea is important to understanding his statements regarding the tonal significance of chords and chord factors and his rules for chord progression.

Within these last fifty years, the greatest writers on music have very assiduously pursued these enquiries concerning the nature and propriety of fundamental successions; which they occasionally exhibit in an additional staff of lines, placed below the others and called a fundamental bass. This bass is not intended to be performed along with the other parts . . . but instead thereof, another bass is substituted consisting of fundamentals and harmonics intermixed, which is called the continued or thorough-bass. The use of the fundamental bass, when subjoined, is only to shew from whence every consonance is derived, and to what note each of the sounds ought to be referred.

The fundamental bass is never subjoined to a piece of music except in examples designed for beginners, . . .  

From difference tones, Holden shows that the lower of the two terms of the perfect fifth is a higher octave of the fundamental and the upper of the two terms of the perfect fourth is a higher octave of the fundamental. Similarly, he uses difference tones to find the fundamental for thirds and sixths.

Dissonant chords. —According to Holden, there are two ways in which dissonant chords can be formed. One of these is by adding another sound to a perfect chord. The other way is by omitting one of the harmonies of the perfect chord and substituting in its place another note. Regarding the dissonance by addition, usually the added

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319 Ibid.
320 Ibid., p. 52.
321 Ibid., p. 54.
Note is either the sixth or seventh. The dissonance then resides in the ambiguity of the fundamental bass. Consider several such structures. In the chord C, E, G, B♭, there is only one perfect fifth, C-G, therefore there is no ambiguity and C is the fundamental bass. In the chord A, C, E, G, however, there are two perfect fifths, A-E and C-G, and either A or C can be considered the fundamental.

"... It must be observed, that no one sound can properly be called the sole fundamental of a dissonant chord, because of the divided attention which the discord creates."³²²

![Fig. 131.—Dissonance by addition³²³](image)

However, the context or position of the chord may make one of the fundamentals preferred, as illustrated in Figure 132.

The C, E, G, B♭ chord is an exception to the rule, caused by the presence of the diminished fifth. The diminished fifth, writes Holden, "has the very peculiar property of referring the bearer to a

³²²Ibid., p. 55.
³²³Ibid., Pl. IV, op. p. 66.
fundamental note, at the distance of a greater third below its lower term. Thus the interval $f^\#-c$ refers to D as fundamental and $c^\#-g$ refers to A as fundamental.

The second kind of dissonance, that accomplished by substitution, is the suspension dissonance.

... [These chords] have another sound substituted instead of one of the proper harmonies, the substituted sound for the most part only disappoints, or suspends, the hearer's expectation, for some part of the time, and afterwards gives place to the proper sound; and therefore these may justly be called dissonances by suspension.

All such dissonances, according to Holden, should be introduced by preparation. This rule is "founded on a natural principal," as follows.

... when we have previously set our attention upon any particular tone, we are ready to imagine we hear the same tone existing along with the other accompanyments of the next following chord, if the discords thereby introduced be not too harsh: for instance an added seventh along with a third and fifth; or a ninth suspending the octave along with

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$^{324}$Ibid.

$^{325}$Ibid., p. 61.

$^{326}$Ibid., p. 59.
the same third and fifth; or a fourth suspending the third, along with the octave and fifth: . . . 327

Principles of progression.--Two principles underlie Holden's rules of progression. The first he calls the "principle of connexion by holding a note."328 The second is that all progression is imitation of the cadence.

The first principle allows fundamental bass movement in skips of thirds, fourths, fifths, and sixths, but not by step. Holden states the principle as follows.

. . . we may freely pass from any one chord to any other, provided there be one sound common to both; which by continuing upon the same degree, connects the two successive chords, . . . 329

However, he is aware that this principle is insufficient by itself. It provides no priority for use of skips and it does not explain examples where the fundamental bass moves by step. "For these reasons we have concluded it more proper to represent the imitation of cadences as the most natural law of fundamental progressions."330 In addition to fundamental bass motion justified by the imitation of cadences other movements are possible by licence. The descent of a second is possible, for example, if not introduced too frequently, when it is used to accomplish some harmonic design, such as "arriving more naturally at a chord which is to follow."331

327 Ibid., p. 89.
328 Ibid., p. 79.
329 Ibid.
330 Ibid., p. 80.
331 Ibid., p. 83.
Holden terms the movement of the fundamental bass "modulation." Within a composition, the fundamental bass may support a transition into the scale of either of the adjuncts—that is, for example, G or F to C—and from the adjuncts to the relative adjuncts of the adjuncts. Similarly, the fundamental bass may move into the sixth, or substitute, and from that point it can move to the relative adjuncts of the sixth. In other words, the fourth, fifth, and sixth degrees of the scale—called by Holden the "system of modulation of a given principal key"—may each have adjuncts and substitutes. Apparently this means that the fourth, fifth, and sixth scale degrees may become temporary tonics. "... such transitions plainly indicate the dependence of both the new keys upon another principal."  

Harmonic possibilities.—Following are examples of harmonic progressions listed by Holden. Figure 133 illustrates cadences on the key, fourth, fifth, and sixth.

Fig. 133.—Fundamental bass illustrating cadences

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332 Ibid.,
333 Ibid., p. 83.
334 Ibid., Pl. VI, op. p. 76.
Figure 134 illustrates a fundamental sequence of sevenths.

"... These cadences are certainly disappointed in the accompaniment; by giving the leading chord--first chord of the cadence--a less third when the scale of the key requires it, ..." 335

Fig. 134.--Fundamental sequence of sevenths 336

Fig. 135.--The fundamental bass with ascending and descending forms of the melodic minor scale 337

335 Ibid., p. 88.
337 Ibid., Pl. VIII, op. p. 94.
The rules apply in minor modes as in the major. Figure 135 illustrates the fundamental bass under ascending and descending forms of the melodic minor scale.

Holden, like Rameau, finds in harmony the source for melody. The "nature of the voice" makes necessary the use of small intervals, rather than the skips natural to fundamental bass, "... and, in general, the melody which is easiest to be sung or relished is founded on the most natural fundamental progression." Figure 136 illustrates a fundamental bass under descending chromatic melodic motion.

![Fig. 136. --Descending chromatic motion supported by fundamental bass][339]

**Chords by supposition.**—By the term "supposition," Holden means "placing below." Supposition "is when the thorough-bass takes the third below the fundamental, and may be practiced in all sorts of fundamental chords; ..." Supposition below a perfect chord produces a chord of the seventh. Similarly, supposition below a chord of the seventh produces a chord of the ninth. Figure 137 is Holden's example of supposition. In the second measure, the note G in the

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thorough-bass supposes the fundamental B in the fundamental bass.

![Chord diagram]

**Fig. 137.**—Example of supposition

Chords by substitution.—"Substitution is a term appropriate to the taking the less 6th, instead of the 5th of a flat series, either in the bass or in any of the upper parts." This is Holden's explanation of the diminished seventh chord. By substituting the flat sixth—as in the minor mode—for the harmony on the fifth degree, and building from that flat sixth a "flat series," a chord is constructed which can substitute for the regular chord on the fifth degree. Holden asserts that the chord functions as comitant harmony.

All these being borrowed from the leading chord of a regular cadence, will, like the original chord, be followed by the perfect chord of the key.

A second kind of substitution provides an explanation for augmented sixth structures resolving to the chord on the fifth degree.

There is another licence concerning which the theorists have been divided in regard to its origin, or fundamental; it will be best conceived as a second kind of substitution, which takes place in the chord of the adjunct 4th of a flat series, by taking the 7th instead of the natural fundamental

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in a gradation on the 5th. This substitution also introduces a new set of chords, all of them containing extreme intervals; for instance if the #4th be in the bass, the chord will consist of either an extreme flat seventh, or a less sixth, joined with a false fifth, and extreme flat third, as at N in exam. LXV. If the flat fifth be in the bass, and the #4th in an upper part, the chord will consist of an extreme sharp sixth, with either a fifth or a tritone, and a greater third, as at M. This last chord has been called the Italian sixth; probably because they first introduced it. Each of these chords will be followed by the adjunct 5th.

Figure 138 illustrates chords by substitution. Measure two shows various positions of an augmented sixth, or diminished third chord progressions to the key note. Measure three shows examples of augmented sixth chords, moving to the dominant.

![Chords by Substitution](image)

Fig. 138. — Examples of chords by substitution

The figurative melody.—Liberties are allowed in order to make the melody more florid and they include suspensions, substitutions, and breaking. Suspensions are entered by repetition and resolved by step downward. Substitution allows unprepared dissonances in a florid melodic line. Holden's rule is only that such dissonances must be resolved. Breaking is the process of subdividing a note into notes

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1. Ibid.
2. Ibid., Pl. VIII, op. p. 98.
3. Ibid., p. 103-105.
of shorter time values. Breaking may be done with skips, repetition, or movement by single degrees—"division by passing notes." Again, the rule is that the dissonance must be resolved in the same part.

Other harmonic vocabulary.—Holden presents a large inventory of possible harmonic structures. Yet he is aware that composers use other structures.

The fancies of composers are so unbounded, and their thirst for variety so insatiable, that the reader ought not to be surprised, if he sometimes meet with passages which cannot be perfectly reconciled to any of the rules above, much less ought he on such occasions to be hasty in censuring either the irregularity of the composer, or the imperfections of these rules.348

Affective ideals.—In his harmonic system, Holden asserts that chord structures have consistent emotional meanings. For example, the "sharp perfect chord" and all its derivations Holden calls "bold and commanding." The "flat perfect chord" and all its derivations he finds "dejected and plaintive."349 Regarding the use of chromaticism, Holden states the following.

The gradual and often unexpected elevations of the voice, in ascending chromatic, render it remarkably expressive of reviving hope; and the contrary depressions of descending chromatic are as aptly suited to languishing and dejection.350

And finally,

The expression may sometimes be heightened in the middle of a phrase, by a judicious choice of fundamental chords. For instance, those chords which include occasional sharp notes, may be used to express joy and elevation; on the contrary, those which include occasional flat notes may express doubtfulness and

347 Ibid., p. 105.
348 Ibid., p. 107.
349 Ibid., p. 48.
350 Ibid., p. 92.
perplexity; an unexpected chord, surprise, etc. and it is very proper to have these particulars in view, ... 351

In summary, Holden's theoretical system rests on a rational basis which looks at both the physical world and the human perceptions of the auditor. His melodies find their source in harmony. Underlying his harmonic rules are the idea that the experience of sound accompanies vibration, the principle of isochronous parcels, insights relative to the role of the memory in perception of musical meanings, and the notion of modules. Holden emphasizes the role of the fifth as a determiner of harmonic structures. His harmonic rules provide for chord progressions from a fundamental counterpoint. His chord structures, in addition to triads, include chords by supposition which are seventh and ninth chords, and chords by substitution, created by replacing chord tones with adjacent notes. In addition, he suggests a method for constructing florid melodic passages and he emphasizes the emotional implications of musical structures.

Harmonic Structures in the Treatises

The three early thorough-bass treatises. The harmonic vocabulary available in the thorough-bass treatises of Locke (1673), Blow (c. 1680), and Keller (1707) present a point of view toward harmonic structure which is different from that found in the earlier treatises by Campion (c. 1612), Playford (1653), and other early seventeenth century theorists. The change is from harmonic structures conceived polyphonically to structures conceived homophonically. In the thorough-bass treatises, it is the sonority of vertical harmonic

351 Ibid., p. 98.
structures that is emphasized, rather than the coincidence of intervals in simultaneously sounding melodic lines.

Retrospective features exist in these three treatises. The convention of harmonic progression in which two voices alternate intervals of a sixth and a fifth to avoid parallel fifths is a horizontal rather than a vertical device. The basic cadence formula in these treatises, the progression $5_1$ to $5_3$ above the fifth scale degree, is a typical cadence structure from earlier contrapuntal styles. Keller is the only one of the three authors to discuss the cadential $6_4$ formula. Another retrospective feature is found in the resolution of the major chord with minor seventh—the dominant seventh chord. Examples in the three thorough-bass treatises show the seventh resolving upward at the cadence.

Several new points of emphasis are apparent in the early thorough-bass treatises. One of these is increased emphasis on tonal relationships, specifically in the progression of dominant to tonic—although the words "dominant" and "tonic" are not used by these theorists. Each of the three treatises includes an example in which secondary chords in a key are preceded by cadence structures, a procedure in which the secondary chords function as temporary tonics. Locke terms this "transition" but Blow presents the example without comment. In his example, Keller suggests the possibility of using a diminished fifth with the sixth to any "sharp note" in the bass. Another evidence of increased emphasis on tonal relationships is the expansion of cadence structures with a dissonant chord preceding the entrance to dominant harmony. Both Blow and Keller suggest the possible use of a diminished seventh chord built on the note a
half-step below the fifth degree of the scale to precede immediately
the cadential progression. In non-cadential progressions, intervals
of the seventh, ninth, and fourth are mentioned as harmonic possi-
bilities. However, these intervals are to be entered by repetition
and resolved by step downward; that is, they are still treated as
suspension structures.

None of the three early thorough-bass treatises presents a
comprehensive system for harmonic progression. When progressions are
presented at all, they are treated as idioms or conventions followed
in composition.

Later theoretical writings.--In the later treatises, two
other harmonic subjects came to the fore: (1) the systematic
organization of harmonic structures in the dimension of time in
order to create meaningful musical relationships, and (2) the ex-
plaining and listing of a useful vocabulary of chord structures.
The first of these subjects deals with the problem of harmonic
progression, which Roger North and later theorists attempted to
solve by the use of a fundamental bass.

Fundamental bass.--The earliest of the English treatises from
which might be gained a rationale for chord progression was the
Philosophical Essay of Francis Lord North (1677). However, Francis
North's ideas are only introductory, and it is in the Roger North
manuscripts (c. 1700-1726) that a system for harmonic progression
is fully developed. From a theory of harmony based on the coinci-
dence of pulses, Roger North explains the meaning of a "proper base"
and lists rules for its normal harmonic progression. The later
theorists, Pepusch (1730 and 1731), Lampe (1737 and 1740),
Antoniootto (1760), and Holden (1770), suggest possible harmonic progressions from a fundamental bass in detail and from other points of view.

Pepusch (1730 and 1731) finds his fundamental bass on what he terms the "perfect concords" of the key. By this, he means that the fundamental bass in a key uses the pitches of the first, fourth, and fifth degrees of the scale. Bass movement to the third and sixth--imperfect concords--and second and seventh--discords--and transition to other keys result in other "modulations."

Lampe (1737 and 1740), like Rameau (1726) finds his justification for the fundamental bass in the sounds of the vibrating string. Antoniotto (1760), on the other hand, uses the technique of fundamental bass--which he terms "fundamental counterpoint"--but is interested only in practical uses rather than theoretical justifications. Holden (1770) justifies fundamental bass theory both by the phenomenon of difference tones and from characteristics of perception.

**Chord structures.**—The transition from polyphonic to homophonic musical thinking is described in part by the theorists' statements about chordal structures. Three phases of development are apparent. In the first stage, described in the treatises prior to 1660, harmonic sonorities are created by combinations of melody lines according to categorical rules for use of specific intervals. In the second stage, exemplified in the early thorough-bass treatises, intervallic sonorities came to be accepted as entities with harmonic meanings that are not necessarily implied from melody. In the third stage, exemplified by the harmonic systems of Roger North (c. 1700-1726), Lampe (1737), Antoniotto (1760), and Holden (1770),
is the awareness that a combination of pitches has some sound--
not necessarily the lowest written note--as a tonal focus, and this
focus has, with the constituent pitches of the chord, a relationship
in the composition to a tonic or key center.

The second stage, in which intervallic sonorities are accepted
as harmonic entities, is described in the treatises of Locke (1673),
Blow (c. 1680), and Keller (1707). In these treatises, the theorists' 
problem is two-fold: to list a vocabulary of possible interval com-
binations and to provide a way to select and connect the combinations.

The second stage is short-lived in England. Already in the 
treatise of Keller (1707) it is being challenged, for he suggests
that six-three and six-four chords are really inversions of a basic
triad. Keller's statements indicate a change in point of view
which was inevitable from the researches of Wallis (1677) and the 
theories of Francis North (1677). Wallis and Francis North said,
in effect, that one set of vibrations is the norm in a complex of
sounds.

In the third stage of development, Roger North (c. 1700-1726),
Pepusch (1730 and 1731), Lampe (1737 and 1740) and the later theorists
held harmonic structures above a thorough-bass to be positions of
chords spelled in thirds, with possible additions of non-harmonic
elements which they called "dissonances," "elegances," or "supposi-
tions." In the treatises of Antoniotto (1760) and Holden (1770),
resulting chordal forms and harmonic progressions were catalogued.
The theoretical writings document the transition from contrapuntal
to homophonic harmonic thinking.
CHAPTER VI

ENGLISH THEORETICAL WRITINGS DURING THE ENLIGHTENMENT

Summary of the Study

It has been the purpose in the preceding chapters to describe the music theoretical ideas of music theorists in the British Isles during the Enlightenment, as they can be known from theoretical writings.

The theoretical writings which comprised the primary resources for this description included didactic counterpoint treatises, translations of earlier theoretical writings--with the translator's commentary, didactic thorough-bass treatises, articles in the Philosophical Transactions of the Royal Society, musical-philosophical works, and miscellaneous writings.

Related writings which provided background for the analysis and evaluation of theoretical sources included general histories of theory and historically oriented studies of music theory and musicians.

The following questions were formulated to provide focus for the analysis and evaluation.

1. What melodic pitch relationships are suggested as meaningful in the treatises of the period?

2. What harmonic relationships of musical sounds are suggested, and how are the harmonic structures organized to achieve larger units of musical meaning?

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3. What, if any, are the indications that musical knowledge of the period is related to other aspects of human understanding, as exhibited through the philosophical, acoustical, mathematical, political, religious, and other areas of cogent expression?

4. Are the theoretical ideas of the various writers related to each other, and is it possible to make definitive statements for the period?

5. In what ways do practices and concepts evolve during the period?

The theoretical writings were studied to find answers to these questions. As a result of the study, five subjects were selected which were emphasized in the treatises. These became the subjects of the substantive chapters: (1) reason and sense, (2) theories of sound, (3) scale, (4) consonance and dissonance, and (5) harmonic vocabulary. The following summary is a review of the contributions of the theorists as described in these chapters.

Reason and Sense

The quest for knowledge of foundations for musical meanings led to a renewal of reason versus sense discussions in musical discourse. These discussions were restated in terms manifesting the interests and insights of English theorists of the Enlightenment. Theorists sought justifications in numbers, in nature, and in human perceptions.

Directions of development. -- Early seventeenth century English treatises by Coperario (c. 1610), Campion (c. 1612), Bevin (1631), Butler (1636), and later treatises by Playford (1653 and later eds.)
and Simpson (1665 and later eds.) were practical and didactic, rather than philosophical. However, in the latter half of the seventeenth century musical-philosophical books and articles revealed a wave of Pythagorean musical thinking having unique new overtones. It was coupled with a new desire for mathematical accuracy and interest in natural philosophy. It reappeared with the editions of the writings of Greek authors in Latin translation by Meibom (1652) and Wallis (1682), and in the English translations of Descartes' Compendium by Brouncker (1653) and Alsted's "Musica" by Birchensha (1664). The rational point of view was stated by Wallis (1677 and 1698), Salmon (1688 and 1705), and Roberts (1694). Countering this rationalism was a reaffirmation of empiricism in the early eighteenth century, apparent in the works of Roger North (c. 1700-1726), Fond (1725), and Antoniotto (1760).

The rational point of view.—Brouncker's translation (1653) made Descartes' Compendium available to the English reader. Descartes stated the Pythagorean point of view transmitted by Zarlino (1562), and added justifications obtained by observation of sympathetic vibration of strings tuned to the fifth and ditone. However, Brouncker, in his "animadversions," asserted that not arithmetical but rather geometrical numbers are descriptive of sense judgments, and the sense of hearing rather than numbers should dictate in musical matters.

Birchensha's translation (1664) of the article on music in Alsted's Encyclopedia (1630) made available to the English reader a statement of Ptolemaic theory and neoplatonism. Music was presented
as a mathematical science with original principles in metaphysics and physics.

The rational point of view was also stated by Wallis in his comments on Salmon's Proposal (1688) and in two articles in the Philosophical Transactions (1698)--all of these written after his translation of Ptolemy's Harmonics (1682). Wallis held that musical perfection is found in just proportions, and temperament is an imperfection.

Roberts (1692) likewise asserted that mathematical proportions were proper for making musical judgments. He demonstrated that syntonie proportions resulted in different string lengths than those of the harmonics of a vibrating string.

Salmon, in his Proposal (1688) and in an article in the Philosophical Transactions (1705) recommended that the theory of music be based on mathematical certainty. In order to prove that mathematical judgments are appropriate, he described an experiment in which the frets on two viols were placed individually for each string by calculation according to syntonie proportions. He held that the experiment affirmed the mathematical point of view.

An article by Pepusch (1746) and manuscript notes (c. 1750) illustrated his knowledge of Greek theoretical systems. His justifications were not based on number proportion alone as a standard of truth. Rather, his norms were the proportions descriptive of the chord of nature.

Smith (1749) presented mathematical information about music in detail. He asserted that the theory of musical sounds could be reduced to study of the harmonics of a single string.
The theological mysticism of Mace (1676) indicated a retrospective point of view. He suggested that concord and discord are, respectively, types of good and evil, that the triad is a symbol of the Trinity, and that the identity of octaves can be understood as parallel points on a spiral proceeding from God as unity to God as infinity.

The empirical point of view. — Writings by the following theorists illustrated the transition to an empirical point of view.

Holder (1694) turned finally to sense judgments for answers to musical questions, although many pages of his Treatise are taken up with discussions of the vibrating string and related number theories. His viewpoint toward perception was Hobbesian, for he held that sound is perceived when external motions cause the vibration of nerves in the human receiver.

Bedford (1705 or 1706) held the Aristoxenian point of view and emphasized that music works on the passions and senses.

Roger North (c. 1700-1726) was eclectic in his writings about perception. It was his intent to find universal principles for good music. When he wrote about the aural stimulus and its immediate effect on the listener, he was materialistic and held that the motion of matter causes sensation. In discussing sensation, memory, reflection, pain and pleasure, he was Lockian. When dealing with the effect of music at emotional and subconscious levels, he held to the existence of innate knowledge.

Malcolm (1721) attempted to syncretize other philosophies. However, his theories were predominantly Lockian. He held that there is a primary world of objects operating uniformly, the secondary
causes of which are perceived. Knowledge, he stated, is gained by the mind perceiving simple ideas. By the process of reflection, the mind perceives the relative and simple ideas of pleasure and pain.

Fond (1725) disclaimed mysticism, neoplatonism; and mathematical rationalism. He asserted that only the experience of music could show how sounds please.

Lampe (1740) also had no sympathy with mathematical justifications. He followed Rameau in finding in the harmonics of the vibrating string reasons for musical practices.

Antoniotto (1760) likewise rejected mathematical justifications for musical meanings. His concern was to combine sounds in order to create agreeable sensations.

Representing different points of view toward perception of musical sound, the theorists discussed the physics of sound and wrote about scale, consonance and dissonance, and harmonic progression.

Musical Sound

Statements by the theorists about the physical characteristics of sound were detailed in the chapter on sound (supra, pp. 71-116). At least five areas of the current knowledge about sound influenced the writings of music theorists: (1) the notion, developed by Boyle (1662), that the air acts like a spring in sound generation in aero-phones and in the transmission of sound; (2) the discovery of the vibration in partials of strings and, later, of the co-vibration of partials; (3) renewed interest in the proportional relationships of vibrating strings, including analogy with the pendulum; (4) principles
of mechanics, including Newton's laws of motion; (5) the phenomenon of difference tones.

The spring of air.--Regarding the notion of the spring of air, Roger North (early 18th c.) used this concept to explain the generation of sound by wind instruments. He observed the action of air as a spring in the sound of a cannon and of an organ pipe and he compared this motion to the vibration of a string.

Vibration of partials.--Wallis (1677) reported the existence of partial vibrations, and knowledge of the co-vibration of partials was affirmed in the early eighteenth century by Sauveur (1701).

Knowledge of the vibrations of string partials was used by theorists to explain the perfection of the major chord. Earlier, Descartes (trans. 1653) had pointed to the sympathetic vibrations of strings tuned to the fifth and the ditone as a physical demonstration of the perfection of the major chord. Malcolm (1721) used the vibration of partials to show the perfection of the major chord (1721). In 1740, Lampe, in the same manner as Rameau, asserted that the co-vibration of partials is proof that harmonic justifications are from the operations of nature. Holden, in 1770, also justified the major chord from the harmonics of the vibrating string.

Knowledge of the vibrations of string partials was also used to support a system for harmonic progression. It was Lampe's theory (1737), for example, that permitting one harmonic sound to be sustained and to become a different harmonic in the subsequent chordal structure provided a system for connecting chords. Likewise, Holden's notion (1770) of the primacy of the fifth in harmonic progression was supported from the relationships observable in the co-vibration of harmonics.
Propositions.--Turning to the renewed interest on the part of some theorists in the proportions of vibrating strings, study of the relationships of string length and frequency were given impetus by analogy with the pendulum. The laws describing the relationships of the pendulum were stated by Galileo Galilei in 1583 and more work was done by Huygens in 1673. Previous to this development, theorists studied the monochord. Now in the pendulum they found visual demonstration of the relationships of vibrating bodies. Statements of the pendulum analogy were found in a number of the theoretical writings studied. Francis North (1677) used it both to describe string motion and to explain the strange sounds of false strings. Holder (1694) used it to explain the motion of vibrating strings. Roger North (early 18th c.) presented the pendulum analogy in detail, and in 1713 Brook Taylor established dynamically that the motion of a string was comparable to the motion of a pendulum with a time isochronous to the time of the string. Other examples were found in the writings of Salmon (1688), Malcolm (1721), and Smith (1749).

Principles of mechanics.--Developments of theories of mechanics were important to harmonic theories. The appearance of the laws of motion in Newton's Principia in 1686 and statements of principles for the transmission of force by Huygens provided information needed to support a theory for sound transmission. Earlier, Benedetti (1585) had suggested a theory for consonance and dissonance based on the coincidence of pulses. Also in the background was the Hobbesian idea that perception is the result of motions in the objects fancied. From these sources developed the theory for the wave motion of sound which said that sound was transmitted by movement of particles of air in
simple harmonic motion, each particle in turn causing movement of adjacent particles until the motion reaches the ears of the hearer. Mechanical ideas supported the theory of consonance and dissonance based on the coincidence of pulses, exemplified in the treatises of Francis North (1677), Roger North (early 18th c.), and Smith (1749).

The phenomenon of difference tones.--Justifications for harmonic practices were made from the phenomenon of difference tones. The discovery of this phenomenon is claimed by Tartini about 1714. On the English scene, Roger North, in his "Theory of Sounds" of 1726, discussed the beats that result when pulses do not strictly coincide. He anticipated Helmholtz in suggesting that such beats are the cause of dissonance and said that the beats might form new musical tones which could be useful in composition. Holden (1770) found in difference tones a system for finding the fundamental of an interval. Apparently neither Holden (1770) nor North (1726) were aware that combination tones may be sum tones as well as difference tones. Rather, they conceived the combination tone as the fundamental of a chord of nature having the constituent sounding pitches as upper factors.

Theories for sound generation.--The theorists stated the following theories for the generation of sound.

1. Sound results from the motion of minute particles of matter in the surface of the sounding body. This theory, stated by Perrault, was transmitted by Malcolm (1721).

2. Sound results from the percussion of body against body. This theory was also stated by Malcolm.
3. Sound results from the percussion of matter against air particles, or air particles against other air particles. Stated by Malcolm, this theory was also held by Francis North (1677).

4. Sound results from the vibration, as a vibrating spring, of either the material of the generator or of an enclosed quantity of air. Roger North (early 18th c.) stated this theory, reflecting knowledge of the research of Boyle (1662).

**Theories for sound transmission.**--Two theories were stated for the transmission of sound.

1. Sound is transmitted as a series of "cracks" caused as the air rushes in to fill an evacuated space. The theory of "cracks" was held by Francis North (1677) and Holder (1694).

2. Sound is transmitted as the result of movement of particles of the air in simple harmonic motion acting on other particles according to the laws of mechanics. Roger North (early 18th c.) stated this theory, influenced by Newton (1687).

**The hearing mechanism.**--Statements about how sound waves are received by the ear were made by Malcolm (1721), Roger North (1715-20), and Turner (1724). Malcolm described the hearing mechanism. Turner mentioned the action of the ear drum. Roger North mentioned functions of the organs of hearing. However, none of the theorists discussed the anatomy of the ear in detail.

**Developments in Scale**

Statements about tuning and temperament demonstrated the theorist's attitude toward historical musical learning, his knowledge of number manipulation techniques, and his attitude toward musical
perception. In addition, the developments in scale during the period demonstrated the evolution of tonal thinking, especially to clarify the concept of modulation from one key to another.

Modulation was a central problem which stimulated the theorists' discussions on scale. Earlier modal systems were diatonic in principle, but the developing homophony required a tonal system in which sounds could be related to various pitches as tonic. Difficulties of intonation were caused in diatonic systems by modulation to new key centers. The theorists' writings detail their struggles to adapt diatonic systems in order to make modulation possible or to expand tempered systems to provide closer approximation of just intervals. Summarizing the theoretical writings about scales and scale relationships will illustrate these points.

Early equal temperament. -- Apparently, Butler found an equal tempered system commonly in use in 1636. His system for computing intervals was based on a division of the octave into semitones from a given pitch. By this system, with the octave re to re accounted by the semitones from 12 to 24, la, the fifth above re, was figured by adding $3/6$ of 12 and $1/12$ of 12, which placed it seven semitones above re.

The movable tone of Descartes. -- The translation by Brouncker in 1653 of the *Compendium* made Descartes' theories available to the English reader. According to his rules, only the proportions 8:9, 9:10, and 15:16 were available for diatonic motion. By allowing either the interval F to G or G to A to be the major whole tone and by allowing the location of B or $B^b$ to be movable, Descartes was able to
obtain just major and minor thirds from any of the diatonic notes of the scale.

**Brouncker and the use of logarithms.**—In his "animadversions," Brouncker pointed out that by using the proportions 8:9, 9:10, and 15:16 for scale division in all ways, there were 210 possible combinations for the octave. However, Brouncker did not advocate the use of these proportions for constructing scales. He held that the sense judged sounds by geometrical rather than arithmetical proportions, and divisions should therefore be by geometric proportions. Also, Brouncker pointed out that intervals might be divided geometrically into any desired number of proportions. Specifically, he divided the octave, using mean proportionals and logarithms, into twelve proportionals and the mean proportional of a string into seventeen equal semitones by sixteen mean proportionals. This latter division provided a closer approximation of just thirds and sixths than resulted from equal temperament of the octave. He also divided the harmonic portion of a string (A:B::B-2A:A) by fifteen proportionals.

With Brouncker's system the theory and techniques for division of any interval into any number of scale degrees were available. Later theorists had a choice between two approaches to scale tuning: they could accept only rational numbers as proper for deciding tuning problems or they could accept geometrical proportionals. The first choice used real numbers and the latter choice resulted in surd numbers. The first alternative resulted in increasing complexity as theorists attempted to develop chromatic systems; the second alternative resulted in increasing complexity as theorists attempted to approximate just intervals.
Birchensha and Pythagorean tuning.—Birchensha followed the proportional system to an impractical extreme. His translation of the work of Alsted presented two tuning systems: the "old diatonic scale" with the proportions 9:8, 9:8, 256:243, 9:8, 9:8, 256:243, and the "perfect syntonic scale" with the proportions 9:8, 10:9, 16:15, 9:8, 10:9, 9:8, and 16:15. Manuscript notes provide evidence that the grand scale promised by Birchensha in connection with the proposed publication of Syntagma Musicae was probably an extended division by 9:8 proportionals, so dividing the octave into thirty-three intervals by means of real numbers. The selection of twelve of these intervals provided close approximations of just tuning, and the selection of other sets of twelve intervals provided for modulation.

Proportions applied to chromatic systems.—Holder (1694) used the diatonic proportions of Didymus to divide the octave (10:9, 9:8, 16:15, 9:8, 10:9, 9:8, and 16:15). In the division of whole tones into semitones, Holder used the proportion 25:24 for one of the semitones, with the other semitone receiving whatever was remainder—that is, 16:15 for the minor tone and 27:25 for the major tone. However, when he presented a practical tuning system Holder approximated meantone temperament.

It was the intent of Wallis (1698) and Salmon in his article (1705) to bring about a return to the syntonic system of Ptolemy (9:8, 10:9, 16:15, 9:8, 10:9, 9:8, 16:15). However, they disagreed on the chromatic application of this system. Salmon (1688) suggested that frets for half-steps be placed midway between the frets for diatonic steps. Wallis (in Salmon 1688) pointed out that the placement should be a musical middle, which is achieved by dividing the tone by
super-particular ratios. By Wallis' method, the fret dividing the major whole tone, 9:8, was spaced by the proportions 18:17 and 17:16.

Malcolm (1721) was similar to Salmon and Wallis in advocating syntonic tuning. However, for division of tones into semitones, Malcolm suggested either division by super-particular ratios or a division in which the proportion 15:16 was used for the lower semitone, with the upper semitone receiving whatever was remainder—that is either 128:135 or 24:25.

Pepusch.—Technical statements on proportional tuning were made by Pepusch, but without sufficient explanation to make clear precisely what he meant. Several aspects of his theories are clear, however. He mentioned the proportions of Pythagorean tuning, which he called the "diatonic genus." In addition, he mentioned a "concinus scale." using the proportions 9:8, 10:9, and 16:15. A notable feature of his scale theory was the presentation of proportions in both ascending and descending forms. Placing the "concinus" proportions in ascending order located the tone—9:8—below the minor tone—10:9—and placing the proportions in descending order located the minor tone below the major tone. As well as discussing proportional systems, Pepusch wrote about equal division systems. In his opinion, the 31 equal divisions of the octave by Huygens (1673) made possible the most perfect temperament of all.

Later tuning theory.—Among the English theorists who advocated some form of equal division, in addition to Brouncker (1653), are Bedford (1705 or 1706), Warren (1725), and Fond (1725). Bedford favored equal temperament. He suggested that just intonation could be approximated by dividing the tone into any desired number
of parts, using logarithms. Also he suggested that the octave or any
other parts of a string might be divided into any number of equal
parts. Warren, using logarithms, advocated division of the octave by
31 equal intervals. Selection of 12 of these intervals provided a
close approximation of just intonation. Warren's system was identi-
cal to that published earlier by Huygens. Pond's proposal was in
favor of using equal division to achieve 12 semitones to the octave.

Roger North (c. 1700-1726), on the other hand, had little
interest in proportions, and his statements on scale tended to be only
practical. In giving tuning instructions, he presented a procedure
for meantone temperament.

Detailed explanations for tuning systems were presented by
Smith (1749). He approximated just intonation by adjusting the rela-
tive sizes of the tones and limmas in an octave divided into five
equal tones and two equal limmas. Using logarithms, he suggested a
possible division of the octave into 50 equal parts. He suggested a
diatonic scale using a limma composed of five and a tone composed of
eight of these parts.

Use of syllables.—Turning to the use of syllables, the common
system throughout the period was a movable system of four syllables.
This system was described in detail in the treatises of Playford (1653
and later eds.) and Simpson (1665 and later eds.). In both of these
works, the four syllables used are mi, fa, sol, and la. Mi is located
by means of the key signature and the syllables fa, sol, and la appear
in order both above and below it. Apparently, the key note was fa
directly above mi in the case of sharp keys—the major mode—and la
below mi in the case of flat keys—the minor mode. In this system,
the key note was truly a "center," surrounded with pitches above and below in a manner similar to the final of hypo modes. This interpretation of the system is strengthened by the few seven syllable systems used by some of the theorists. Butler (1636), for example, presented a seven syllable system using ut, re, mi, fa, sol, la, and pha. In his system, the seventh syllable, pha, referred to a lowered seventh degree rather than to a leading tone; apparently, his key note was fa. Similarly, Roger North (c. 1726) presented two possible seven syllable systems: do, re, mi, fa, sol, la, fa and go, ar, be, ca, do, ei, fa. In both of these systems, the seventh syllable referred to a lowered seventh degree, and the key note for a sharp (major) key was the fourth scale degree.

Theories of Consonance and Dissonance

Directions of change.--The uses of consonance and dissonance and even the meanings of the terms underwent extensive change in the hundred years following the Restoration, as harmonic styles changed from a polyphonic modal to a homophonic tonal texture. The change was away from de facto listings in which intervals were considered absolute sonorities, each located immovably in a specific consonance-dissonance category toward recognition of the relative sonorities and tensions of harmonic structures within a musical complex.

Justification systems.--In the treatises of Coperario (c. 1610), Campion (c. 1612), Bevin (1631), and Butler (1636), intervals are classified in categorical lists. These lists formed the immediate heritage of the theorists of the late seventeenth and early eighteenth centuries. In addition, they were heirs to at least four different
systems of justification for the sound of intervals: (1) number symbolism, from Pythagoras, and transmitted through Boethius, (2) the senario, from Zarlino (1562), in which proportions up to the number six were used to compare the lengths of vibrating strings, (3) a theory of consonance and dissonance based on the coincidence of motions, and (4) the idea from Aristoxenus that sense perception is proper for judging musical matters.

The third system of justification, the theory of consonance and dissonance based on the coincidence of motions, was advanced in early Baroque Italy by Benedetti (1585), who pointed out that the vibrations of sound in air waves may agree or disagree. Another advocate was Galileo Galilei (1638) whose experiments with pendulums provided a technique for comparing motions. This theory was stated in the following ways: (1) One approach, mentioned by Malcolm (1721) held as important the total number of concurrences between strings without regard to time. (2) A second approach, transmitted by Mersenne (1636-37) and Kircher (1650), rated intervals in an order of consonance based on the time required for the consonance to complete a cycle. In this system, the simpler consonances are thought to be generated before the more complex. (3) A third approach was concerned with the coincidence of pulses in the air or in the perception. This approach was advanced by Francis North (1677), Holder (1694), and Roger North (c. 1700-1726).

**Systems of categorizations.**—The categorizations of consonances found in the early theoretical writings were essentially similar but exhibited minor differences. For example, opinions regarding the
unison differed. Descartes (trans. 1653) and Holder (1694) did not consider the unison a consonance, although it was held to be a consonance by their contemporaries. In this, they followed the Pythagoreans who said that one (unity) was not a number but the basis of numbers. Another example of variation was in the catalogues of intervals larger than the octave. Bevin (1636) listed compound consonances as separate intervals in the early pages of his treatise, but later reduced them to the simple intervals. Descartes (trans. 1653) listed compound intervals as separate consonance up to the triple octave; Alsted (trans. 1664) listed them similarly. Most extreme in this regard is the treatise of Smith (1749). He listed compound intervals in proportions up to 1:30—four octaves plus a seventh. Another variation in approach was in the sub-categorization of concords. Alsted (trans. 1664) and Simpson (1665), for example, categorized the unison, fifth, octave, and the compounds of these intervals as perfect concords and other concords as unperfect or imperfect concords. Butler (1636), on the other hand, used the term "perfect" to refer to the major second, major seventh, as well as octaves. The term "imperfect" he applied to minor intervals. He added the term "primary concords" to refer to the major third and fifth, and "secondary concords" to refer to sixths and the minor third.

Approaches to the fourth. Other differences were apparent in the theorists' approach to the fourth. Bevin (1636) did not list the fourth as a concord; Butler (1636) listed it as a secondary concord. Descartes (trans. 1653) listed the fourth as a concord and pointed out
that it was generated between the fifth and octave. To him the fourth was "unhappy" because it so closely approximates the fifth. Alsted (trans. 1664) presented the fourth as a dissonance, then later as a consonance obtained between the fifth and octave. To Simpson (1665), Blow (c. 1680), and Keller (1707), the fourth was a dissonance.

Changing notions of consonance and dissonance.—Extensive changes toward the notions of consonance and dissonance became apparent in the treatises of Malcolm (1721), Roger North (c. 1700-1726), Pepusch (1737 and 1740), and Antoniotto (1760). Each of these theorists stated new insights regarding consonant and dissonant structures.

Malcolm (1721) expressed dissatisfaction with the available rationale for explaining the meaning of intervallic structures. He was aware of the different effects of various intervals, but found that none of the justification systems was adequate to explain these effects. He applied the rule of simplicity of proportions and found it inadequate. He ordered the intervals according to the number of vibrations accomplished in the same time, according to the number of coincidences of vibrations per unit of time, and according to Mersenne's proposition that the more agreeable consonances are generated in time before those which are more complex or harsh. He concluded that a proper definition of concord must take into account both the coincidence of vibrations and the proportional relationships. In suggesting this, he anticipated the approach later used by Smith (1749) to develop a comprehensive chart listing a hierarchy of intervals.

Roger North (c. 1700-1726) was the first English theorist to drop the traditional meanings for the terms consonance and dissonance.
in attempting to describe the harmonic materials of the developing major-minor tonal practice. Initially, his theory for musical meanings originated with the theory of consonance by coincidence of pulses. Added to this was his awareness of the importance of perception and memory. To North, not only do two pitches exist at the moment they are simultaneously performed, they also endure in the memory and relate both to what came before and what follows after. These insights opened to North a new world of tonal musical meanings. The contrast between his new world and that which preceded was made manifest in his comments on the Prencourt tract. To North, dissonance could only exist if a tone had no apparent orientation to a harmonic context. The term dissonance was improper, from his point of view, to apply to any note of the scale. Rather, all sounds of a key he considered proper to harmonization--indeed, what were commonly called dissonances he considered the greatest "elegances." Elegances were proper in varying degrees of appropriateness. In making aesthetic decisions, intent and context were important criteria. Structuring of a composition involved the relating of pitches instantaneously with other pitches and a bass and in a temporal dimension with chord structures that precede and follow.

The theories of Pepusch (1730, 1731) were a blend of the old and the new. In the opening pages of his treatise and in the manuscripts he listed consonant and dissonant intervals. However, he used the terms "perfect concord," "imperfect concord," and "discord" to refer not only to the intervals but also to the degrees of the scale, and the terms "common concord" and "uncommon concord" to refer to
positions of the triad above a bass. Apparently, he meant to imply something about tonal organization within a composition, for the perfect concords—the key note, fourth, and fifth—required common concords for normal harmonization, and the imperfect concords—third and sixth scale degrees—and discords—second and seventh scale degrees—required uncommon concords for normal harmonization. From these rules, Pepusch developed a system for both creating harmonic structures and connecting the structures in harmonic progression.

A different point of view was expressed by Antoniotto (1760), who held that if individual pitches of a harmonic structure are distinguishable, the structure is dissonant. To Antoniotto, most harmonic structures are dissonant—only perfect octaves and fifths are consonant. His problem in composition was to list a vocabulary of dissonant structures and establish rules for proper progression. It may be recalled, in this regard, that Roger North took the opposite point of view: to him all harmonic structures were consonant. The apparent disagreement between Antoniotto and North was semantic rather than conceptual, however, and both approaches resulted in systems for understanding sonorous moments and organizing them into coherent tonal structures.

Developments in Harmonic Theory

Areas of development.—Harmonic possibilities for musical composition listed in the treatises gave evidence of the transition during the period from contrapuntal to tonal homophonic harmonic thinking. This transition was apparent in five areas. (1) The concept of interval and chord inversion emerged, and harmonic structures came to be viewed as chords spelled in thirds above a fundamental bass.
(2) Chordal structures came to be understood as moments of sonority related to a fundamental, and a vocabulary of such structures was developed. (3) Principles for the tonal architecture of a composition were developed; important, in this regard, were principles for chord progression from a fundamental bass. (4) There developed an awareness of the basic nature of dominant and tonic relationships, although the terms "dominant" and "tonic" were not commonly used. Related to this development, there was an emphasis on cadence structures, secondary dominant relationships, passing modulations, and full modulation. (5) Principles were developed for the proper use of rapidly moving parts, specifically, in the use of non-chord tones. Each of these areas of development is briefly summarized below.

Interval and chord inversion.--The sympathetic vibration of fifths and ditones mentioned by Descartes (trans. 1653), the vibration of partials reported by Wallis (1677), and, later, the co-vibration of partials all suggested that a lower placed fundamental might be the true bass to a combination of tones. The coincidence of pulses theory, fully developed in Francis North's Essay of 1677 also pointed to the possible interpretation of all chordal structures by relation to a fundamental which may or may not be the lowest performed tone. Of the theorists studied, Keller (1707) was the first to suggest that the harmonic structures of figured bass might be interpreted as chords spelled upward in thirds. With Roger North's (early 18th c.) statement that a harmonic structure has a proper base, the principle of chord inversion was stated in a mature form. The principle of chord inversion was also presented by Lampe (1737), Antoniotto (1760), and
Holden (1770). Holden supported the principle of inversion both from the observation of difference tones and from characteristics of human perceptions.

Harmonic structures.--The notion that chord structures provided moments of homophonic sonority was already established in the thorough-bass treatises of Locke (1673), Blow (c. 1680), and Keller (1707). However, in these treatises, with the possible exception of Keller's, the specific color of a combination was viewed as resulting largely because of the characteristics of the constituent intervals. A new tonal point of view was apparent in the harmonic structures of Roger North (c. 1700-1726). With his development of the notion of "proper base," harmonic structures were viewed as harmonic creations having meaning related to a "key" fundamental. Once this point was clearly established, his problem, and that of later theorists, was to list a vocabulary of such structures and seek to understand the harmonic implications. The resulting vocabulary of chord structures was detailed in the discussions of the harmonic vocabulary of the theorists. With the treatises of Antoniotto (1760) and Holden (1770), chord structures available included triads and seventh chords in root position and inversions; ninth, eleventh, and thirteenth chords; secondary dominant structures; and augmented sixth chords; and the way was open for the creation of other structures oriented to a fundamental bass.

Harmonic progression.--Developments in the area of harmonic progression were of two kinds: principles for voice leading and rules for harmonic progression. Principles for voice leading, including the avoidance of parallel fifths and octaves, were developed in contrapuntal practice. Such principles were stated in a mature form
in the early thorough-bass treatises, though there were some individual idiosyncracies. An example of one of the idiosyncracies was the avoidance of parallel fifths by the use of anticipations or suspensions, resulting in the alternation of intervals of the fifth and sixth. Another idiosyncracy was the use of the upward resolving seventh at the cadence.

Elemental rules for harmonic progression were also found in the early thorough-bass works. These rules took the form of harmonic idioms and cadence formulae. Each of the three early thorough-bass works concluded with an example which demonstrated that lengthy harmonic structures could be achieved by the techniques of thorough-bass.

However, the earliest works in which detailed principles for chord progression were found were the manuscripts of Roger North (c. 1720). In his manuscripts, North described a system for harmonic progression using his "proper base." To North, proper base motion was possible in skips. The more perfect the interval, the more normal is the movement of the proper base. For example, according to North, movement of the proper base to a chord a fifth or third away was good because the mind could acquiesce to the new harmony. The possibilities and implications of the system of proper base provided a system for the tonal architecture of a musical composition.

Later English theorists of the Enlightenment listed similar principles for harmonic progression, each exhibiting specific points of emphasis. Pepusch (1730, 1731), for example, as Rameau (1722), called the underlying bass a "fundamental bass." He suggested that the most common fundamental bass movement was to the "common concords"--
first, fourth and fifth degrees—of a key, but movement was also possible to the "uncommon concords"—third and sixth degrees—and even to the "discords"—second and seventh degrees. Progression of the fundamental bass he called "modulation." Lampe (1737) used the term "natural bass" to refer to the underlying bass. Chord connections were natural, from his point of view, if two adjacent chords had one or more notes in common, because the common note unites the harmony. Antoniotto's terminology (1760) was different from that of North, Pepusch, or Lampe. He referred to the underlying bass as a fundamental counterpoint. Of central importance in the movement of the fundamental counterpoint was the skip of "guide," (I-V) and the skip of cadence (V-I). Also possible were skips of thirds and sixths. Holden's terminology (1770) was similar to that of Rameau (1722) and Pepusch (1730, 1731) in referring to the underlying bass as a fundamental bass. He held that the fundamental bass was the lowest difference tone.

The importance of dominant and tonic relationships.—During the hundred years after the Restoration, there developed among English theorists an increasing awareness of the importance of the harmonic relationships which later music theorists termed dominant and tonic. In the early thorough-bass treatises, this developing awareness was noted as an increase in the number of examples for cadential structures. Also, the summary examples of transition in these works are examples of transitory modulations in which dominant structures have an important place.

Observations of the physical characteristics of sound supported the importance of dominant and tonic relationships. The close relation
of chords on the fifth scale degree and those on the first scale degree received emphasis by observations of the harmonics of the vibrating string, in the theory of consonance by coincidence of pulses, and later, through the phenomena of difference tones.

The importance of dominant and tonic relationships was illustrated by the preoccupation of Bedford (c. 1705 or 1706) with harmonizations on the sharp scale degrees and with cadence formulas. Similarly, this awareness was demonstrated by Roger North (c. 1726) when he pointed out that the chief accord in the conjunction of keys was the movement from a key note to its fifth and back again to the key note. The extent to which the awareness of the basic nature of dominant and tonic relationships was developed was demonstrated in the treatises of Antoniutto (1760) and Holden (1770). Antoniutto defined the composition of music as "an harmonic progression of divers cadences . . ." (supra, p. 340) and the skip of a fifth downward or fourth upward in the fundamental counterpoint he called the "terminate, perfect, consonant skip of cadence . . ." (supra, p. 325). Holden held the primacy of the fifth as a fundamental insight undergirding his harmonic theories.

Non-chord tones.—In the developing tonal awareness, the function of tones which were not a part of a triadic structure required special explanation. Traditional systems for dissonance treatment, as in the treatise of Bevin (1636), for example, did not provide the colors of meanings required for the new tonal homophonic context. What was needed was a method for explaining the harmonic relationships which resulted when one or more voice parts moved more rapidly than
others in the harmonic scheme. By "division," and "figurate harmony,"
North (c. 1726) and Antoniotto (1760) suggested that it was appropriate
to ornament a melodic line with arpeggiation, suspensions, and rhyth-
mic filling in between chord tones with passing tones and auxiliaries.
In the most ornamental forms, the decorations became the idiomatic
shakes, trills, "beat-ups," and "back-falls,"--not to mention simple
runs--characteristic of idiomatic keyboard performance.

Conclusions.--It was the purpose in this dissertation to de-
scribe the writings about music theory in the British Isles during the
Enlightenment. The following developments were documented.

1. Theorists continued the reason versus sense discussion,
using techniques and vocabulary appropriate to the time.

2. Theoretical writings reflected contemporary developments
in mathematics, natural philosophy, and empirical philosophy.

3. The major and minor scale systems were in use throughout
the period, although there was not agreement on tuning theories and
procedures.

4. The common syllable system was movable, using four
syllables.

5. Concepts of consonance and dissonance underwent extensive
alteration. In the early part of the period, intervals were consider-
ed absolute moments of either consonance or dissonance; in the later,
various terminology was used. The direction of development was toward
consonance and dissonance as relative ideas within a tonal framework.

6. The concept of chord inversion was established.
7. Chord structures came to be understood as simultaneous sounds related to a bass and to preceding and following chords.

8. Principles for the tonal structure of a composition were developed, specifically through the use of the fundamental bass.

9. Theorists wrote about the tonal importance of dominant and tonic relationships.

10. Principles were developed by which the harmonic and melodic functions of non-chord tones might be understood.

The musical ideas expressed in the theoretical writings of theorists in the British Isles from 1660 to 1760 reflect the intellectual discussions of the Enlightenment and indicate the various authors' points of view in the transition from modal polyphonic to tonal homophonic musical thinking.
Alsted, Johann Heinrich, 1588-1638. *Templum Musicum, or The musical synopsis of the learned and famous Johannes Heinricus-Alstedius, being a compendium of the rudiments both of the mathematicall and practicall part of musick, of which subject not any book is extant in our English tongue.* Translated by John Birchensha. London: P. Dring, 1664.


Anonymous. "Memoranda by an Englishman." Unpublished manuscript, British Museum Sloan 2686. 131 folios, 10.4 x 16.2 cm.

Most of the information in this manuscript is not about music. However, there are tables of musical proportions and crude drawings of musical instruments.

Anonymous. "Musical Observations and Experiments in Musical Sounds Belonging to the Theoric Part of Music, A short introduction to the knowledge of descant or composing of music: also the most exact way for the tuning of an organ, harpschord or espineta." Unpublished manuscript, British Museum Harley 4160. Scope: 45 folios, 11.5 x 18 cm., as follows:

1-3v, title page and table of contents.
4r-32v, text on Music at the creation, Music was the first science, Music at the birth of our Saviour, Music at the end of the world, Music is heaven, Music everlasting.
33r-34v, The way of making an artificial nightingale. The artificial nightingale is constructed using a lead cistern of 20-30 gallons and pipes to let the water in and make the sound.
35r-36v, The most exact way for the tuning of an organ, harpsichord, virginal, or espineta.
37r-41v, A short introduction to the knowledge of descant or composing of music.
42r-44r, Table of contents.
Dating: The author mentions the date the "4th of May, 1698, [when] the king of France did shew them [his waterworks] to Miniere Binning, Earl of Portland, Embassador from England." He also mentions organ pipes of alabaster in the city of Mantua, which were broken when the Germans took the city, "about 40-50 years ago," (fol. 21v). This probably refers to the sack of Mantua by the Austrians in 1630. Watermark is a Strasbourg Lily, similar to Churchill 401 or Heawood 1786. Probably written soon after 1698.

Scope: 109 folios of various sizes. Following are the contents of Additional 4388.
1-13, Miscellaneous mathematical and geometrical calculations.
14-38, Discussion of Birchensha's scale and comparison with the author's scale.
39-44, Further comments and comparisons of the author's and Birchensha's scales.
45-52, Quotations and notes on other musical topics including Rhythm. Excerpts from Morley, Mersenne, Campion, Kepler.
53-66, Miscellaneous computations related to scale.
67-68, Quotation of Birchensha's description of his scale.
69, Advertisement for Syntagma Musicae.
70-83, A manuscript copy of Descartes's Compendium Musicae copied in 1650.
84-109, Miscellaneous notes and musical examples. Included is music by Dowland (fol. 101r) and Henry Lawes (fol. 103).

Dating: A collection of miscellaneous papers. Fol. 30 carries the date Feb. 13, 1666, and is on paper carrying Cardinal's Hat watermark which Heawood found elsewhere, 1649-1670, Heawood 2582. Fols. 39-44 are on paper having the Strasbourg Bend and Lily watermark, Churchill 429. Fol. 69 is a print of the advertisement of 1672 for Birchensha's proposed book, Syntagma Musicae. Apparently these are miscellaneous notes collected by someone other than Birchensha during the period approximately 1650-1675.

11 folios, 15 x 19.7 cm., except for one folio showing a diagram for proportionall division which is 15.5 x 21.7 cm.
The date 1702 appears on the title page, apparently in the same hand as the text.
It has been pointed out by Lady Jeans that ff. 1, 6, 10v-11
appear to be in the handwriting of Thomas Salmon. In addition,
there are insertions in the manuscript, also apparently in
Salmon's handwriting. However, the system of placing frets
on the viol suggested in this manuscript is not the same
system advocated by Salmon. In this manuscript, it is sug-
gested that frets be fitted all the way across the finger-
board at 8/9, 4/5, 3/4, 2/3, and 1/2 of the distance to the
nut, whereas Salmon advocated movable frets for each string.
Frets for the semitones are located similar to the system used
by Salmon; that is, one half the distance between the frets
for the tones. The semitone frets between 2/3 and 1/2 are
different for each string. Tuning is to be done by stopping
the strings and matching unisons. Apparently this manuscript
was written by someone other than Salmon, possibly a student,
who followed Salmon's ideas regarding tuning.

Antoniotto, Giorgio, 1692-1776. L'arte armonica; or a treatise on the
composition of musick. 3 books, 2 vols., bound as one.
London: John Johnson, 1760.
In three books with an introduction on the history and
progress of music from its beginning to this time.
Book 1: Containing the general and particular definitions
of the whole harmonic art; modern system of sounds, two new
systems of combination of sounds, and their progression,
formed by the author.
Book 2: Containing the fundamental harmony, explained by
the fundamental counterpoint . . .
Book 3: Containing the figurate harmony, its difference
from the fundamental.
Two printings of this edition were made. The second print-
ing has a longer list of errata, a different title page,
and plates are printed on separate leaves rather than back to
back. In other respects the printings appear to be identical.

Bedford, Arthur, 1668-1745. "Observations Concerning Musick Made Anno
Domini 1705 or 1706 by the Learned and my very worthy Friend,
the Reverend Mr. Bedford, Chaplain to the Haberdasher's
Hospital at Hoxton, near London." Unpublished manuscript,
British Museum Additional 4917.
Scope: 63 ff., 15.5 x 20 cm. Instruction in the art
of composition. Supports equal tempered division of
the octave by twelve proportionals. Emphasizes
cadences and what later theorists term dominant
relationships.
The Observations are quite different from Bedford's
published works on music. The latter are critical of
the church music of the time and suggest corrective
measures.
Dating: The handwriting is apparently the same in the manuscript and title page. Watermark is of the Pro Patria kind, with a crown and GR, Heawood 3696, found elsewhere in 1724-26. Inasmuch as Bedford was appointed Chaplain to the Haberdasher's Hospital in 1724, the actual writing of this manuscript may be later than the dates on the title page. c. 1725.

The Excellency of Divine Musick; or a sermon preach'd at the parish-church of St. Michael's Crooked Lane, in the City of London, on Thursday, the fourth day of October, and at Sir George Wheeler's Chapel, in Spittle-fields, on Monday the Fifth of November, in the year of our Lord, 1733, before several members of such societies who are lovers of Psalmody, to which is added, a specimen of easy, grave tunes, instead of those which are used in our profane and wandering ballads. London: W. Pearson, 1733.

The Great Abuse of Musick, in two parts, containing an account of the use and design of musick among the ancient Jews, Greeks, Romans, and others; with their concern for, and care to prevent the abuse thereof, and also an account of the immorality and profaneness, which is occasioned by the corruption of that most noble science in the present age. London: J. H. for J. Wyatt, 1711.

The Temple Musick, or an essay concerning the method of singing the Psalms of David in the temple before the Babylonish captivity, wherein the musick of our cathedrals is vindicated, and supposed to be conformable, not only to that of the primitive Christians, but also to the practice of the church in all preceding ages. London: H. Mortlock, 1706.


Scope: Rules for composition, with examples. Ruff (Ruff, op. cit., pp. 41-44) says that this is a garbled copy of Coperario's Rules How to Compose.

"Rules for Playing of a Thorough-Bass Upon Organ and Harpsicon." Unpublished manuscript, British Museum Additional 34072, (ff. 1-5).

Boyle, Robert, 1627-1691. *New Experiments Physico-Mechanical, touching the spring of air, and its effects (made for the most part in a new pneumatic engine).* Oxford: H. Hall, 1660.

Written by the natural philosopher and chemist Robert Boyle by way of letter to the Right Honorable Charles Lord Viscount of Dungarven. Experiment 27, pp. 205-214 is related to musical sound. A second edition was published in 1662.


This is an instructional treatise in sight singing. The scope was expanded in later editions.
1st edition: 35 pp., 2 pl., 51 pp. of examples.
2nd edition: Edinburgh: The Author, 1762. 64 pp., 2 pl.,
72 pp. of examples.
3rd edition: London: The Author, 1763. 59 pp., 2 pl.,
72 pp. of examples.


Brouncker was the first president of the Royal Society of London. In the "Animadversions," he suggests dividing the octave into 12 semitones by dividing the mean proportional of a string into 17 equal semitones. This division he does both algebraically and using logarithms.


One of the most important and oft quoted early seventeenth century treatises. Made more interesting and less readable by the Rev. Mr. Butler's innovations regarding spelling.

Campion, Thomas, 1567-1620. *A New Way of Making Foure Parts in Counterpoint, by a most familiar and infallible rule. Secondly, a necessary discourse of keves and their proper closes. Thirdly, the allowed passages of all concords perfect, or imperfect, are declared. Also by way of preface, the nature of the scale is expressed, with a briefe method teaching to sing.* London: T. S. for John Browne, n.d., c. 1612.


Referred to by Hawkins as "not unworthy the notice of a learned musician (Hawkins, op. cit., p. 32). This article provides information on Greek modes and melodies.


Descartes, Rene, 1596-1650. Renatus Descartes Excellent Compendium of Musick: with necessary and judicious animadversions thereupon. Translated by William Lord Brouncker. London: Thomas Harper for Humphrey Moseley, 1653. Includes comments by Brouncker which are as interesting as Descartes's text, which was written c. 1618. Brouncker states that the geometric is preferred to the arithmetic division, contrary to Descartes. A copy in Latin of Descartes's Compendium is in British Museum Additional 4388, fol. 70r-83r.

Domville, Silas, alias Taylor, 1624-1678. "A Collection of Rules in Musicke from the Most Knowing Masters in that Science with Mr. [John] Birchensha's 6 Rules of Composition; and his Enlargements There-on to William Lord Brouncker." Unpublished manuscript, British Museum Additional 4910, fol. 39-62. Scope: Quotations, examples, and information on musical composition collected from Locke, Birchensha and Simpson, Domville promises "Birchensha's six rules," but only five rules are listed in Birchensha's handwriting. In the same manuscript are included a short treatise in German, headed "Excerpta ex Claveri Disquisitionibus" (fol. 1-10); a counterpoint treatise in Latin, beginning "Cum Deo conditore nostro" (fol. 11-38); and another German Treatise entitled "Tractat. von der Musicalische Composition" (fol. 62-83).


A satire. Added to the treatise available in the British Museum are handwritten comments by T. W. Taphouse, of Oxford, stating that this book is an attack upon one Barnabas Gunn, composer and at one time organist of Gloucester cathedral, and also post-master and box-maker at Birmingham.


In the preface it is mentioned that the art of thorough bass was invented in 1605 by Viadana. Page 19 has a chart of the circle of fifths.

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Hoegi, Pierre, late 18th c. *A Tabular System Whereby the Art of Composing Minuets is Made so Easy that Any Person, Without the least knowledge of Musick, May Compose Ten Thousand, All Different, and in the Most Pleasing and Correct Manner.* London: Welcker's Music Shop, 1770?

A devisive system for composing minuets by selecting one measure from each of several pages. Interesting, but of little value to this study.

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Contains both a theory of harmony and a harmonic system. The Essay was published again, Edinburgh: University Press for William Blackwood and John Murray, 1807. Comparison reveals the two printings to have identical texts, although printed in different format. Plates appear in the text in the 1770 edition and at the end of the text in the 1807 edition.

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Designed to accompany the Scheme. Includes a circular slide rule for selecting appropriate pitches for the scale.
A Scheme Demonstrating the Perfection and Harmony of Sounds.
Westminster: J. Cliuer and A. Campbell, 1726.

In the form of a huge plate, 53.5 cm. x 76.5 cm., showing various systems for division of the octave. Included is division by 55 parts into 46 tones, and division into 670 particles.


According to F. T. Arnold, this treatise was published again, London: Walsh, n. d. (Arnold, op. cit., p. 247). It was printed two more times: London: R. Meares, 1721, and with Holder's Treatise, London: W. Pearson, 1731. The edition has extensive corrections, clarifications, and additions. These include grammatical improvements, more detailed examples, and corrections of figurations. Also, in the 1731 edition, downward resolving sevenths on dominant harmony replace earlier examples of upward resolving sevenths. However, upward resolving sevenths still occur within the examples. Other idiosyncracies are retained, including the key signature with no sharps and flats to indicate the key of F and the signature with two flats to indicate the key of E♭. However, these keys appear on other pages in each publication with the customary signatures of one flat and three flats. (Cf. p. 185 of the 1731 edition and p. 8 of the 1707 edition.) Examples of unusual approach to the fifth appear in both publications. (Cf. p. 191 of the 1731 edition with p. 10 of the 1707 edition.)


Natural law justification for the perfection of the major chord in the harmonics of the vibrating string. Rameau is mentioned.


From a system based on natural law theory, develops a system of thorough-bass. Distinction is made between "thorough bass" and "natural bass."


Locke's critical response to Salmon's Essay. Locke uses largely invective to criticize Salmon's system for improvement of notation.

The Present Practice of Musick Vindicated Against the Exceptions and New Way of Attaining Musick Lately Published by Thomas Salmon, M. A. London: N. Brooke, 1673.

To this is added "Duellum Musicum" by J. Phillips and a letter from J. Playford to Mr. T. Salmon by way of confutation of his Essay. This book includes additional critical responses to Salmon's suggestions for clef reform, stimulated by Salmon's Vindication of an Essay.

Mace, Thomas, 1619?-1709? Musick's Monument: or a remembrance of the best practical musick both divine and civil that has ever been known, to have been in the world. London: T. Ratcliffe and N. Thompson for the Author, 1676.

Part I is an apology for church music and instruction in singing; part II is an instructional lute treatise; and part III is an instructional viol treatise.


A detailed treatise with extensive sections devoted to the harmonic arithmetic. It was reprinted London: J. Osborn and T. Longman, 1730. In addition, part was republished, "Corrected and abridged by an eminent Musician." The first edition of the abridgement included only Chapters I, XI, and part of Chapter XIV of the original work: London: J. French, 1776. Second edition of the abridgement, London: 1779. (The British Museum copy of this edition was destroyed in the war and was unavailable for examination.)


Contains the following, with Meibom's comments:

Aristoxeni Harmonicorum Elementorum Libri III
Euclidis Introductio Harmonica
Nicomachi Garesini Pythagorici Harmonices Manuale
Alypui Introductio Musica
Gaudentii Philosophi, Introductio Harmonica
Bacchii Senioris Introductio Arti Musicae
Aristides Quintilianii De Musica Libri III
Martiani Capellae De Musica Libri IX
Meibom visited England in 1674.


Elementary instruction in each of the seven liberal arts: Grammar, Arithmetic, Geometry, Music, Astronomy, Rhetoric, and Logic. The discussion on music, pp. 89-103, includes names of notes, solfeggio, and rhythm.


Suggests that the perfection of the major chord is the result of coincidence of pulses.

North, Roger, 1653-1734. "An Essay of Musical Ayre, tending chiefly to shew the foundations of melody Joyned with Harmony, Whereby may be discovered the Native genious of good Musick, and concluding with some notes concerning the Excellent art of voluntary. Being the 3rd and last part of the Musicall Recollections." Unpublished manuscript, British Museum Additional 32536, ff. 1-90.

Dating: Wilson (Wilson, *op. cit.* pp. 361-364) studied the North manuscripts, and his dating is followed here. Additional 32536 he dates c. 1715-20.


________. "The Musical Gramarian, or a Practick Essay upon Harmony, plain and artificiall. With Notes of comparison between the Elder and Later musick, and somewhat Historicall of both." Unpublished manuscript, British Museum Additional 32533. c. 1726.

________. "The Theory of Sounds, Taking rise from the first principles of action that affect the sense of hearing, and giving phisical solutions of tone, Harmony and discord, shewing their anatomy, with the manner how most Instruments of Musick are made to yield delicious as well as triumphant sounds, with Intent to leave no mistery in musick untouch't. Being the 2nd part of the Musicall Recollections." Unpublished manuscript, British Museum Additional, 32534. c. 1715-20.

________. "The Theory of Sounds, Shewing the Genesis, Propagation, Effects and Augmentations of them. Reduced to a specific inquiry into the cripticks of harmony and discord, with eikons annexed exposing them to ocular inspection." Unpublished manuscript, British Museum Additional, 32535. Contains two re-writings of "The Theory of Sounds." The first, ff. 1-73, North has dated 1726. The second, ff. 74-149, North has dated 1728.
Unpublished manuscript, British Museum Additional, 32531. c. 1710.
Contains the following:
1-2, Draft introduction.
3-7, Introduction.
8-41, Pencourt tracts, with annotations.
   8-27, "Short easy, and plaine rules to learne in a few days the principles of Musick, and chiefly what relate to the use of the Espinetta Harpsichord or Organ."
27v-28, An easy way to learn to sing in a short time.
29-41, The treatise of the continued or thro-base.
42-58, Miscellaneous notes, including comments on Frances North's Essay of 1677 and on rhythm, including critical comments on Vossius's De viribus rythmi.

Unpublished manuscript, British Museum Additional 32549. (c. 1700).
Contains the following:
1-30, Unannotated copy of the Pencourt tracts.
31-35, A manuscript copy of Robert's (1692) "Discourse Concerning the Musicall Notes of the Trumpet and Trumpet-Marine."
39-87, Accounts of experiments.
89-102, A philosophical essay.
103-109, Accounts of experiments.

Unpublished manuscript, British Museum Additional 32537. (c. 1710).
Contains miscellaneous manuscript notes which are probably earlier drafts for the "Musical Grammarian" and "Theory of Sounds."

Pasquali, Nicolo. Thorough Bass Made Easy: or Practical rules for finding and applying its various chords with little trouble; together with variety of examples in notes, shewing the manner of accompanying concertos, solos, songs, and recitatives. Edinburgh: R. Bremmer, 1757.

[Peusch, John Christopher], 1667-1752. A Short Treatise on Harmony, Containing All the Chief Rules for Composing in 2, 3, 4 parts, Dedicated to All Lovers of Music. London: J. Walls, 1730.
This may have been sent to press by James Hamilton, Viscount Paisley. (Cf. Hawkins, op. cit., V, 345.)

This was probably published by Peusch to correct errors and inadequacies of the 1730 edition.
"On the Various Genera and Species of Music Among the Ancients; with some Observations Concerning Their Scale."
Philosophical Transactions, IX (1746), 268-272.

Scope: Manuscript notes on scale, mode and proportion.
May have been written in connection with the article appearing in the Philosophical Transactions.

Dating: Three kinds of paper are included in the manuscript. Ff. 1-3 and 23 have the VRYHEY with circled crown and GR, Heawood 3148, of 1745. Ff. 4-14 and 17-18 have the Strasbourg Bend and Lily, Churchill 429, found elsewhere in 1683. Ff. 15-16, 19-22 have the Strasbourg Lily with a block I Ville-dary, Churchill 407, which he found elsewhere in 1758. Date: c. 1750.
Scope: Manuscript notes on scale, mode and proportion.
May have been written in connection with the article appearing in the Philosophical Transactions.

London: 1653.
Published in nineteen numbered and unnumbered editions, from 1653-1730, as follows:
1660: 3d ed., London. "To which is added a third book, entitled the art of descant, or composing musick in parts, by Dr. Tho. Campion." The section by Campion appears in editions from 1660-1687.
1662: London. "With annotations thereon by Mr. Christopher Simpson."


Comparison of the frequency of natural harmonics of the vibrating string with frequency resulting from proportional tuning systems.


The initial document in the Salmon versus Locke controversy. Recommends adoption of nomenclature of the first seven letters of the alphabet and giving up of Guidonian names, and recommends the use of only one clef. The preface is signed by J. Birchensha.

Proposal to Perform Music in Perfect and Mathematical Proportions. London: J. Lawrence, 1688.

Recommends returning to the perfect proportions of just intonation. "Remarks" by John Wallis conclude the book.

"The Theory of Music Reduced to Arithmetical and Geometrical Proportions." *Philosophical Transactions.* XXIV (1705), 243-246.

Account of an experiment in support of just intonation.


In the first letter, dated 4 Dec., 1705, Salmon expresses appreciation to Dr. Sloane for printing his paper (above) in the Royal Society Proceedings. It is Salmon's hope that "wee may proceed to those improvements wherein the Grecians excelled us." Specifically, he refers to the Greek enharmonical music, "which was their best."

In the second letter, dated 8 Jan., 1706, Salmon comments on the publication of his article and requests Dr. Sloan's help in finding a patron for support in making "an advancement in the Enharmonick musick."


In the form of a letter to Dr. John Wallis, this is Salmon's response to Locke's criticism of the Essay to the Advancement of Musick.
Annotations upon Campion's Art of Descant. Incorporated with Playford's Brief Introduction, 2d ed., 1660, until Purcell's treatise replaced that of Campion.

The following editions were published:

Mathematical and geometrical approach to harmonic relationships, by Robert Smith, cousin of Cotes and head of Trinity College.
An unabridged re-publication of the first edition with a new introduction by J. Murray Barbour is available.

London: J. and H. Hughes, 1771.
An explanation in English of the theories of Tartini.

Taylor, Brook, 1685-1731. "On the Motion of a Tense String."
Philosophical Transactions, XXVIII (1713), 14-16.

Instruction in the rudiments of singing. Paragraphs at the end on the abuse of music.
There is some question about the identify of this William Turner; there is no reference to the degree on the title page, so this may not be William Turner, D. Mus., 1651-1740.

Vossius' comments on the rythmus. This has been translated
into German in *Sammlung vermischtener Schriften für Beforderung
der schönen Wissenschaften und der freien Küste.* Berlin: Friedrich Nicolai, I (1759), 1-84 and 215-320.

Translation of the text regarding experiments made by the Academie del Cimento.


——. "On the Division of the Monochord or Section of the Musical Canon." *Philosophical Transactions*, IV (1698), 240-242.

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Provides a system of temperament identical to that of Huygens, in which the octave is divided into 32 equal intervals, using logarithms. Of the 32 intervals, twelve are to be used in the scale, closely approximating just intonation. Warren includes a circular slide rule to use in selecting the proper pitches.
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