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A COMPUTER-ASSISTED STUDY OF SELECTED
KYRIES FROM THE PARODY MASSES OF
CLEMENS NON PAPA

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A COMPUTER-ASSISTED STUDY OF SELECTED KYRIES FROM THE PARODY MASSES OF CLEMENS NON PAPA

By

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ABSTRACT

A COMPUTER-ASSISTED STUDY OF SELECTED KYRIES FROM THE PARODY MASSES OF CLEMENS NON PAPA

By

John David Zimmerly

The goal of this thesis is the development of new computer-oriented techniques for the study of borrowing procedures in Renaissance music, focusing on the Kyries from the five parody Masses by Clemens non Papa which use chansons as models.

The foundation of the computer methodology is a simplified encoding system for Renaissance music named VASL, based on the principle of segmenting music into small sections to facilitate the programming of either linear or vertical analysis. However, the chief advantage of VASL was found in the development of an analytical technique termed "numeric score reduction" (the combining of specific groups of notes from a score into single average pitch values which can be plotted as points on a graph).

The application of numeric score reduction to the study of sixteenth-century parody technique proved particularly enlightening when the relationship between the Mass and its model seemed vague or non-existent. Numeric score reduction revealed subtle structural elements transferred from the models to the Masses by putting them into a form which could be objectively graphed and measured.

ACKNOWLEDGEMENTS

I wish to express sincere appreciation to my major advisor, Dr. Dale Bonge, for his guidance and helpful suggestions during the preparation of this thesis. I would also like to thank Dr. Theodore Johnson and Dr. David Liptak for reading this thesis and making further suggestions for its improvement.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Although the decade between 1965 and 1975 was a very active period for computer applications to music research, only limited success was achieved in opening up the many new areas of musical understanding initially envisioned. Since this first wave of pilot projects, a leveling off seems to have occurred especially in the area of style analysis.

There are several possible reasons for this apparent decline in the use of the computer in music research. First, the need for some kind of formal training in computer skills has always been a barrier. A lack of understanding by the uninitiated has often led either to false hopes or to skepticism, and to a view of the computer more as a gimmick than a research tool. In an article summarizing accomplishments in computer-assisted music research, Harry Lincoln has pointed out two additional problems:

> The hard fact is that certain aspects of computer applications to music research continue to prove stumbling blocks. Among these are the tedious preparation of input and the need for output in music notation.[1]

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[1]Harry B. Lincoln, "Use of the computer in Music Research: A Short Report on Accomplishments, Limitations and Future Needs," Computers and the Humanities, VIII (September, 1974), 285.

The manual encoding of music into a machine-usable form has long been an obstacle limiting large-scale projects and discouraging many researchers because of the thousands of error-prone punch cards usually required as input.[2] The solution to this problem may soon be found in recent hardware developments which have allowed the coupling of an optical scanner to a small computer. This combination of optical scanner and computer is already being used in many fields. Probably only a modest amount of programming would enable the scanner to recognize standard music notation and permit the computer to translate it into one of the many languages already developed for manual encoding. An additional problem caused by hardware limitations is the printing of standard music notation by the computer. This, too, can be solved with current technology, but a satisfactory printing system has yet to be developed.

Lincoln also mentions another problem which may very well be the single most important reason why relatively few studies have made a significant contribution to musical scholarship:

> These hardware problems will undoubtedly be solved in the next few years but more basic questions are likely to remain: 'What does one look for?' and 'How does one phrase the problem in unambiguous terms which are computable?'[3]

A great deal of creative thinking and development will be required to overcome this obstacle and generate a new

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[2]For definitions of technical terms see appendix D.

[3]Lincoln, "Use of the Computer," p. 285.

wave of projects. In the past most computer-assisted analysis has been either of a statistical nature (interval counts, etc.) or an attempt to automate specific aspects of traditional analysis. Until the advent of a workable optical scanner either type of analysis is probably not very practical, and even after the optical scanner comes into general use, the real advantage of the computer may not be in the duplication of traditional analysis procedures. Instead, a new type of analysis system will probably be required, one designed around the computer's special capabilities and aimed at supplementing, not replacing, conventional analysis. Writing in 1966 about computer applications for the humanities, Louis Milic already seemed aware of this point:

> Thus we must learn to ask it [the computer] larger questions than we can answer and to detect what escapes our un-aided senses. This may involve not only proposing old questions in new ways but even thinking up new questions. The computer can be made an extension of man only if it opens avenues we have not suspected the existence of.[4]

Keeping in mind the concepts stated by Lincoln and Milic, the focus of this thesis will be the development of new computer-oriented techniques for the analysis of Renaissance music in general and sixteenth-century parody technique in particular. The specific music to be investigated will be the Kyrie movements from the five parody Masses by Clemens non Papa which use chansons as their models. This body of music was chosen for several reasons. First, there is an absence of recent studies dealing with the

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[4]Louis T. Milic, "The Next Step," Computers and the Humanities, I (September, 1966), 4-5.

Masses of this major sixteenth-century composer.[5] Second, the project requires a unified body of music. Finally, the concept of parody technique offers an excellent opportunity for studying the transformation of musical ideas and for the comparison of musical styles.

Related Research

A brief survey of the more prominent projects shows that while computer-assisted analysis has been used to study music from virtually every period, there has been a relatively high concentration of studies dealing with early music, and particularly music of the Renaissance. One reason for the popularity of computer studies of early music may be the relatively limited number of notational elements as compared with nineteenth- or twentieth-century music. Encoding and programming are greatly simplified by the presence of a precise number of voice parts and the absence of dynamic markings, phrase markings, articulation etc.

One of the first dissertations dealing with computer-assisted analysis of early music was completed by James Curry in 1969. Curry's study dealt with the Kyrie movements from five Masses by Johannes Ockeghem.[6] Concentrating

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[5]The most recent study appears to be Joseph Schmidt-Görg, "Die Messen des Clemens non Papa," Zeitschrift für Musikwissenschaft, IX (1926-27), 129-158.

[6]James L. Curry, "A Computer-Aided Analytical Study of Kyries in Selected Masses of Johannes Ockeghem" (unpublished Ph.D. dissertation, University of Iowa, 1969).

on dissonance treatment, Curry identified the more common melodic contours which Ockeghem used in a dissonant context. The computer was used to measure the harmonic intervals above the lowest-sounding voice in the Kyries, and to analyze the types of melodic movement into and out of these intervals. The resulting data was used in part to set up interval classes similar to consonance and dissonance.

Several interesting dissertations dealing with computer-assisted analysis have appeared in the seventies. Raymond Erickson has done a stylistic analysis of Notre Dame Organa to settle questions regarding the use of modal rhythm in the duplum.[7] A structural analysis of the music correlated rhythmic points of stress and the medieval principle of consonance. Results showed an overwhelming number of consonant intervals at these points, and the study suggests, on musical rather than merely theoretical grounds, that a modal framework is probable. In another dissertation Philip Patrick has used the computer to study a suspension formation in the Masses of Josquin Desprez.[8] Patrick attempted to formulate "constructs" which would help to identify the suspension formation and to trace any large-scale structural elements associated with it. The computer was used to find the suspensions and to reduce

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[7] Raymond F. Erickson, "Rhythmic Problems and Melodic Structure in Organum Purum: A Computer-assisted Study" (unpublished Ph.D. dissertation, Yale University, 1970).

[8] Philip H. Patrick, "A Computer study of a Suspension-Formation in the Masses of Josquin Desprez" (unpublished Ph.D. dissertation, Princeton University, 1973).

them by removing melodic ornamentation so that only the basic suspension formation remained. One of the most recent studies is by David Stech, who has written a computer program to assist in the micro-analysis of melodic lines.[9] The program was designed to help the analyst locate specific types of melodic patterns.

Several large-scale projects have also been attempted in recent years. At the University of Chicago, Lawrence Bernstein has headed a project to study the entire repertory of sixteenth-century French secular polyphonic chansons.[10] The project includes a style analysis and the generation of a thematic concordance of the repertory. Arthur Mendel has been involved since the mid-sixties in a major project at Princeton University to study the Masses and motets of Josquin Desprez.[11] Another ambitious project, designed to build a thematic index of sixteenth-century Italian music for the purpose of identifying anonymous works, duplications, and borrowings, has been carried out in part by Harry Lincoln from the State University of New York at Binghamton.[12]

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[9] David Alan Stech, "A Computer-assisted Approach to Micro-analysis of Melodic Lines" (unpublished Ph.D. dissertation, Michigan State University, 1976).

[10] Lawrence F. Bernstein and Joseph P. Olive, "Computers and the 16th-Century Chanson: A Pilot Project for the University of Chicago," Computers and the Humanities, III (January, 1969), 153-160.

[11] Arthur Mendel, "Some Preliminary Attempts at Computer-assisted Style Analysis in Music," Computer and the Humanities, IV (September, 1969), 41-52.

[12] Harry B. Lincoln, "The Thematic Index: A Computer Application to Musicology," Computers and the Humanities, II (May, 1968), 215-220.

Examination of the more prominent computer-assisted projects related to the analysis of early music has helped to demonstrate some of the approaches already explored. As previously stated, the goal of this study is the development of new analytical principles designed specifically for the computer. Although within the limits of a small-scale project a complete analytical system cannot be developed, the principles presented in this thesis may serve as the foundation for such development in the future.

CHAPTER II

SIXTEENTH-CENTURY PARODY TECHNIQUE

Fourteen of the fifteen Masses by Clemens non Papa are based on pre-existing chansons or motets and are generally referred to as parody Masses. However, the term "parody" seems to be under attack by recent scholarship. Lewis Lockwood believes that the term originated somewhat by accident in the nineteenth century, and has gained widespread use only since then. He supports this theory by a detailed investigation of primary sources of the period, and has determined that "parody" (or parodia) is not used in any of them. Instead, the word "imitatio" seems the prevalent term for this compositional practice in the sixteenth century.[13]

Another problem with the term "parody" is the wide variety of definitions applied to it. According to Lockwood, very few sixteenth-century theorists devote any attention to the practice of polyphonic derivation despite its importance as a compositional technique of this period. His research indicates that the most detailed account of parody procedures by a contemporary theorist is to be found in Book

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[13]Lewis Lockwood, "On 'Parody' as Term and Concept in 16th-Century Music," Aspects of Medieval and Renaissance Music: A Birthday Offering to Gustave Reese, ed. by Jan La Rue (New York: Norton, 1966), pp. 560-566.

XII of Pietro Cerone's El melopeo y maestro published in 1613. Cerone has many valuable comments to offer on the art of Mass composition, some of which are specifically related to the practice of borrowing. Only these points are extracted and paraphrased below.

1) The invention at the beginning of the first Kyrie, the Gloria, the Credo, the Sanctus, and the Agnus Dei should correspond to the beginning of the model, though their contrapuntal treatment of this material should vary.

2) The Christe may be based on a subsidiary motive from the model or one invented by the composer.

3) The beginnings of the last Kyrie and the second and third Agnus Dei may be based on freely-invented material or on other subsidiary material from the model.

4) The endings of the last Kyrie, the Gloria, the Credo, the Sanctus, the Osanna and the third Agnus Dei should use, though in diverse ways, the endings of the model.

5) The endings of the Christe, the Et in terra, the Patrem omnipotentem, the Pleni sunt coeli or Benedictus, and the second Agnus Dei may close on the confinal of the tone.

6) In the course of the Mass, the more use that is made of internal motives from the model, the more praiseworthy the elaboration will be.[14]

As can be seen by this extract from Cerone, even contemporary sources offered only a limited description of the practice of borrowing.

The extension of parody to include types of borrowing other than those found in sixteenth-century polyphonic styles has also led to much confusion. In an effort to

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[14]A translation of the relevant section appears in Oliver Strunk, Source Readings in Music History, (New York: Norton, 1950), pp. 265-268.

clarify this situation Ludwig Finscher has attempted to outline the development of Mass composition from the fifteenth-century cantus-firmus style to the sixteenth-century parody style. Finscher proposes that, in the first stage, two or three voices were taken over intact and combined with several new voices, the substance of the borrowed material not being altered. In the second stage, borrowed voices formed the framework of the parody but were paraphrased by interpolations, colorations and rhythmic variation. By stage three motives or phrases, not whole voices, were adapted and paraphrased in new contrapuntal combinations. Finally, during the fourth stage, a whole composition or section from it was adapted, with the entire contrapuntal structure being reworked in the parody.[15]

More recently, Lewis Lockwood has added some new insight into the changes that occurred during the transition from cantus-firmus Mass to parody Mass. The essence of his observations deals with the new importance of motives as building blocks in sixteenth-century parody technique:

> In older Masses, one or more entire lines are taken over and serve as foundation for whole sections or movements of the Mass; indeed, the borrowed voice cannot be treated otherwise without destroying its linear integrity. In the newer parody Mass, however, the composer seeking to elaborate--or re-elaborate--the borrowed material, takes from the model individual motives and phrases, sometimes incorporating the

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[15]Ludwig Finscher, "Loyset Compere and His Works," Musica Disciplina, XIII (1959), pp. 141-142.

> original complex with minor modifications, sometimes establishing new contrapuntal combinations. In either case, the essential element is no longer the total line but the individual motive.[16]

Carrying the concept of motives one step further, Quentin Quereau points out in his study of fourteen parody Masses by Palestrina that:

> ... when a sixteenth-century composer borrows more than motives alone and includes relationships between successive motive entries he has entered the realm of parody.[17]

Lewis Lockwood believes that the new importance of motives as the major compositional element of the sixteenth-century parody Mass was due to a change in the type of model composers chose as a basis for their Masses. He argues that in the fifteenth century the typical model was the chanson, with its layered construction. The discant and tenor lines usually created the basic framework of the fifteenth-century chanson or motet to which one or two other voices were added. The two basic voices were generally self-contained melodic lines. Imitation was sometimes used at this time, but it was still not a decisive element in the shaping of an entire composition.

However, in the sixteenth century, Lockwood believes that there was a shift to the motet as the typical model

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[16]Lewis Lockwood, "A View of the Early Sixteenth-Century Parody Mass," The Department of Music, Queens College of the City of New York Twenty-fifth Anniversary Festschrift, ed. by Albert Mell (New York: Queens College Press, 1964), p. 61.

[17]Quentin Wolcott Quereau, "Palestrina and the Motteti del Fiore of Jacques Moderne: A Study of Borrowing Procedures in Fourteen Parody Masses" (unpublished Ph.D. dissertation, Yale University, 1974).

for a parody Mass, and that motivic imitation became a very important compositional element. In light of this theory it is interesting to note that in five of the twelve Masses by Clemens for which the models are known, chansons are used as models. Did he nevertheless utilize the sixteenth-century technique of motivic imitations? A study of the Masses by Clemens based on chansons rather than on motets should help to answer this question.

CHAPTER III

COMPUTER METHODOLOGY AND THE ANALYSIS PROGRAM

The Encoding System

Musical scholars who wish to utilize the computer must translate, or encode, the music with which they are working into numerals and letters in order to make it accessible to the computer. A number of such encoding languages have been devised, the most well known of which is the Digital Alternate Representation of Music Symbols (usually referred as DARMS).[18] However, DARMS and other existing languages were found to contain certain features unnecessary for the present project, while lacking other features which were required.[19] For this reason it was decided to develop a new language, named VASL (Vertically Aligned Segmented Language), having a very specialized and uncluttered vocabulary designed to simplify the process of encoding and programming. VASL contains no characters to indicate time signature, key signature, accidentals or musica ficta. Each of these elements is absorbed by the encoding language. Features such as accidentals and musica ficta could easily be added to VASL at a later time,

[18] Raymond Erickson, "The Darms Project: A Status Report," Computers and the Humanities, IX (1976), 291-298.

[19] For a detailed description of some of the better-known encoding languages see Barry S. Brook, Musicology and the Computer, (New York: City University of New York Press, 1970).

but were not required for the present study. The capacity to handle triplets and triple meters was also not necessary for the particular music being dealt with, so these capabilities were omitted as well.

VASL is based on the principle of segmenting the score into small sections. For the purposes of this study, units equivalent to three measures of modern notation were used. This principle facilitates the programming of either linear or vertical analysis and helps open up possibilities for new kinds of analysis involving both. The following description of the encoding process shows how the music notation is translated into an alpha-numeric representation, and how this representation is key punched onto data cards.

The basic vocabulary of VASL may be outlined as follows:

1) The numeric system used to represent pitch assigns to every semitone within the range of the piano a unique numeric value. The pitch middle-C is given a value of 40 because it is the fortieth note on the piano when starting with the lowest note. Numeric values for the other semitones are assigned sequentially in the following manner:

The numeric value for each pitch is unaffected by the chromatic designation used. For example, B-flat above middle-C retains its numeric value of 50 even if the pitch is notated as A-sharp in the score. The numeric value of 99 indicates no pitch, therefore a rest.

2) Rhythmic duration is indicated as follows:

W = whole
H = half
Q = quarter
E = eighth
S = sixteenth
. = dotted note value
J = tied note value

3) Card layout:

VASL has a built in numbering system which has been designed in such a way that a unique sequential number can be assigned to each card in columns 1 through 6. This feature was conceived as a safeguard. In the event that the data cards are dropped, they can be run through a card sorter and put back in sequence automatically.

The first card of a data deck is used to indicate the title of the composition and the name of the composer.

CARD COLUMNS	ENTRY
1-2	Enter a unique number from 1 to 99 identifying the composition.
3-6	Enter four zeros "0000".[20]
7-99	Enter the title of the composition and the composer in free form.

All subsequent data cards represent the musical score.

CARD COLUMNS	ENTRY
1-2	Enter the same identification number used for the title card.
3-5	Enter a unique sequential number for each data card starting with "001".
6	Enter the voice number -- assign voice numbers sequentially starting with the first soprano equal to "1".
7-10	Leave blank.

Columns 11 through 15 are a unit and represent one note value or rest value.

11-12	Enter the proper pitch value.
13	If the note is dotted enter a period ".".
14	If two notes are tied enter a "J" for the second note of the tie.

This unit can be repeated up to fourteen times on one card or until the note values and rest values of three measures have been accounted for. If more than fourteen values are present in a three-measure segment, punch a dash "-" in

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[20] Standard computer practice dictates that periods remain outside of quotation marks unless part of the input.

column 80 and continue on the next card punching the same information into columns 1-2 and 6 and incrementing columns 3-5 by one.

The Edit Program

The translation of music into letters and numerals tends to give rise to a great deal of clerical error. For this reason a program was written to edit the encoded data. Two types of editing capabilities are provided by the program. First, the data from the cards is spread out and organized to simplify visual verification of the encoded data. The second editing feature is programmatic. The rhythmic values of each card are added up separately, and a total for the card is printed on the far right hand side of the report. This simple editing procedure reveals the two most common encoding errors, which are the omission or repetition of a note and the encoding of an incorrect or invalid duration code (see Figure 1).

The Analysis Program

The analysis program consists of five individual routines which are selected through the use of an option card bearing the number of the routine that the analyst wishes to run. The format of the option card is as follows:

CARD COLUMNS	ENTRY
1-6	Enter the program identification code "MUSP02".
7	Enter the number of the analysis routine to be run (1 through 5).
9-80	Leave blank.

*** CARD EDIT REPORT *** PAGE 01

COMP	CARD	VOICE	KYRIE I * MISSA JAY VEU LE CERF BY CLEMENS NON PAPA													
02	001	1	45H	52Q	52Q	52Q.	50S	52S	54Q	52Q	49Q	52Q	50Q	49Q		= 48
02	002	2	99W	99W	99W											= 48
02	003	3	99W	40H	45Q	45Q	45Q.	44S	45S	47Q	45Q					= 48
02	004	4	99W	99W	99W											= 48
02	005	5	99W	99W	99W											= 48
02	006	1	49E J	47E	49E	45E	47Q	49H	47Q	50Q	49H	47Q	49H			= 48
02	007	2	45H	52Q	52Q	52Q.	50S	52S	54W	52H						= 48
02	008	3	42Q	45Q	44Q	45H	44Q	42Q	40Q	38H	37E	38E	40E	42E		= 48
02	009	4	99W	99W	99H	33H										= 48
02	010	5	99W	99W	99W											= 48
02	011	1	49Q J	47E	45E	47H	45Q	52Q.	50E	49Q	47Q	49Q	99Q	52Q		= 48
02	012	2	52W J	49W	99Q	52Q.	50E	49Q								= 48
02	013	3	44Q	45H	44Q	45H	99Q	45Q	42Q	45Q	44Q	45Q				= 48
02	014	4	40Q	40Q	40Q.	38S	40S	42Q	40Q	37Q	40Q	38Q	37Q	35Q	33Q	= 48
02	015	5	99H	28H	33Q	33Q	33Q.	32S	33S	35Q	33Q	28Q	33Q			= 48

Figure 1. Report from the edit program.

The first option is not really an analysis routine at all. Instead, this routine produces a new kind of graphic score notation (see Figure 2) which was initially designed to assist in the editing of encoded music. This new notation is based on the principle of maintaining each voice part on a single horizontal plane. Each printed line of graphic notation represents a three-measure segment of music which corresponds to the three-measure encoding segments of VASL. Measure numbers appear across the top of each segment, with the line of asterisks just below indicating quarter-note divisions of the segment, and the line of asterisks across the bottom indicating sixteenth-note divisions. The numbers along the left-hand side of each segment represent the voice parts: soprano, alto, tenor, bass etc. The two-digit numbers on each plane, or voice part, indicate the encoded pitch values, and the dashes represent the endoded duration values. A single two-digit number represents a sixteenth note. An eighth note is indicated when two dashes follow the numeral. Six dashes following a numeral designate a quarter note. The pattern continues for all possible note values or combination of note values.

Although this notation was originally conceived as an aid in the editing of encoded music, it soon became apparent that the notation might be useful as an analytical tool. Even a superficial look at a sample of the graphic notation reveals a sense of texture not available in either Renaissance or modern notation. Another feature of the new

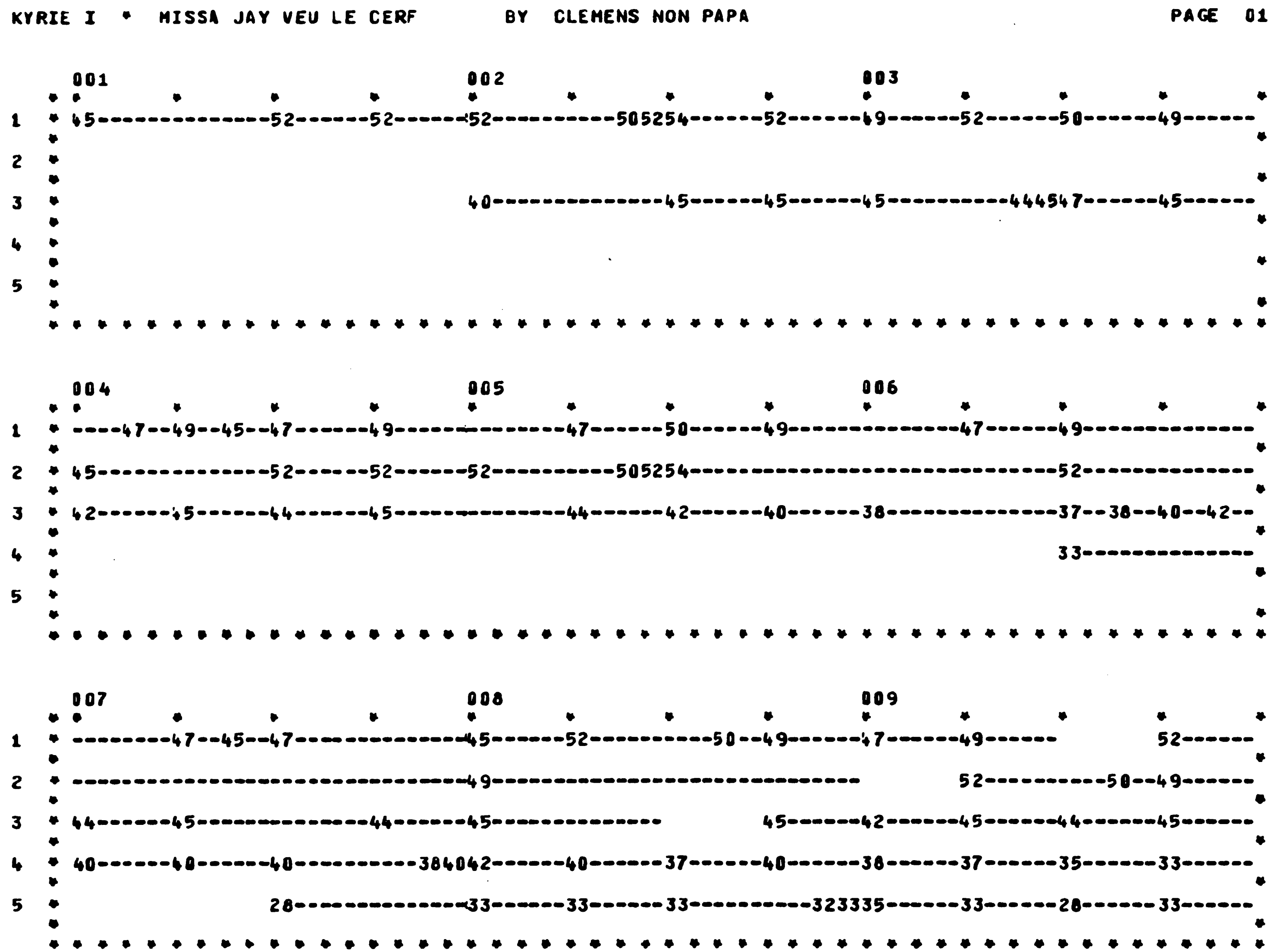

Figure 2. Sample of new graphic score notation.

notation is the elimination of bar lines from the score, which is more in keeping with Renaissance notation. Although it was not so used in this study, the possibility of employing graphic score notation as an analytical tool was one of several interesting and unexpected discoveries stemming from this project. In the future, a computer-assisted analysis project could be developed from this beginning.

The next four options of the analysis program use a principle developed for this study called "numeric score reduction." This analytical procedure is based on the concept of combining specific groups of notes from a score and producing a single pitch value representing the average pitch value of the combined notes. These average pitch values are then plotted as points on a graph for analytical interpretation. For this study the points were plotted manually, but it would be relatively simple to write a program to plot the points using the printer from the computer.

The analysis program enables the analyst to combine and average the notes of a musical score in four different ways. Option two combines and averages the elements of each voice separately (see Figure 3) while option three combines the whole polyphonic complex, producing one average pitch value for each measure (see Figure 4). Options four and five divide the score into half-note units. The specific function of option four is to combine and average the elements of each voice separately (see Figure 5), while option five combines the whole polyphonic complex, producing one average pitch value for every two quarter notes (see Figure 6).

The principle of numeric score reduction has great potential as an analytical approach to music. First, it enables the analyst to measure or quantify musical events, thus giving him a more precise way of dealing with certain aspects of music than would be possible through his unaided senses. This can be very helpful when attempting to determine the relationship between two sections of music or when trying to test theories which are based more on intuitive feeling than on hard fact. Another feature of numeric score reduction (using options three or five of the analysis program) is that a visual impression can be gained of the polyphonic complex as a whole by reducing it to a single line.[21] This can prove beneficial when one is studying the overall shape of a composition. Finally, the process of numeric score reduction puts music into a form that enables the analyst to study it using concepts and analytical tools already developed for other fields.

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[21]This is demonstrated on page 32 where the average pitch values are plotted on a graph.

```
KYRIE I  *  MISSA JAY VEU LE CERF       BY  CLEMENS NON PAPA                        PAGE  01

      001                         002                          003
    * *       *       *       *   *       *       *       *    *       *       *       *       *
1   * 48.50                       52.37                        50.00
    *                                                                                          *
2   *
    *                                                                                          *
3   *                             42.50                        45.43
    *                                                                                          *
4   *
    *                                                                                          *
5   *
    *                                                                                          *
    * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

      004                         005                          006
    * *       *       *       *   *       *       *       *    *       *       *       *       *
1   * 47.75                       48.75                        48.50
    *                                                                                          *
2   * 48.50                       52.87                        53.00
    *                                                                                          *
3   * 44.00                       42.75                        38.62
    *                                                                                          *
4   *                                                          33.00
    *                                                                                          *
5   *
    *                                                                                          *
    * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

      007                         008                          009
    * *       *       *       *   *       *       *       *    *       *       *       *       *
1   * 47.25                       49.25                        49.33
    *                                                                                          *
2   * 52.00                       49.00                        50.66
    *                                                                                          *
3   * 44.50                       45.00                        44.00
    *                                                                                          *
4   * 39.87                       39.75                        35.75
    *                                                                                          *
5   * 28.00                       32.93                        32.25
    *                                                                                          *
    * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 3. Numeric score reduction: option 2.

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KYRIE I  *  MISSA JAY VEU LE CERF       BY  CLEMENS NON PAPA                              PAGE  01

  001                             002                             003
* *       *       *       *       *       *       *       *       *       *       *       *       *
  48.50                           47.43                           47.71

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  004                             005                             006
* *       *       *       *       *       *       *       *       *       *       *       *       *
  46.75                           48.12                           43.28

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  007                             008                             009
* *       *       *       *       *       *       *       *       *       *       *       *       *
  42.32                           43.18                           42.39

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  010                             011                             012
* *       *       *       *       *       *       *       *       *       *       *       *       *
  42.03                           40.05                           39.74

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  013                             014                             015
* *       *       *       *       *       *       *       *       *       *       *       *       *
  45.53                           41.82                           42.83

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  016                             017                             018
* *       *       *       *       *       *       *       *       *       *       *       *       *
  42.39                           41.90                           39.98

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 4. Numeric score reduction: option 3.

KYRIE I * MISSA JAY VEU LE CERF BY CLEMENS NON PAPA PAGE 01

	001		002		003	
1	45.00	52.00	51.75	53.00	50.50	49.50
2						
3			40.00	45.00	44.87	46.00
4						
5						

	004		005		006	
1	47.50	48.00	48.00	49.50	48.00	49.00
2	45.00	52.00	51.75	54.00	54.00	52.00
3	43.50	44.50	44.50	41.00	38.00	39.25
4						33.00
5						

	007		008		009	
1	47.50	47.00	48.50	50.00	48.00	52.00
2	52.00	52.00	49.00	49.00	52.00	50.00
3	44.50	44.50	45.00	45.00	43.50	44.50
4	40.00	39.75	41.00	38.50	37.50	34.00
5		28.00	33.00	32.87	34.00	30.50

Figure 5. Numeric score reduction: option 4.

```
KYRIE I  *  MISSA JAY VEU LE CERF       BY  CLEMENS NON PAPA                   PAGE  01

     001                            002                            003
  * *       *       *       *       *       *       *       *       *       *       *       *       *
    ↑5.00           52.00           45.87           49.00           47.68           47.75

  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     004                            005                            006
  * *       *       *       *       *       *       *       *       *       *       *       *       *
    45.33           48.16           48.08           48.16           46.66           43.31

  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     007                            008                            009
  * *       *       *       *       *       *       *       *       *       *       *       *       *
    46.00           42.25           43.30           43.07           43.00           42.20

  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     010                            011                            012
  * *       *       *       *       *       *       *       *       *       *       *       *       *
    41.60           42.30           39.75           39.90           38.75           ↑5.68

  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     013                            014                            015
  * *       *       *       *       *       *       *       *       *       *       *       *       *
    45.50           45.25           44.68           42.30           42.60           43.07

  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     016                            017                            018
  * *       *       *       *       *       *       *       *       *       *       *       *       *
    43.00           42.20           41.50           42.15           39.60           39.90

  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 6. Numeric score reduction: option 5.

CHAPTER IV

NUMERIC SCORE REDUCTION APPLIED TO THE KYRIES OF CLEMENS

The Life of Clemens

Although very little is known about the life of Clemens (and even this information is controversial), a short biography seems appropriate before proceeding to an examination of his music. Jacques Clement, later known as Jacobus Clemens non Papa, was a Dutchman from the counties of Holland and Zeeland (the western provinces of the present Kingdom of the Netherlands). Members of the Clement family, who are thought to have been the ancestors of Clemens, settled in Middelburg on the isle of Walcheren sometime in the fifteenth century.[22]

The nearest musical center to Middelburg was Burges, and from there come the earliest documents concerning Clemens. Apparently no record exists to substantiate his date of birth, but it is thought to have been about 1510. It appears that the first published composition by Clemens was the chanson "Le departir est sans departement," printed by Attaignant in 1536. Clemens was a very prolific composer, known to have written at least 15 Masses, 231

[22]Karel Ph. Bernet Kempers, "Bibliography of the Sacred Works of Jacobus Clemens non Papa," Musica Disciplina, XVIII (1964), 85.

motets, 158 3-part canticles, and a large number of chansons.

In 1544 Clemens became a singer in the choir of Burges's famous church of Saint-Donatian under the direction of Johannes de Hollande. On March 26th of the same year, Johannes de Hollande was dismissed and Clemens was chosen to succeed him. While in Burges, Clemens was also master of the children at the church and lodged with the choirboys at the house of Jan de Backere. His name vanishes from Burges in June 1545, but appears later that year in Antwerp.[23]

Soon after Clemens arrived in Antwerp, he sold some chansons and motets to the editor, Tilman Susato. In his Huitiesme Livre, a collection of chansons, the designation "non Papa" was apparently first added to Clemens name. The reason for this addition is still uncertain. There appears to be no foundation to the well-known story that Clemens was called "Clemens non Papa" to distinguish him from Pope Clement VII. The Pope reigned from 1523 to 1534, so a confusion with him seems unlikely. A more reasonable explanation comes from the fact that a poet in holy orders named Clement or Clemens lived in Ypres and was known as "Pere Clemens" or, in Latin, "Clemens Papa." Further research has shown that this was probably the man from whom Clemens wanted to distinguish himself.[24]

The last datable document on Clemens indicates that

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[23]Bernet Kempers, "Bibliography of the Sacred Works," p. 87.

[24]Karel Ph. Bernet Kempers, Jacobus Clemens non Papa und seine Motetten (Augsburg: Filser, 1928), p. 11.

he stayed in Bois le Duc (now capital of the Dutch province of North Brabant) from October until December 24th, 1550. No known document exists to substantiate the date of Clemens death. All that is definitely known is that Jacobus Vaet published an elegy on the death of Clemens sometime in 1558. The only other evidence (interpreted by some as an indication of Clemens death in 1556) is the fact that in that year a series of publications began, devoted entirely to the Masses, motets and souterliedekins of Clemens.

All fourteen of the parody Masses by Clemens were later published by Pierre Phalise in Louvain.[25] The following list was designed to categorize them by the type of model used. Also indicated is the composer of the model and the number of voice parts in each Mass.

CLEMEN'S MASSES BASED ON CHANSONS

Title	Chanson Composer	Voices
Misericorde	Clemens non Papa	4
Languir my fault	Claudin de Sermisy	5
A la fontaine du prez	Adrian Willaert	6
Or combien est	Claudin de Sermisy	4
Jay veu le cerf	Pierre de Manchicourt	5

[25]Bernet Kempers, "Bibliography of the Sacred Works," pp. 94-97.

CLEMEN'S MASSES BASED ON MOTETS

Title	Motet Composer	Voices
Caro mea	Pierre de Manchicourt	5
Virtute magna	Andreas de sylva	4
Ecce quam bonum	Clemens non Papa	5
Pastores quidnam vidistis	Clemens non Papa	5
Quam pulchra es	Jean Lupi or Lupus Hellinck	4
Spes salutis	Lupus Hellinck	4
Panis quem ego dabo	Lupus Hellinck	4

CLEMEN'S MASSES BASED ON UNKNOWN MODELS

Title	Voices
En espoir	4
Gaude lux Donatiane	5

An Analysis of Two Kyries by Clemens

The five chansons used as models by Clemens are in two distinct styles. The two chansons by Claudin de Sermisy and the chanson by Clemens are in the Parisian style while the more imitative Netherlandish style is found in the chansons by Adrian Willaert and Pierre de Manchicourt. A comparative study of one Mass in each style demonstrates the use of numeric score reduction as an analytical tool. "Missa Jay veu le cerf," based on the chanson by Pierre de Manchicourt, was chosen as an example of a Mass based on a model in the Netherlandish style, whereas "Missa Or combien est," based on a chanson by Claudin de Sermisy, was chosen as an example of a Mass based on a Parisian model.

Experimentation with numeric score reduction and the Kyries of Clemens indicated that a promising aspect of this analytical procedure for studying parody technique was the combining of the whole polyphonic complex into one line. In tests using both whole-note averaging (option 3) and half-note averaging (option 5) the latter appeared to be the most effective procedure for the analysis of imitative polyphony, since it reflected greater detail. This detail is necessary because in imitative polyphony voices often enter or drop out in the middle of a measure. The system of whole-note averaging tends to obscure these changes. Thus the five Kyries and their models are graphed using half-note averaging.

An explanation of several features of the graphs may facilitate the understanding of numeric score reduction. The heavy black horizontal line running through the middle of each graph represents a pitch value of forty, or middle-C, and was added to the graph as a point of reference. Time is represented horizontally, and for this reason measure numbers appear across the top of each graph. Pitch value is represented vertically, and thus pitch values appear on the left.

The first pair of graphs (Figures 7 and 8) shows the opening sections of the chansons "Jay veu le cerf" and "Or combien est" represented by numeric score reduction. A visual comparison of the two graphs reveals a striking contrast. The Parisian chanson (Figure 7) maintains a relatively smooth line, with the gentle curves of the graph roughly corresponding to the phrasing of the music. Also the pitch range of this graph is quite narrow, with the upper limit being a pitch value of forty-nine and the lower limit a pitch value of forty-three, or a pitch range of seven. In contrast to this the chanson in the Netherlandish style (Figure 8) has an upper-limit pitch value of fifty-two and a lower-limit pitch value of thirty-four, or a pitch range of nineteen. This graph also has a more irregular character and maintains a much less even line. Thus the contrast in style reflected by the graphs seems to parallel the stylistic contrast which exists between the two pieces of music.

Figures 9 and 10 show the opening twenty measures of the first Kyrie of the Mass, "Jay veu le cerf," and the

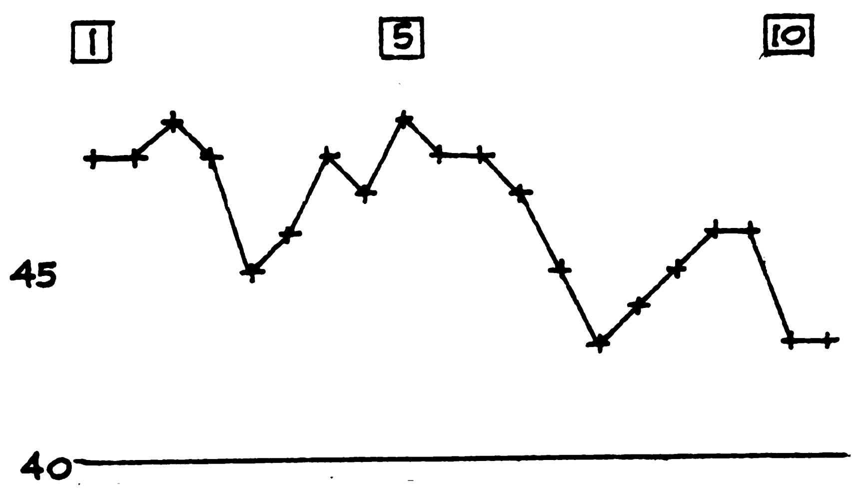

Figure 7. Chanson "Or combien est."

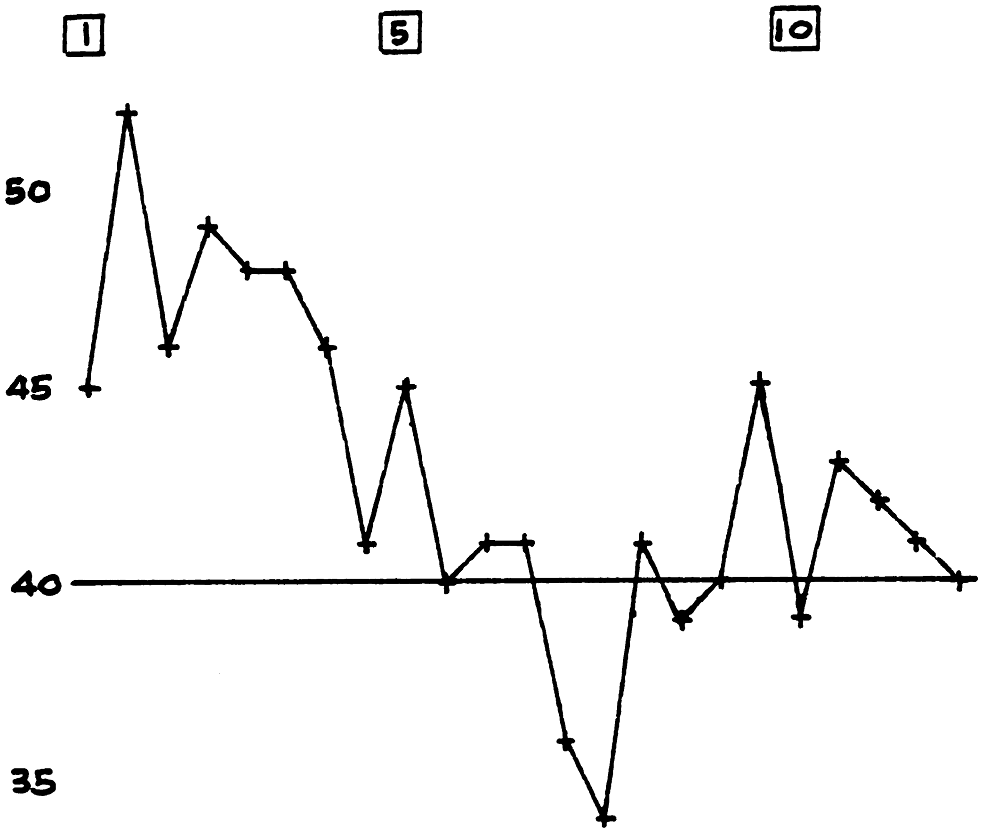

Figure 8. Chanson "Jay veu le cerf."

opening twelve measures of the chanson, "Jay veu le cerf." The first six points on the graph of the Mass correspond exactly to the first six points on the graph of the chanson. However, beginning in measure four the correspondence between the two graphs is much less exact. In order to more effectively study the overall structure of each graph a second line was drawn through those points believed to represent the general trend of the points as a whole. Although there could be different interpretations as to which points hold the most significance, changes in the

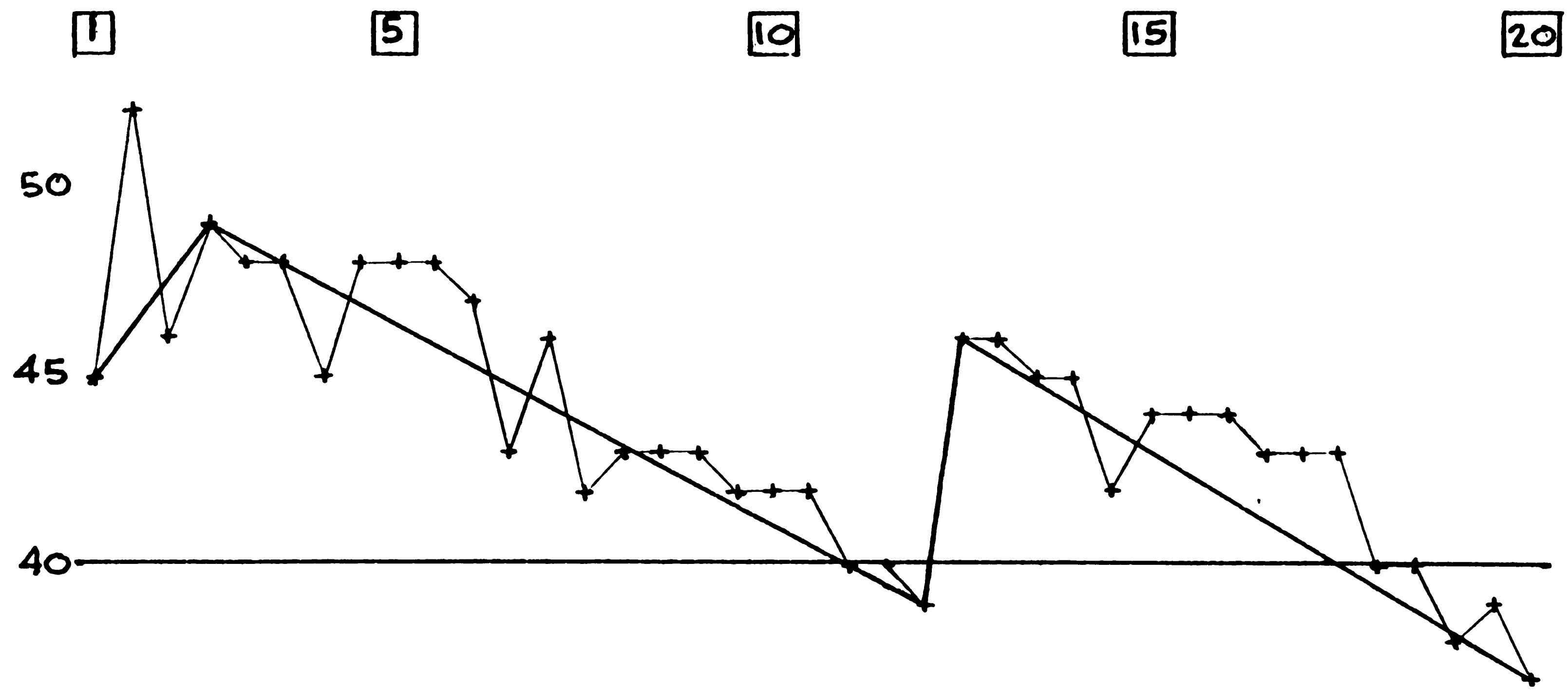

Figure 9. Kyrie I of "Missa Jay veu le cerf."

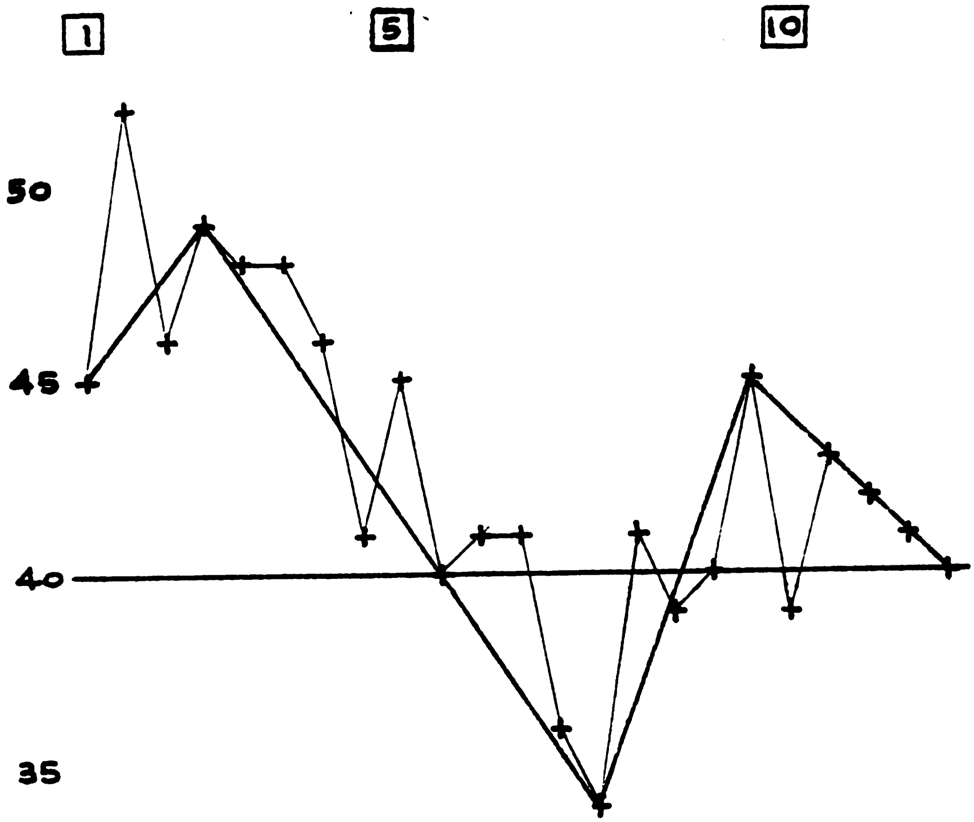

Figure 10. Chanson "Jay veu le cerf."

points selected would not greatly alter the overall picture that emerges.

Beginning in measure two, both graphs indicate a rapid drop in pitch value. In Figure 9 this drop continues for five-and-one-half measures while in Figure 10 it continues for ten measures. At this point both graphs reflect a dramatic rise in pitch value followed by another decline. Using the graphs, an argument could be made that the first Kyrie of the Mass, "Jay veu le cerf," is an expanded version of its model.

Figure 11 is a graph of the opening ten measures of the first Kyrie of the Mass, "Or combien est," and Figure 12 is a graph of the opening ten measures of its model. To help demonstrate the relationship between the two graphs, the points at the apex and base of each curve have been circled and numbered. A comparison of these points reveals a strong relationship between the Mass and its model. First, there is a one to one correspondence between the apex and base of each curve in Figures 11 and 12. Second, the circled points of the two graphs correspond in their position relative to the measure numbers. Finally, when the circled points are compared to the music it is found that in both graphs the curves tend to conform to the phrase structure. These relationships would seem to indicate that although the Mass begins somewhat differently than its model, the overall structure of the two phrases is very similar.

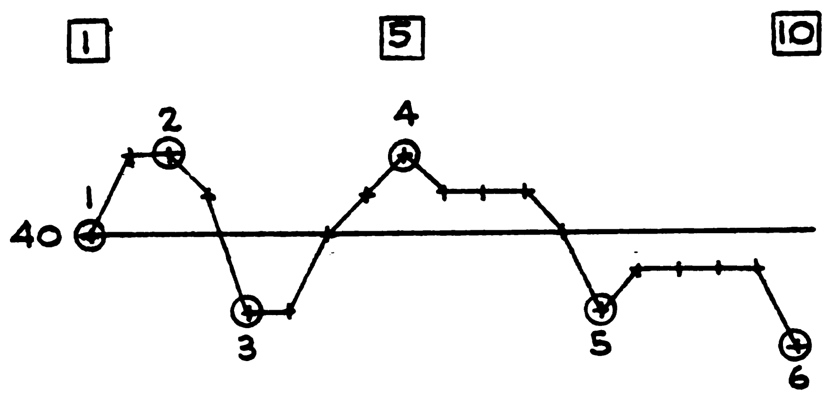

Figure 11. Kyrie I of "Missa Or combien est."

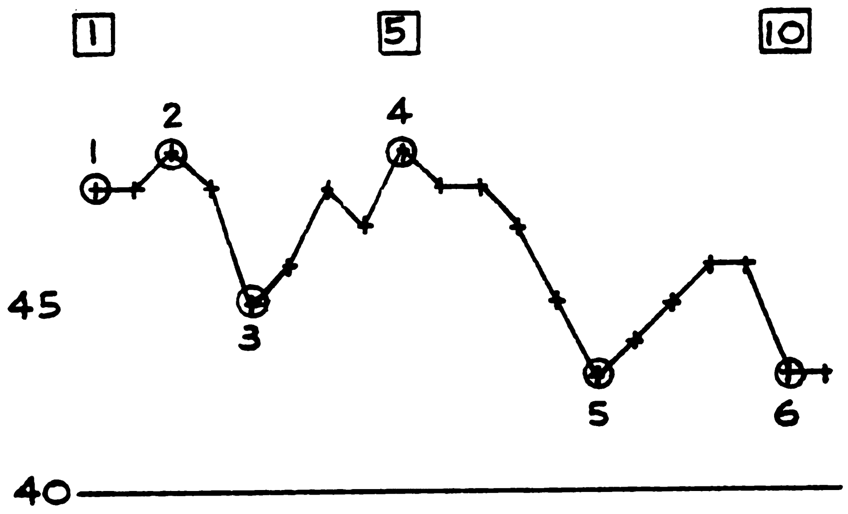

Figure 12. Chanson "Or combien est."

A very similar structural relationship exists between the Christe of "Missa Or combien est" (Figure 13) and its model (Figure 14). As in the previous graphs the apex and base of each major curve has been circled and numbered for interpretation. Although the circled points of the two graphs do not correspond in their position relative to the measure numbers (as they did in the first Kyrie), other structural similarities exist. The vertical distance (or change in pitch value) between points 2 and 3 of both graphs is seven. The vertical distance between points 3 and 4 is also seven. Points 4 and 5 have a vertical distance of five, while points 7 and 8 have a vertical distance of four. The only deviation in this pattern occurs between points 5, 6 and 7. In Figure 15 the vertical distance between points 5 and 6 is five and between points 6 and 7

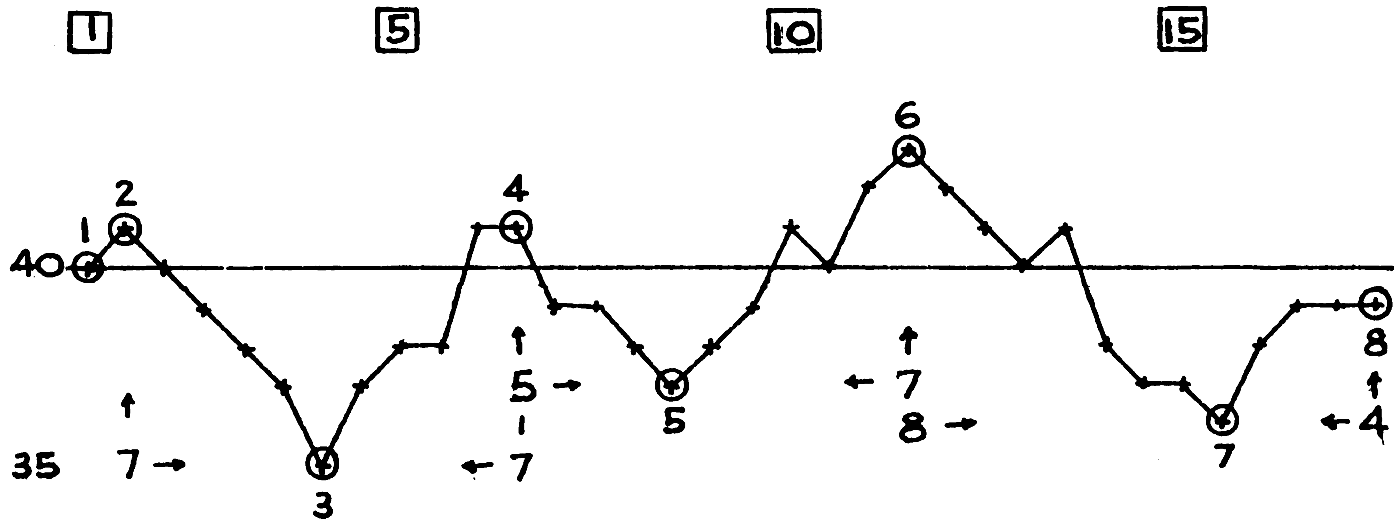

Figure 13. Christe of "Missa Or combien est."

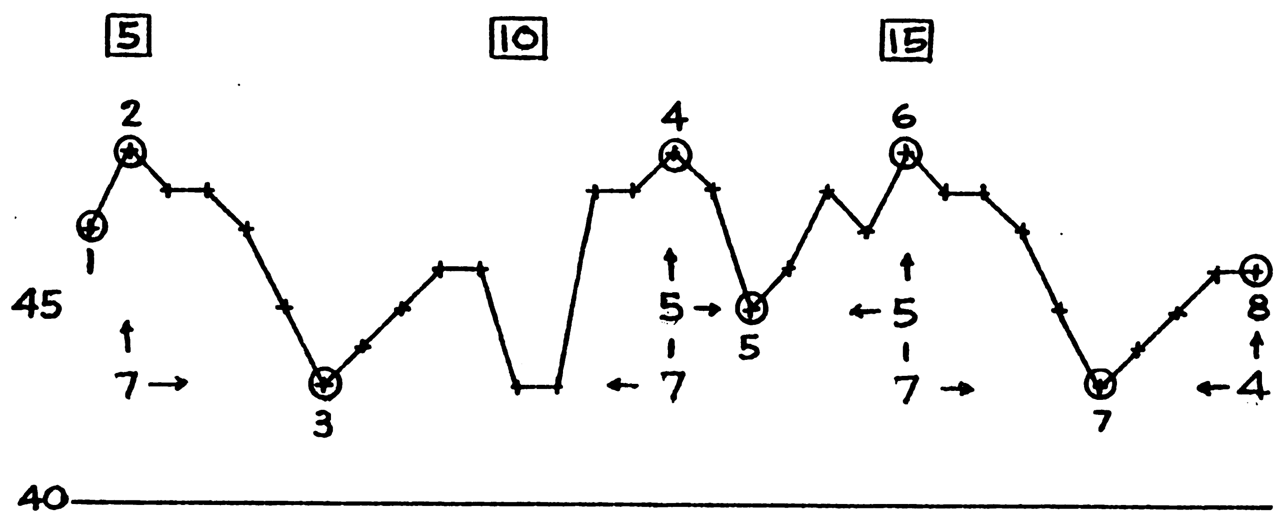

Figure 14. Chanson "Or combien est."

is seven. The vertical distance between points 5 and 6 in Figure 14 is seven while the difference between points 6 and 7 is eight.

These pitch-related structural similarities become even more interesting when a comparison is made between the two sections of music. The musical relationship between the Christe and its model is very subtle. In fact, without the aid of the two graphs a correspondence between the two might go unnoticed.

No strong structural similarity was found between the Christe of "Missa Jay veu le cerf" and the model, but a similarity did appear in the second Kyrie. The following pair of graphs (Figures 15 and 16) shows the relationship between the first sixteen measures of the Kyrie and the last seventeen measures of the model. The circled points 1, 3 and 5 have a pitch value of forty-five in both the Kyrie and the model and point 6 has a pitch value of thirty-seven. The vertical distance between points 1 and 2 and also between points 2 and 3 is five in Figure 17 and six in Figure 16. The vertical distance between points 3 and 4 and also between points 4 and 5 is twelve in Figure 17 and eleven in Figure 16.

A visual comparison of the overall structure of the two graphs also helps to establish their similarities. The most striking feature common to both graphs is the drastic changes in pitch value between points 3, 4 and 5. This general observation, coupled with the detailed discussion of vertical distance and pitch value, helps to clarify

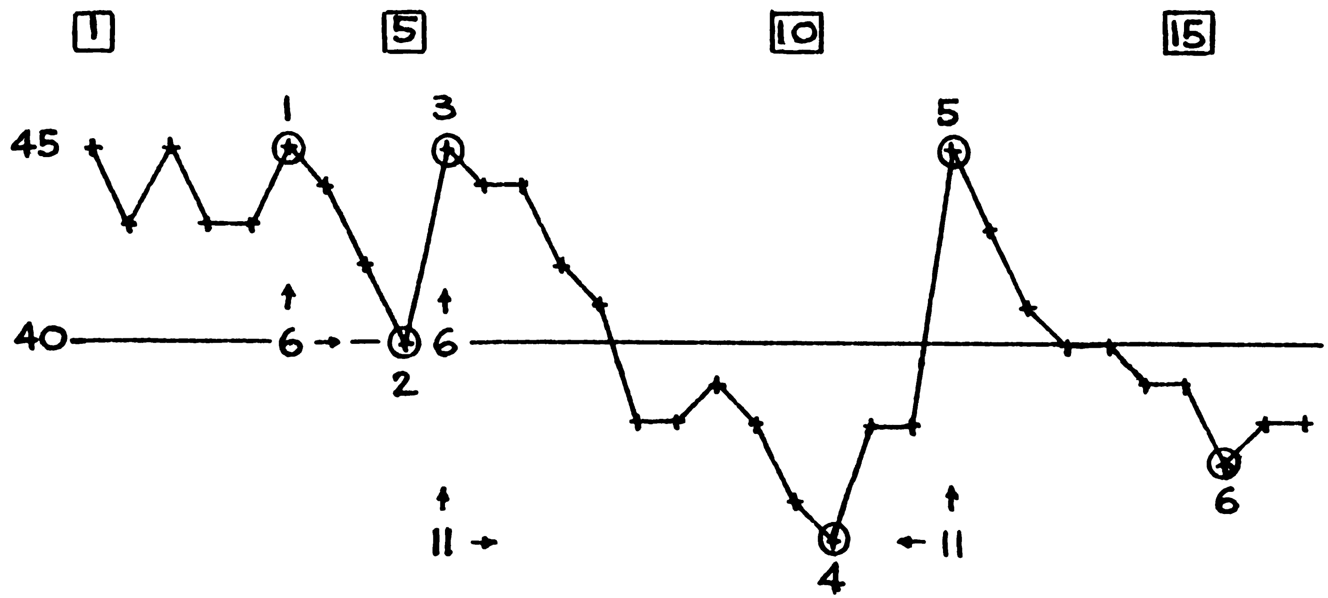

Figure 15. Kyrie II of "Missa Jay veu le cerf."

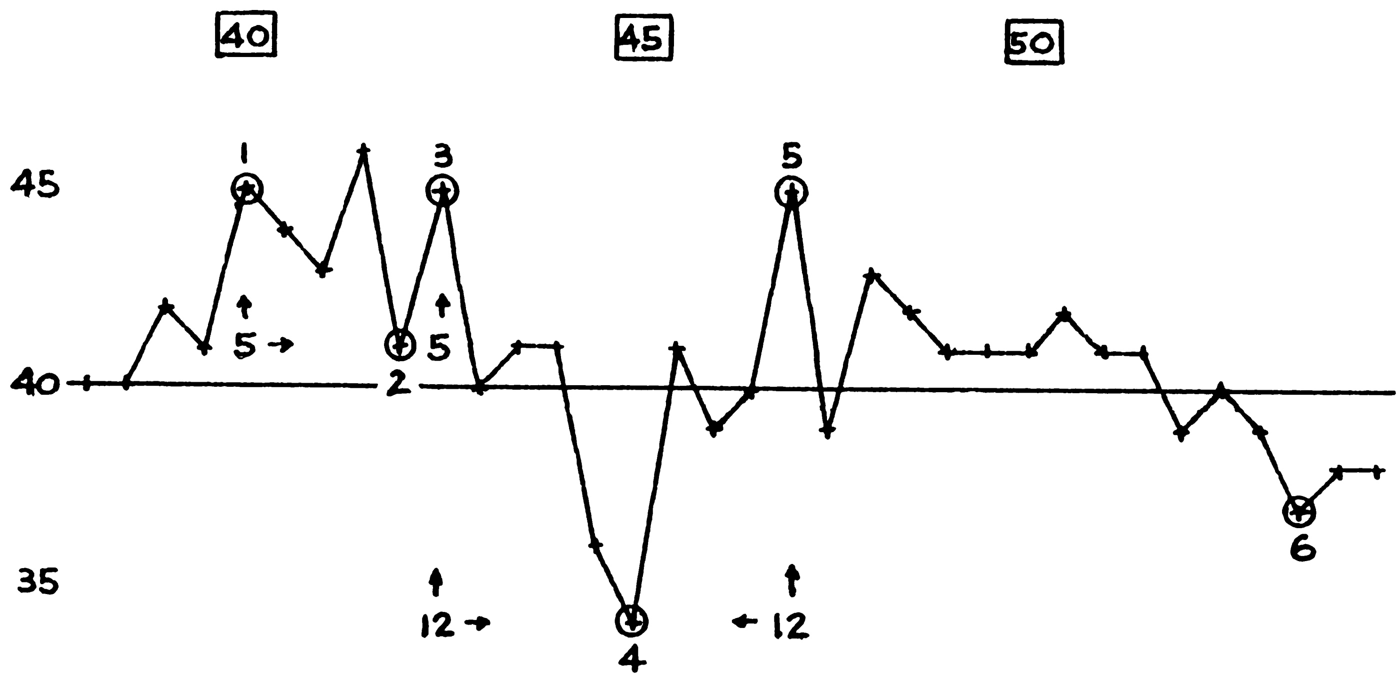

Figure 16. Chanson "Jay veu le cerf."

the relationship between the second Kyrie and its model.

The next pair of graphs (Figures 17 and 18) shows the first eleven measures of the second Kyrie in the Mass, "Or combien est," and the last eleven measures of its model. The strong relationship between the two graphs at the beginning is revealed by the exact correspondence of the pitch relationships of the first five circled points in their position relative to the measure numbers. However, after measure five their similarity diminishes significantly. A relationship can be seen between points 5, 6 and 7, but the strongest indication of a correspondence between the Mass and its model is to be found in the first five points.

The final graph (Figure 19) shows the entire chanson, "Jay veu le cerf," represented by numeric score reduction. Several interesting observations can be made from the study

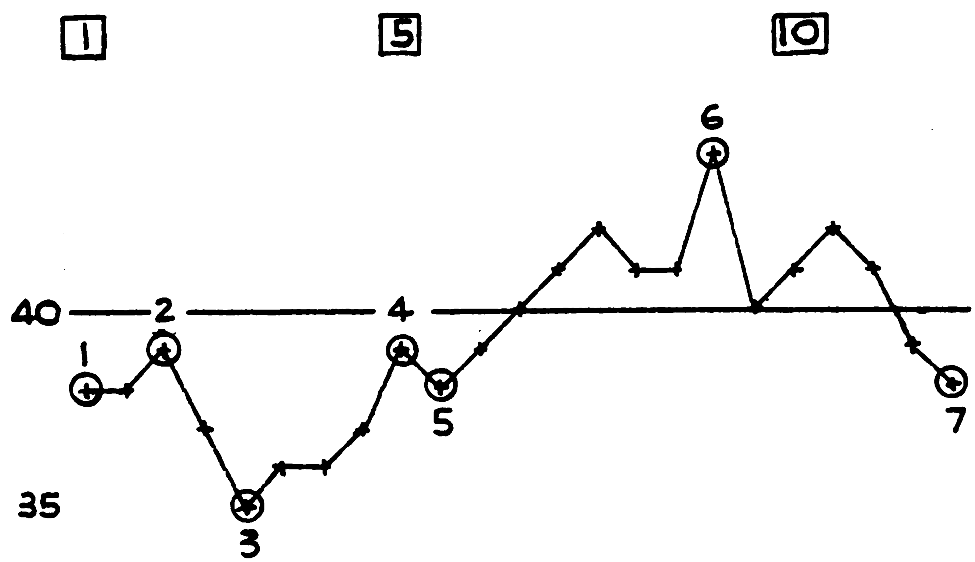

Figure 17. Kyrie II of "Missa Or combien est."

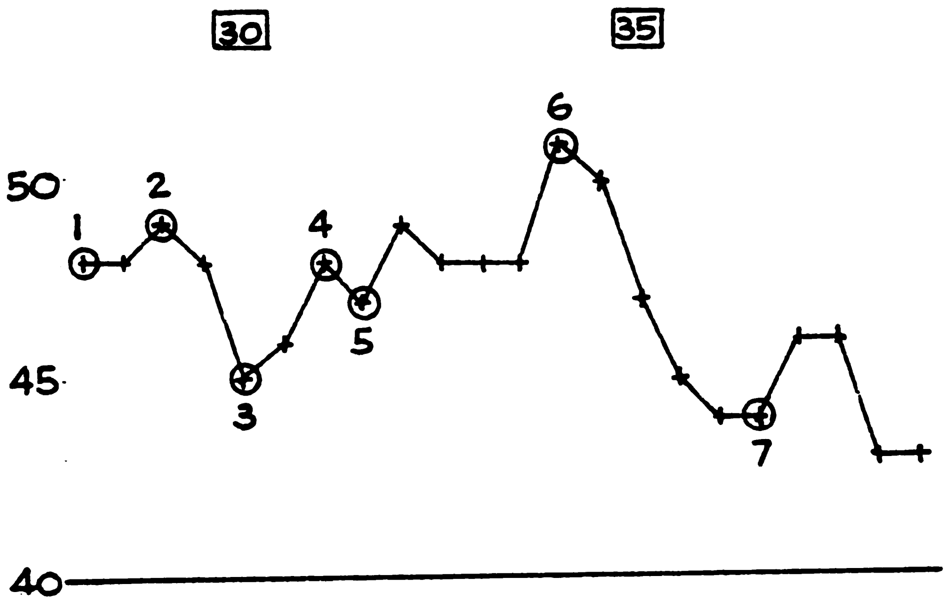

Figure 18. Chanson "Or combien est."

of the graph of a whole composition. In this chanson the material beginning in measure four returns in measure forty-one. The graph shows these two sections as having a dramatic drop in pitch value while the middle section alternates between short segments of rather even pitch value and segments of moderate change in pitch value. The contrast in style reflected by the graph seems to parallel the overall "A B A" form of the chanson.

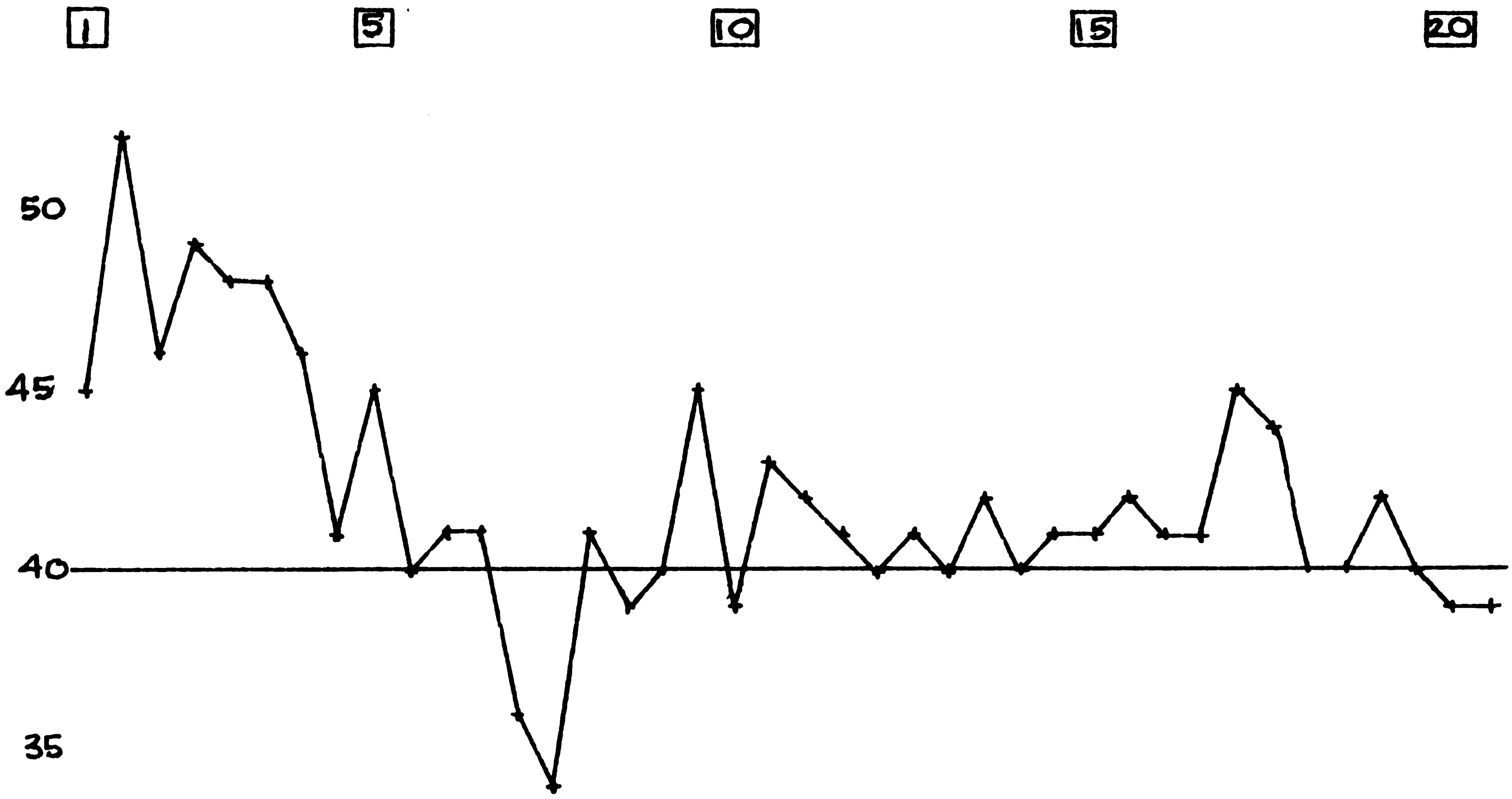

Figure 19. Chanson "Jay veu le cerf."

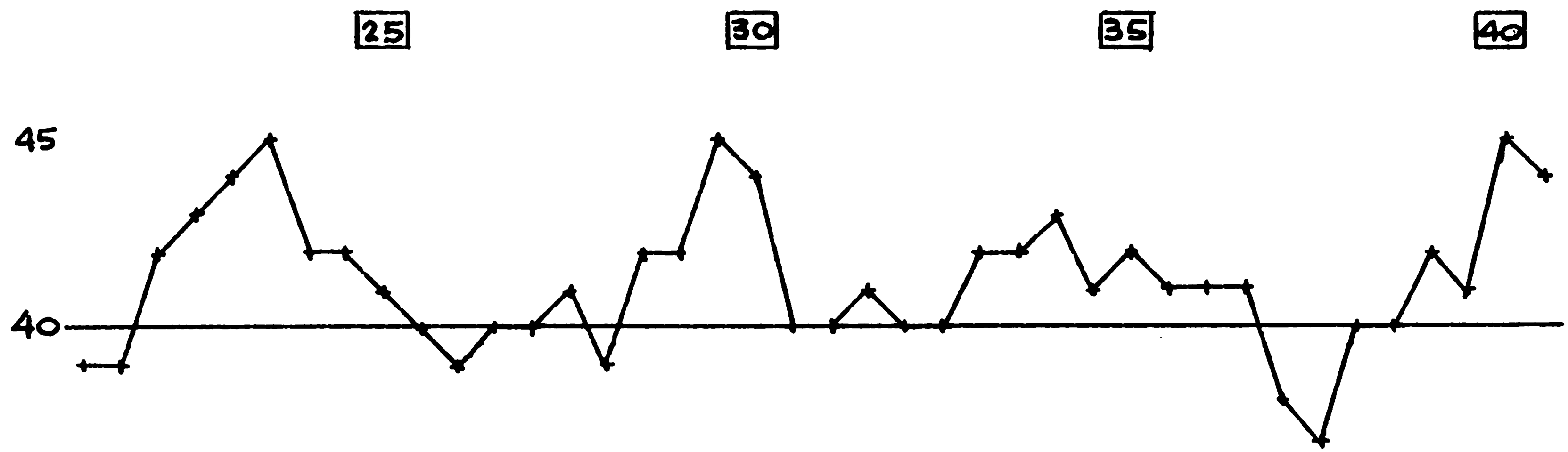

Figure 19 (cont'd.).

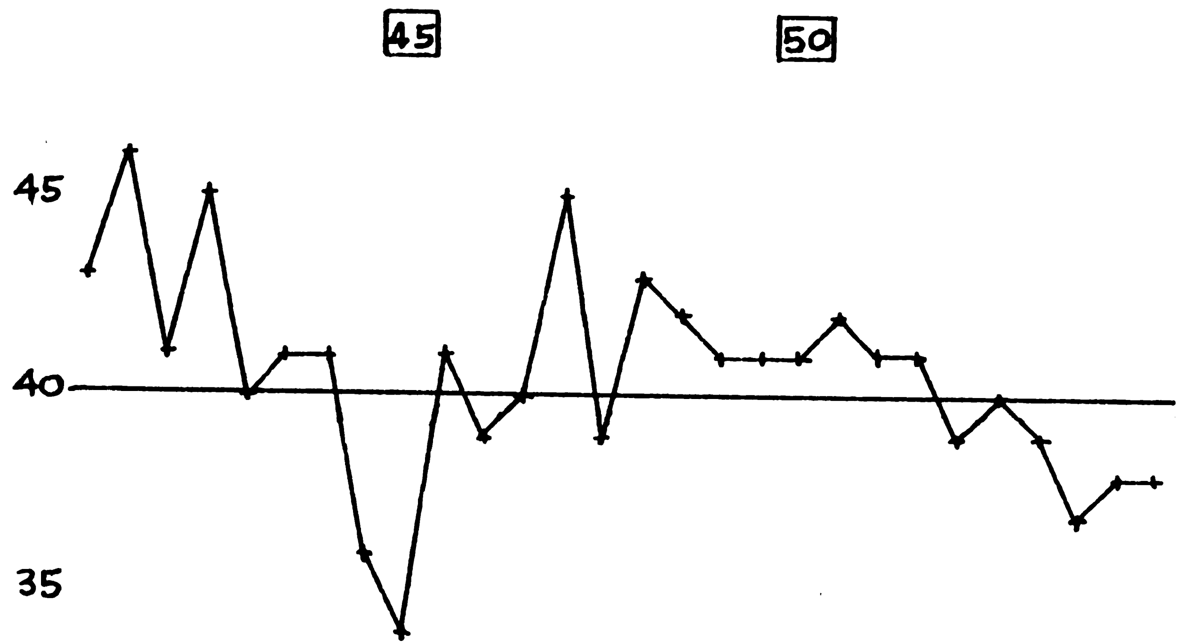

Figure 19 (cont'd.).

CHAPTER V

SUMMARY AND CONCLUSIONS

This thesis was originally conceived as an attempt to develop new analytical techniques specifically oriented around the computer. Although several potentially worthwhile techniques were discovered, the major result of this effort was the development of numeric score reduction.

The application of numeric score reduction to the study of sixteenth-century parody technique proved to be a useful supplement to traditional analysis methods. This was particularly true when the relationship between the Mass and its model seemed vague or nonexistent. In these situations numeric score reduction helped to reveal many subtle structural elements transferred from the models to the Masses by putting them into a form which could be objectively graphed and measured. A good example of this was the Christe from "Missa Or combien est" in which the major structural element transferred from the model was what is seen graphically as the vertical distance, or change in pitch value, between curves. (No conventional musical term exists for this concept when applied to an entire polyphonic complex.)

Numeric score reduction has also assisted in dealing with current theories about the importance of motives in sixteenth-century parody technique and Lewis Lockwood's theory of the change in model from the chanson to the motet. Although the present graphs (option 4) are not very useful for the study of individual motives and melodic lines, they can be effective in the analysis of phrase structure and voice entry. Phrase structure is reflected by the graphs as curves, with the base of each major curve often corresponding to the end of a phrase, a cadence or the beginning of a new phrase. This is particularly true in graphs of Parisian chansons and the Masses derived from them. The graphs tend to reflect voice entries as dips or slight drops in pitch value. This occurs most often in graphs of Netherlandish chansons and the Masses derived from them. By showing the transfer of stylistic characteristics from model to Mass, numeric score reduction helps support a theory that Clemens' Masses based on Netherlandish models tend toward sixteenth-century motivic borrowing while those based on Parisian models are more oriented around fifteenth-century linear forms of borrowing.

The study of sixteenth-century parody technique is only one possible use for numeric score reduction. Much music employs the principle of repetition. At times the repeated material is only a motive or melodic line, but frequently it is a phrase or whole section of a composition. A good example of this concept is sonata form. The techniques of numeric score reduction might prove valuable for studying the relationship of the exposition to the development and recapitulation.

The development of graphic notation, numeric score reduction and the encoding language, VASL, can be the foundation for the future development of a new analytical system. With the aid of new technological developments, such as the optical scanner, a system of this type will have great potential for the study of musical style.

APPENDICES

APPENDIX A

SOURCE LISTINGS OF THE EDIT PROGRAM AND MUSIC ANALYSIS PROGRAM

```
IDENTIFICATION DIVISION.
PROGRAM-ID. MUSP01.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. 6500.
OBJECT-COMPUTER. 6500.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT CARD-FILE ASSIGN TO INPUT.
    SELECT PRINT-FILE ASSIGN TO OUTPUT.
DATA DIVISION.
FILE SECTION.
FD  CARD-FILE
    LABEL RECORDS ARE OMITTED
    VALUE OF ID IS ≠MUSCRD≠.
01  CARD-REC-1.
    03  COMP-NO-C                   PIC  99.
    03  CARD-NO-C                   PIC  999.
    03  VOICE-NO-C                  PIC  9.
    03  FILLER                      PIC  XXXX.
    03  COMP-TITLE-C                PIC  X(70).
01  CARD-REC-2.
    03  FILLER                      PIC  X(10).
    03  MUS-DATA-C OCCURS 14 TIMES.
        05  PITCH-CODE-C            PIC  99.
        05  DUR-CODE-C              PIC  X.
        05  DOT-CODE-C              PIC  X.
        05  TIE-CODE-C              PIC  X.
FD PRINT-FILE
    LABEL RECORDS ARE OMITTED
    LINAGE IS 52
    VALUE OF ID IS ≠MUSPRT≠.
01  PRINT-REC-1.
    03  REPORT-HEAD-P               PIC  X(105).
    03  FILLER                      PIC  X(27).
01  PRINT-REC-2.
    03  FILLER                      PIC  XX.
    03  COMP-NO-P                   PIC  99.
    03  FILLER                      PIC  X(4).
    03 CARD-NO-P                    PIC  999.
    03  FILLER                      PIC  X(4).
    03  VOICE-NO-P                  PIC  9.
    03  FILLER                      PIC  X(5).
    03  MUSDATAP OCCURS 14 TIMES.
        05  MUS-DATA-P              PIC  X(5).
        05  FILLER                  PIC  X.
    03  FILLER                      PIC  X.
    03  EQUAL-P                     PIC  X.
    03  FILLER                      PIC  X.
    03  CRD-TOT-P                   PIC  99.
    03  FILLER                      PIC  X(22).
WORKING-STORAGE SECTION.
77  SUB-CTR                         PIC  99    VALUE  ZERO.
77  HOLD-VOICE-NO                   PIC  9     VALUE  ZERO.
77  HOLD-DUR                        PIC  99    VALUE  ZERO.
77  HOLD-DOT                        PIC  99    VALUE  ZERO.
77  HOLD-TOT                        PIC  99    VALUE  ZERO.
01  HEAD-1.
    03  CC-1                        PIC  9       VALUE    1.
    03  FILLER                      PIC  X(23)   VALUE    SPACES.
    03  FILLER                      PIC  X(24)   VALUE
        ≠*** CARD EDIT REPORT ***≠.
    03  FILLER                      PIC  X(48)   VALUE    SPACES.
    03  FILLER                      PIC  X(6)    VALUE    ≠PAGE  ≠.
    03  PAGE-NO-P                   PIC  99.
01  HEAD-2.
    03  FILLER                      PIC  X(21)   VALUE
        ≠ COMP   CARD   VOICE   ≠.
    03  COMP-TITLE-H                PIC  X(84).
    03  FILLER                      PIC  X(27)   VALUE    SPACES.
```

```
PROCEDURE DIVISION.
PRELIMINARY.
     OPEN INPUT CARD-FILE.
     OPEN OUTPUT PRINT-FILE.
     READ CARD-FILE  AT END
         GO TO CLOSE-RTN.
     MOVE VOICE-NO-C TO HOLD-VOICE-NO.
     MOVE 01 TO PAGE-NO-P.
     MOVE COMP-TITLE-C TO COMP-TITLE-H.
     PERFORM HEADING-RTN.
READ-RTN.
     READ CARD-FILE  AT END
         GO TO CLOSE-RTN.
     IF  VOICE-NO-C IS LESS THAN HOLD-VOICE-NO
         MOVE SPACES TO PRINT-REC-1
         WRITE PRINT-REC-1 BEFORE ADVANCING 1 LINE.
     MOVE COMP-NO-C TO COMP-NO-P.
     MOVE CARD-NO-C TO CARD-NO-P.
     MOVE VOICE-NO-C TO HOLD-VOICE-NO.
     MOVE VOICE-NO-C TO VOICE-NO-P.
     MOVE ZEROS TO SUB-CTR.
FILL-MUS-DATA.
     ADD 1 TO SUB-CTR.
     IF  SUB-CTR IS GREATER THAN 14
         SUBTRACT 1 FROM SUB-CTR
         GO TO PRINT-MUS-DATA.
     IF  PITCH-CODE-C (SUB-CTR) = SPACES
         GO TO PRINT-MUS-DATA.
     MOVE MUS-DATA-C (SUB-CTR) TO MUS-DATA-P (SUB-CTR).
DURATION-RTN.
     IF  DUR-CODE-C (SUB-CTR) = ≠W≠
         MOVE 16 TO HOLD-DUR         ELSE
     IF  DUR-CODE-C (SUB-CTR) = ≠H≠
         MOVE 8 TO HOLD-DUR          ELSE
     IF  DUR-CODE-C (SUB-CTR) = ≠Q≠
         MOVE 4 TO HOLD-DUR          ELSE
     IF  DUR-CODE-C (SUB-CTR) = ≠E≠
         MOVE 2 TO HOLD-DUR          ELSE
     MOVE 1 TO HOLD-DUR.
     IF  DOT-CODE-C (SUB-CTR) = SPACE
         ADD HOLD-DUR TO HOLD-TOT
         GO TO FILL-MUS-DATA.
     DIVIDE HOLD-DUR BY 2 GIVING HOLD-DOT.
     ADD HOLD-DOT TO HOLD-DUR.
     ADD HOLD-DUR TO HOLD-TOT.
     GO TO FILL-MUS-DATA.
PRINT-MUS-DATA.
     IF  TIE-CODE-C (SUB-CTR) = ≠-≠
         GO TO CONT-PRT-RTN.
     MOVE ≠=≠ TO EQUAL-P.
     MOVE HOLD-TOT TO CRD-TOT-P.
     MOVE ZEROS TO HOLD-TOT.
CONT-PRT-RTN.
     WRITE PRINT-REC-2 BEFORE ADVANCING 2 LINES
         AT END-OF-PAGE PERFORM HEADING-RTN.
     MOVE SPACES TO PRINT-REC-1.
     GO TO READ-RTN.
HEADING-RTN.
     MOVE SPACES TO PRINT-REC-1.
     MOVE HEAD-1 TO REPORT-HEAD-P.
     WRITE PRINT-REC-1 BEFORE ADVANCING 3 LINES.
     MOVE HEAD-2 TO REPORT-HEAD-P.
     WRITE PRINT-REC-1 BEFORE ADVANCING 2 LINES.
     MOVE SPACES TO PRINT-REC-1.
     ADD 1 TO PAGE-NO-P.
CLOSE-RTN.
     CLOSE CARD-FILE.
     CLOSE PRINT-FILE.
     STOP RUN.
```

```
IDENTIFICATION DIVISION.
PROGRAM-ID. MUSP02.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. 6500.
OBJECT-COMPUTER. 6500.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT MUS-DATA-FILE ASSIGN TO INPUT.
    SELECT PRINT-FILE ASSIGN TO OUTPUT.
DATA DIVISION.
FILE SECTION.
FD  MUS-DATA-FILE
    LABEL RECORDS ARE OMITTED
    VALUE OF ID IS ≠MUSF01≠.
01  CARD-REC.
    03  CARD-ID                         PIC   X(6).
    03  CARD-OPT                        PIC   X.
    03  FILLER                          PIC   X(73).
01  DATA-REC-1.
    03  COMP-NO-D                       PIC   99.
    03  CARD-NO-D                       PIC   999.
    03  VOICE-NO-D                      PIC   9.
    03  FILLER                          PIC   X(4).
    03  COMP-TITLE-D                    PIC   X(70).
01  DATA-REC-2.
    03  FILLER                          PIC   X(10).
    03  MUS-DATA-D OCCURS 14 TIMES.
        05  PITCH-CODE-D                PIC   99.
        05  DUR-CODE-D                  PIC   X.
        05  DOT-CODE-D                  PIC   X.
        05  TIE-CODE-D                  PIC   X.
FD  PRINT-FILE
    LABEL RECORDS ARE OMITTED
    LINAGE IS 48
    VALUE OF ID IS ≠MUSPRT≠.
01  PRINT-REC-1.
    03  FILLER                          PIC   X(6).
    03  PRT-ASTERISKS                   PIC   X(98).
01  PRINT-REC-2.
    03  FILLER                          PIC   X.
    03  VOICE-NAME-P                    PIC   XX.
    03  FILLER                          PIC   X.
    03  ASTERISK-1                      PIC   X.
    03  FILLER                          PIC   X.
    03  MUS-DATA-P OCCURS 48 TIMES
                                        PIC   XX.
    03  ASTERISK-2                      PIC   X.
    03  FILLER                          PIC   X.
01  PRINT-REC-3.
    03  FILLER                          PIC   X(6).
    03  PRINT-AVERAGE OCCURS 6 TIMES.
        06  PRT-AVG                     PIC   99.99.
        06  FILLER                      PIC   X(11).
    03  FILLER                          PIC   XX.
WORKING-STORAGE SECTION.
77  MEASURE-CTR                         PIC   999      VALUE     ZERO.
77  MUS-DATA-CTR                        PIC   99       VALUE     ZERO.
77  PRT-DATA-CTR                        PIC   99       VALUE     ZERO.
77  HOLD-DUR                            PIC   99       VALUE     ZERO.
77  HOLD-VOICE-NO                       PIC   9        VALUE     ZERO.
77  HOLD-DOT                            PIC   99       VALUE     ZERO.
77  HOLD-OPT                            PIC   9        VALUE     ZERO.
77  PITCH-CTR                           PIC   99       VALUE     ZERO.
77  PITCH-TOT-CTR                       PIC   99       VALUE     ZERO.
77  PITCH-TOT                           PIC   9(4)     VALUE     ZERO.
77  PITCH-AVG                           PIC   99V99    VALUE     ZERO.
77  SUB-CTR                             PIC   9        VALUE     ZERO.
01  HOLD-AVERAGE.
    03  HOLD-AVG  OCCURS 6 TIMES PIC   9(4)V99.
    03  AVG-CTR   OCCURS 6 TIMES PIC   99.
01  HEAD-1.
    03  FILLER                          PIC   X        VALUE     SPACES.
    03  REPORT-HEAD-H                   PIC   X(70).
    03  FILLER                          PIC   X(24)    VALUE     SPACES.
    03  FILLER                          PIC   X(6)     VALUE     ≠PAGE  ≠.
```

```
     03  PAGE-NO-P                      PIC  99.
 01  HEAD-2.
     03  FILLER                         PIC  X(6)    VALUE   SPACES.
     03  MEASURE-NUMBER OCCURS 3 TIMES.
         05  MEASURE-NO-P               PIC  XXX.
         05  FILLER                     PIC  X(29).
 01  HEAD-3.
     03  FILLER                         PIC  X(6)    VALUE   ≠     * ≠.
     03  FILLER                         PIC  X(32)   VALUE
         ≠*          *          *       *      ≠.
     03  FILLER                         PIC  X(32)   VALUE
         ≠*          *          *       *      ≠.
     03  FILLER                         PIC  X(33)   VALUE
         ≠*          *          *       *     *≠.
 01  HEAD-4.
     03  FILLER                         PIC  X(6)    VALUE   ≠     * ≠.
     03  FILLER                         PIC  X(96)   VALUE   SPACES.
     03  FILLER                         PIC  X       VALUE   ≠*≠.
```

```
PROCEDURE DIVISION.
PRELIMINARY.
    OPEN INPUT MUS-DATA-FILE.
    OPEN OUTPUT PRINT-FILE.
    READ MUS-DATA-FILE AT END
        GO TO CLOSE-RTN.
    MOVE CARD-OPT TO HOLD-OPT.
    READ MUS-DATA-FILE AT END
        GO TO CLOSE-RTN.
    MOVE COMP-TITLE-D TO REPORT-HEAD-H.
    MOVE VOICE-NO-D TO HOLD-VOICE-NO.
    MOVE 01 TO PAGE-NO-P.
    PERFORM PAGE-HEAD-RTN THRU LINE-HEAD-RTN.
    MOVE ZEROS TO HOLD-AVERAGE.
READ-RTN.
    READ MUS-DATA-FILE AT END
        GO TO CLOSE-RTN.
    MOVE ZEROS TO MUS-DATA-CTR.
    IF  VOICE-NO-D = HOLD-VOICE-NO
        GO TO FILL-PRINT-LINE.
    IF  VOICE-NO-D IS LESS THAN HOLD-VOICE-NO
        PERFORM CK-END-OF-PAGE THRU LINE-HEAD-RTN.
    MOVE VOICE-NO-D TO HOLD-VOICE-NO.
    IF  HOLD-OPT = 2 OR 4 OR 5
        GO TO FILL-PRINT-LINE.
    MOVE VOICE-NO-D TO VOICE-NAME-P.
    MOVE ≠*≠ TO ASTERISK-1.
FILL-PRINT-LINE.
    ADD 1 TO MUS-DATA-CTR.
    IF  PITCH-CODE-D (MUS-DATA-CTR) = ZERO
        GO TO PRINT-MUS-DATA.
    IF  PITCH-CODE-D (MUS-DATA-CTR) = SPACES
        GO TO PRINT-MUS-DATA.
    IF  MUS-DATA-CTR IS GREATER THAN 14
        SUBTRACT 1 FROM MUS-DATA-CTR
        GO TO PRINT-MUS-DATA.
DURATION-RTN.
    IF  DUR-CODE-D (MUS-DATA-CTR) = ≠W≠
        MOVE 16 TO HOLD-DUR        ELSE
    IF  DUR-CODE-D (MUS-DATA-CTR) = ≠H≠
        MOVE 8 TO HOLD-DUR         ELSE
    IF  DUR-CODE-D (MUS-DATA-CTR) = ≠Q≠
        MOVE 4 TO HOLD-DUR         ELSE
    IF  DUR-CODE-D (MUS-DATA-CTR) = ≠E≠
        MOVE 2 TO HOLD-DUR         ELSE
    MOVE     1 TO HOLD-DUR.
    IF  DOT-CODE-D (MUS-DATA-CTR) = SPACE
        GO TO CONT-DUR-RTN.
    DIVIDE HOLD-DUR BY 2 GIVING HOLD-DOT.
    ADD HOLD-DOT TO HOLD-DUR.
CONT-DUR-RTN.
    IF  HOLD-OPT EQUALS 1
        GO TO SPECIAL-RTN-1.
    IF  HOLD-OPT = 2
        GO TO SPECIAL-RTN-2.
    IF  HOLD-OPT EQUALS 3
        GO TO SPECIAL-RTN-3.
    IF  HOLD-OPT EQUALS 4
        GO TO SPECIAL-RTN-4.
*
******************************************************************
*
STANDARD-RTN.
    ADD 1 TO PRT-DATA-CTR.
    SUBTRACT 1 FROM HOLD-DUR.
    IF  PITCH-CODE-D (MUS-DATA-CTR) = 99
        MOVE SPACES TO MUS-DATA-P (PRT-DATA-CTR)
        GO TO PRINT-LOOP.
    IF  TIE-CODE-D (MUS-DATA-CTR) = ≠J≠
        MOVE ≠--≠ TO MUS-DATA-P (PRT-DATA-CTR)     ELSE
    MOVE MUS-DATA-D (MUS-DATA-CTR) TO MUS-DATA-P (PRT-DATA-CTR).
PRINT-LOOP.
    IF  HOLD-DUR = ZERO
        GO TO FILL-PRINT-LINE.
    ADD 1 TO PRT-DATA-CTR.
    SUBTRACT 1 FROM HOLD-DUR.
```

```
     IF  PITCH-CODE-O (MUS-DATA-CTR) = 99
         MOVE SPACES TO MUS-DATA-P (PRT-DATA-CTR)     ELSE
     MOVE ≠--≠ TO MUS-DATA-P (PRT-DATA-CTR).
     GO TO PRINT-LOOP.
SPECIAL-RTN-1.
     ADD 1 TO PRT-DATA-CTR.
     ADD 1 TO PITCH-CTR.
     SUBTRACT 1 FROM HOLD-DUR.
     IF  PITCH-CTR IS GREATER THAN 16
         PERFORM AVERAGE-RTN THRU CONT-AVG
         MOVE 1 TO PITCH-CTR.
     IF  PITCH-CODE-O (MUS-DATA-CTR) NOT EQUAL 99
         ADD PITCH-CODE-O (MUS-DATA-CTR) TO PITCH-TOT
         ADD 1 TO PITCH-TOT-CTR.
     IF  HOLD-DUR = ZERO
         GO TO FILL-PRINT-LINE.
     GO TO SPECIAL-RTN-1.
AVERAGE-RTN.
     IF  PITCH-TOT = ZERO
         GO TO CONT-AVG.
     DIVIDE PITCH-TOT BY PITCH-TOT-CTR GIVING PITCH-AVG.
     IF  PRT-DATA-CTR LESS THAN 18
         MOVE PITCH-AVG TO PRT-AVG (1)            ELSE
     IF  PRT-DATA-CTR GREATER THAN 17 AND LESS THAN 34
         MOVE PITCH-AVG TO PRT-AVG (3)            ELSE
     MOVE PITCH-AVG TO PRT-AVG (5).
CONT-AVG.
     MOVE ZEROS TO PITCH-AVG.
     MOVE ZEROS TO PITCH-TOT.
     MOVE ZEROS TO PITCH-TOT-CTR.

SPECIAL-RTN-2.
     ADD 1 TO PRT-DATA-CTR.
     ADD 1 TO PITCH-CTR.
     SUBTRACT 1 FROM HOLD-DUR.
     IF  PITCH-CTR IS GREATER THAN 16
         PERFORM AVERAGE-RTN-2 THRU CONT-AVG-2
         MOVE 1 TO PITCH-CTR.
     IF  PITCH-CODE-O (MUS-DATA-CTR) NOT EQUAL 99
         ADD PITCH-CODE-O (MUS-DATA-CTR) TO PITCH-TOT
         ADD 1 TO PITCH-TOT-CTR.
     IF  HOLD-DUR = ZERO
         GO TO FILL-PRINT-LINE.
     GO TO SPECIAL-RTN-2.
AVERAGE-RTN-2.
     IF  PITCH-TOT = ZERO
         GO TO CONT-AVG-2.
     DIVIDE PITCH-TOT BY PITCH-TOT-CTR GIVING PITCH-AVG.
     IF  PRT-DATA-CTR LESS THAN 18
         ADD PITCH-AVG TO HOLD-AVG (1)
         ADD 1 TO AVG-CTR (1)                     ELSE
     IF  PRT-DATA-CTR GREATER THAN 17 AND LESS THAN 34
         ADD PITCH-AVG TO HOLD-AVG (3)
         ADD 1 TO AVG-CTR (3)                     ELSE
     ADD PITCH-AVG TO HOLD-AVG (5)
     ADD 1 TO AVG-CTR (5).
CONT-AVG-2.
     MOVE ZEROS TO PITCH-AVG.
     MOVE ZEROS TO PITCH-TOT.
     MOVE ZEROS TO PITCH-TOT-CTR.
PRINT-RTN-2.
     ADD 1 TO SUB-CTR.
     IF  SUB-CTR GREATER THAN 5
         GO TO WRITE-PRT-2.
     IF  SUB-CTR = 2
         GO TO PRINT-RTN-2.
     IF  SUB-CTR = 4
         GO TO PRINT-RTN-2.
     DIVIDE HOLD-AVG (SUB-CTR) BY AVG-CTR (SUB-CTR)
         GIVING HOLD-AVG (SUB-CTR).
     MOVE HOLD-AVG (SUB-CTR) TO PRT-AVG (SUB-CTR).
     MOVE ZEROS TO HOLD-AVG (SUB-CTR).
     MOVE ZEROS TO AVG-CTR (SUB-CTR).
     GO TO PRINT-RTN-2.
WRITE-PRT-2.
     MOVE ZEROS TO SUB-CTR.
```

```
     WRITE PRINT-REC-3 BEFORE ADVANCING 2 LINES.
     MOVE SPACES TO PRINT-REC-3.
*
 SPECIAL-RTN-3.
     ADD 1 TO PITCH-CTR.
     SUBTRACT 1 FROM HOLD-DUR.
     IF   PITCH-CTR GREATER THAN 8
          ADD 1 TO SUB-CTR
          PERFORM AVERAGE-RTN-3 THRU CONT-AVG-3
          MOVE 1 TO PITCH-CTR.
     IF   PITCH-CODE-O (MUS-DATA-CTR) NOT EQUAL 99
          ADD PITCH-CODE-O (MUS-DATA-CTR) TO PITCH-TOT
          ADD 1 TO PITCH-TOT-CTR.
     IF HOLD-DUR = ZERO
          GO TO FILL-PRINT-LINE.
     GO TO SPECIAL-RTN-3.
 AVERAGE-RTN-3.
     IF   PITCH-TOT = ZERO
          GO TO CONT-AVG-3.
     DIVIDE PITCH-TOT BY PITCH-TOT-CTR GIVING PITCH-AVG.
     MOVE PITCH-AVG TO PRT-AVG (SUB-CTR).
 CONT-AVG-3.
     MOVE ZEROS TO PITCH-AVG.
     MOVE ZEROS TO PITCH-TOT.
     MOVE ZEROS TO PITCH-TOT-CTR.
 SPECIAL-RTN-4.
     ADD 1 TO PITCH-CTR.
     SUBTRACT 1 FROM HOLD-DUR.
     IF   PITCH-CTR GREATER THAN 8
          ADD 1 TO SUB-CTR
          PERFORM AVERAGE-RTN-4 THRU CONT-AVG-4
          MOVE 1 TO PITCH-CTR.
     IF   PITCH-CODE-O (MUS-DATA-CTR) NOT EQUAL 99
          ADD PITCH-CODE-O (MUS-DATA-CTR) TO PITCH-TOT
          ADD 1 TO PITCH-TOT-CTR.
     IF   HOLD-DUR = ZERO
          GO TO FILL-PRINT-LINE.
*
     GO TO SPECIAL-RTN-4.
 AVERAGE-RTN-4.
     IF   PITCH-TOT = ZERO
          GO TO CONT-AVG-4.
     DIVIDE PITCH-TOT BY PITCH-TOT-CTR GIVING PITCH-AVG.
     ADD PITCH-AVG TO HOLD-AVG (SUB-CTR).
     ADD 1 TO AVG-CTR (SUB-CTR).
 CONT-AVG-4.
     MOVE ZEROS TO PITCH-AVG.
     MOVE ZEROS TO PITCH-TOT.
     MOVE ZEROS TO PITCH-TOT-CTR.
 PRINT-RTN-4.
     ADD 1 TO SUB-CTR.
     IF   SUB-CTR GREATER THAN 6
          GO TO WRITE-PRT-4.
     DIVIDE HOLD-AVG (SUB-CTR) BY AVG-CTR (SUB-CTR)
          GIVING HOLD-AVG (SUB-CTR).
     MOVE HOLD-AVG (SUB-CTR) TO PRT-AVG (SUB-CTR).
     MOVE ZEROS TO HOLD-AVG (SUB-CTR).
     MOVE ZEROS TO AVG-CTR (SUB-CTR).
     GO TO PRINT-RTN-4.
 WRITE-PRT-4.
     MOVE ZEROS TO SUB-CTR.
     WRITE PRINT-REC-3 BEFORE ADVANCING 2 LINES.
     MOVE SPACES TO PRINT-REC-3.
*
****************************************************************
*
 CK-END-OF-PAGE.
     IF   HOLD-OPT = 2
          MOVE ZEROS TO SUB-CTR
          PERFORM PRINT-RTN-2 THRU WRITE-PRT-2.
     IF   HOLD-OPT = 4
          MOVE ZEROS TO SUB-CTR
          PERFORM PRINT-RTN-4 THRU WRITE-PRT-4.
     MOVE ≠*≠ TO ASTERISK-1.
     MOVE ALL ≠* ≠ TO PRT-ASTERISKS.
     WRITE PRINT-REC-1 BEFORE ADVANCING 3 LINES
```

```
           AT END-OF-PAGE GO TO PAGE-HEAD-RTN.
       GO TO LINE-HEAD-RTN.
   PAGE-HEAD-RTN.
       MOVE HEAD-1 TO PRINT-REC-1.
       WRITE PRINT-REC-1 BEFORE ADVANCING 3 LINES.
       ADD 1 TO PAGE-NO-P.
   LINE-HEAD-RTN.
       ADD 1 TO MEASURE-CTR.
       MOVE MEASURE-CTR TO MEASURE-NO-P (1).
       ADD 1 TO MEASURE-CTR.
       MOVE MEASURE-CTR TO MEASURE-NO-P (2).
       ADD 1 TO MEASURE-CTR.
       MOVE MEASURE-CTR TO MEASURE-NO-P (3).
       MOVE HEAD-2 TO PRINT-REC-1.
       WRITE PRINT-REC-1 BEFORE ADVANCING 1 LINE.
       MOVE HEAD-3 TO PRINT-REC-1.
       WRITE PRINT-REC-1 BEFORE ADVANCING 1 LINE.
       MOVE SPACES TO PRINT-REC-1.
   PRINT-MUS-DATA.
       IF   TIE-CODE-D (MUS-DATA-CTR) = ≠-≠
            GO TO READ-RTN.
       IF   HOLD-OPT = 1
            PERFORM AVERAGE-RTN THRU CONT-AVG
            MOVE ZEROS TO PITCH-CTR.
       IF   HOLD-OPT = 2
            PERFORM AVERAGE-RTN-2 THRU CONT-AVG-2
            MOVE ZEROS TO PITCH-CTR
            MOVE ZEROS TO PRT-DATA-CTR
            GO TO READ-RTN.
       IF   HOLD-OPT = 3
            ADD 1 TO SUB-CTR
            PERFORM AVERAGE-RTN-3 THRU CONT-AVG-3
            MOVE ZEROS TO SUB-CTR
            MOVE ZEROS TO PITCH-CTR.
       IF   HOLD-OPT = 4
            ADD 1 TO SUB-CTR
            PERFORM AVERAGE-RTN-4 THRU CONT-AVG-4
            MOVE ZEROS TO SUB-CTR
            MOVE ZEROS TO PITCH-CTR
            GO TO READ-RTN.
       WRITE PRINT-REC-2 BEFORE ADVANCING 1 LINE.
       MOVE HEAD-4 TO PRINT-REC-1.
       WRITE PRINT-REC-1 BEFORE ADVANCING 1 LINE.
       MOVE SPACES TO PRINT-REC-1.
       MOVE ZEROS TO PRT-DATA-CTR.
       GO TO READ-RTN.
   CLOSE-RTN.
       IF   HOLD-OPT = 2
            MOVE ZEROS TO SUB-CTR
            PERFORM PRINT-RTN-2 THRU WRITE-PRT-2.
       IF   HOLD-OPT = 4
            MOVE ZEROS TO SUB-CTR
            PERFORM PRINT-RTN-4 THRU WRITE-PRT-4.
       MOVE ≠*≠ TO ASTERISK-1.
       MOVE ALL ≠* ≠ TO ART-ASTERISKS.
       WRITE PRINT-REC-1.
       CLOSE MUS-DATA-FILE.
       CLOSE PRINT-FILE.
       STOP RUN.
```

APPENDIX B

COMPUTER OUTPUT FOR THE ANALYZED MUSIC

CHANSON * JAY VEU LE CERF BY PIERRE DE MANCHICOURT PAGE 01

001		002		003	
45.00	52.00	46.00	49.00	47.75	47.75
004		005		006	
45.87	41.25	44.75	39.87	41.00	41.16
007		008		009	
35.75	33.87	40.50	38.84	39.58	45.00
010		011		012	
39.33	42.50	42.12	40.87	40.00	40.62
013		014		015	
40.12	41.62	39.87	40.50	40.50	41.75
016		017		018	
40.83	40.58	45.16	43.50	40.25	40.12

019	41.75	40.00	020	39.18	39.12	021	38.75	39.33
022	42.06	42.62	023	43.75	45.00	024	41.87	41.87
025	40.55	40.25	026	38.87	40.06	027	39.87	40.87
028	39.33	42.33	029	41.50	45.16	030	44.33	39.81
031	39.62	40.50	032	39.62	39.50	033	41.87	42.12
034	43.37	41.31	035	41.68	41.25	036	40.50	40.56

CHANSON * JAY VEU LE CERF BY PIERRE DE MANCHICOURT

037		038		039	
38.37	37.25	40.12	39.87	41.87	40.68
040		041		042	
45.16	43.50	42.66	45.87	41.00	44.75
043		044		045	
39.87	41.00	41.16	35.75	33.87	40.50
046		047		048	
38.84	39.58	43.50	39.33	42.50	42.12
049		050		051	
40.75	40.52	41.37	41.87	40.56	40.75
052		053		054	
39.80	40.12	38.62	36.87	37.75	37.75

KYRIE I * MISSA JAY VEU LE CERF BY CLEMENS NON PAPA

001		002		003	
45.00	52.00	45.87	49.08	47.68	47.75
004		005		006	
45.33	48.16	48.08	48.16	46.66	43.31
007		008		009	
46.00	42.25	43.30	43.07	43.00	42.20
010		011		012	
41.60	42.30	39.75	39.90	38.75	45.68
013		014		015	
45.50	45.25	44.68	42.30	42.60	43.07
016		017		018	
43.09	42.20	41.50	42.15	39.60	39.90

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KYRIE I  *  MISSA JAY VEU LE CERF      BY  CLEMENS NON PAPA                      PAGE  02

  019                             020                             021
* *       *       *       *       *       *       *       *       *       *       *       *       *
  37.55           39.05           37.35           38.00           37.60           37.60

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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CHRISTE * MISSA JAY VEU LE CERF BY CLEMENS NON PAPA PAGE 01

001		002		003	
52.00	47.25	44.50	44.50	44.50	43.83
004		005		006	
43.50	45.16	48.50	46.50	44.00	43.66
007		008		009	
43.16	42.66	41.83	45.58	46.50	45.83
010		011		012	
46.66	47.16	48.33	49.66	48.33	46.00
013		014		015	
45.83	45.33	43.83	45.00	44.33	43.83
016		017		018	
45.25	47.33	49.66	48.33	46.16	46.33

019		020		021	
45.33	43.83	45.00	44.33	43.83	42.58
022		023		024	
45.16	45.16	44.66	44.66	00.00	00.00

KYRIE II * MISSA JAY VEU LE CERF BY CLEMENS NON PAPA PAGE 01

001		002		003	
45.00	43.33	44.50	42.75	42.70	45.25
004		005		006	
43.50	42.37	40.00	44.87	44.31	43.75
007		008		009	
42.10	41.10	38.31	37.81	38.80	37.50
010		011		012	
36.12	35.12	37.50	38.30	45.12	43.43
013		014		015	
40.80	40.20	40.00	39.25	38.80	37.45
016		017		018	
39.20	39.05	38.70	37.70	37.60	37.60

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KYRIE II  *  MISSA JAY VEU LE CERF     BY  CLEMENS NON PAPA                          PAGE  02

   019                             020                             021
 * *       *       *       *       *       *       *       *       *       *       *       *
   37.63           37.50           00.00           00.00           00.00           00.00

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CHANSON *. O COMBIEN EST BY CLAUDIN OR SANDRIN PAGE 01

001	47.50	47.50	002	48.75	48.12	003	45.12	45.50
004	47.50	46.75	005	48.68	48.12	006	47.75	46.87
007	45.12	42.81	008	44.25	45.43	009	46.25	45.87
010	43.00	43.00	011	47.50	47.50	012	48.75	48.12
013	45.12	45.50	014	47.50	46.75	015	48.68	48.12
016	47.75	46.87	017	45.12	42.81	018	44.25	45.31

019	46.25	45.87	020	44.50	47.50	021	46.50	45.12
022	45.73	44.12	023	43.25	45.50	024	44.50	46.75
025	46.75	48.75	026	48.50	49.00	027	47.87	46.25
028	47.50	47.50	029	48.75	48.12	030	45.12	45.50
031	47.50	46.75	032	48.68	48.12	033	47.75	47.75
034	50.75	49.75	035	46.50	45.37	036	43.75	44.43

CHANSON * O COMBIEN EST BY CLAUDIN OR SANDRIN PAGE 03

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 137                             038                             039
* *          *          *        *        *        *        *        *        *        *        *
 46.25               45.87       43.00             43.00             00.00             00.00

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KYRIE I * MISSA OR COMBIEN EST BY CLEMENS NON PAPA

001		002		003	
39.87	41.50	41.75	41.12	38.12	38.25
004		005		006	
39.75	41.00	41.75	40.75	40.75	41.12
007		008		009	
39.50	37.81	39.12	39.31	39.00	38.87
010		011		012	
36.62	39.50	38.12	35.62	36.87	38.37
013		014		015	
36.81	35.62	35.87	37.25	40.12	38.18
016		017		018	
38.87	36.75	00.00	00.00	00.00	00.00

CHRISTE * MISSA OR COMBIEN EST BY CLEMENS NON PAPA PAGE 01

001	39.75	40.87	002	39.75	38.75	003	37.81	37.12
004	35.37	37.12	005	38.12	38.25	006	40.87	41.37
007	39.00	39.00	008	37.93	36.75	009	37.50	38.62
010	40.50	39.75	011	41.87	42.68	012	42.25	40.87
013	39.75	40.50	014	37.87	36.87	015	36.75	35.50
016	38.12	38.75	017	38.75	38.75	018	00.00	00.00

KYRIE II * MISSA OR COMBIEN EST BY CLEMENS NON PAPA

001		002		003	
37.50	38.12	38.50	37.12	34.75	35.56
004		005		006	
36.00	36.87	38.50	38.12	38.50	39.75
007		008		009	
41.00	41.68	41.12	40.75	44.00	40.25
010		011		012	
41.37	41.37	41.25	38.87	37.87	39.12
013		014		015	
40.75	42.12	40.12	38.62	36.87	37.25
016		017		018	
40.12	40.25	38.18	38.87	37.68	38.25

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KYRIE II  *  MISSA OR COMBIEN EST        BY  CLEMENS NON PAPA                        PAGE  02

    019                           020                           021
*  *         *         *         *         *         *         *         *         *         *         *         *
    36.73           36.75           00.00           00.00           00.00           00.00

*  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
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APPENDIX C

THE MUSIC THAT WAS ANALYZED

Jay veu le cerf

Pierre de Manchicourt


ne. ie bois ie bois à ty mon bel a - mi ie bois a ty mon bel a
et a ta sou re - rai -
mi. ie bois à ty mon bel a mi. ie bois à
ty mon bel a - mi et à ta sou - ve - rai -
à ta sou re rai - ne. ie bois à tv mon bel a - mi et à ta sou - re -
- mi et à ta sou - ve - rai - ne et à ta sou - ve - rai - ne.
- ne
ty mon bel a - mi et à ta sou - ve - rai - - ne.
ne. et à ta sou - ve - rai - ne. Si tu
rai - ne. et à ta sou - re - rai - - ne. Si tu ne
Si tu ne fais ain - si que mi tu pai - ras pin te plai -
Si tu ne fais - ain - si que mi tu pai - ras, si
ne fais ain - si que mi tu pai - ras pin - te plai - ne,
fais ain - si que mi, si tu ne fais ain - si
ne, si tu ne fais ain - si que mi tu pai - ras pin - te
tu ne fais ain - si que mi tu pai - ras pin - te plai - -
si tu ne fais ain - si que my tu pai - ras pin - te plai - ne. tu pai - ras
que my tu pai - ras pin - te, tu pai - ras pin - te plai - ne,


plai - - ne. Iay veu le cerf du
ne, tu pai ras pin - te plai - ne. Iay
pin - te plai - - ne. Iay veu le cerf,
tu pai ras pin - te plai - ne. Iay veu, iay veu le cerf du bois sail - lir et
bois sail - lir et boire à la fon - tai - ne, iay veu
veu le cerf du bois sail - lir et boi - re à la fon - tai - - ne,
iay veu le cerf du bois sail - lir et boire à
boire à la fon - tai - ne, iay veu le cerf du bois sail-
et boi - re à la fon - tai - ne, et boire à la fon - tai -
et boi - re à la fon - - tai - - ne, et boi - re à la fon-tai -
la fon - tai - ne, et boi - re à la fon - tai - ne, et boi -
lir . et boi - re à la fon - tai - ne, et boi - re à la fon - tai - ne,
- ne, et boi - re à la fon - tai - - ne.
ne. et boire à la fon - tai - - ne.
re à la fon - tai - - - ne.
et boi - re à la fon - tai - - - ne.

Missa Jay veu le cerf

KYRIE

Clemens non Papa


Ky - ri - e Ky-rie e - le - i - son.
ri - e Ky - rie e-le - i - son.
ri - e e - lei - son, Ky - ri - e e-lei - son.
rie e - le - i - son e le - i - son.
i - son, Ky - rie e - le - i - son, e - le - i - son.
Chri - ste e - lei son, Chri - ste e - lei - son, Chri - ste e -
Chri - ste e - lei - son, Chri - ste e -
Chri - ste e - le - i - son, e le - i
le - i - son Chri - ste e - le - i - son, Chri - ste e -
le - i - son. Chri - ste e - le -
son. Chri - ste e - lei - son, Chri - ste e le - i - son, e - le - i - son, e -
le - i son e - le - i - son e - le -
i - son e - le - i - son e - le -
le - i - son. Chri - ste e - le - i - son, e - le - i - son, e - le - i -


- - i son. e - le - i - son e - le - i - son
- i - son. Chri - ste e le - i - son
son. Chri - ste e - le - - i son e - le - i - son
Ky - rie e - le - i - son, Ky - ri - e e - le - i -
Ky - rie e - le i - son, e - lei -
Ky - rie e - le - i - son Ky - rie e le - i -
Ky - rie e - le - i - son,
Ky - rie e - le - i -
son e le - - i - son Ky - - ri - e - - e - le - - i - son
son, Ky - rie e - le - i - son, Ky - rie e -
son, e - le - i - son, Ky - rie e - le -
Ky - rie e - le - i - son, e - le - - i - son e -
son, Ky - rie e - le - i - son, Ky -


Ky - rie e - le - - -
le - - i - son, e - - le - i - son
- i son, Ky - rie e - le - - -
lei - - son, Ky - rie e - le - i - son, Ky - rie e - le - i -
rie - e le - i - son, Ky - ri - e le - i
i - son.
Ky - rie e - le - - i - son.
i - son. Ky - rie e - le - - i - son.
son e - lei - son.
son Ky - rie e - le - - i - - son.

O combien est

Claudin ou Sandrin


voy mon bien fi - nir soub-dai - ne - ment Mon tra - vail croist sous cou - ver -
voy mon bien fi - nir soub-dai - ne - ment Mon tra - - vail croist sous cou -
voy mon bien fi - nir soub-dai - ne - ment Mon tra - vail croist sous cou - ver -
bien fi - nir soub - dai - ne - ment Mon tra - vail croist sous cou - ver -
te pen - sé - - e Sans es - - pé - rer je souf - fre
- ver - te pen - sé - e Sans es - pé - rer je
te pen - sé - - e Sans es - - pé - rer je
te pen - sé - - e Sans es - - pe - rer je
dou - - ce - ment Le mal le mal que sent u - ne a - mye
souf - fre dou - ce - ment Le mal le mal que sent u - ne a - - mye
souf - fre dou - - ce - ment Le mal le mal que sent u - ne a - mye
souf - fre dou - ce - ment Le mal le mal que sent u - ne a - mye
of - fen - sé - - - e Le e
of - fen - sé - - - e Le e
of - fen - sé - - - e Le e
of - fen - sé - - - e Le e

Missa Or combien est

KYRIE

Clemens non Papa


son, e - le - i - son.
son. Ky - ri - e e - le - i - son.
i - son, Ky - ri - e e - lei - son.
son, Ky - ri - e e - le - i - son.
Chri - ste e - le - i - son, Chri -
Chri - ste e - le - i - son, Chri -
Chri - ste e - lei - son, Chri - ste e - le - i -
Chri - ste e - le - i - son, Chri - ste e - le -
ste e - le - i - son. Chri - ste e - le -
ste e - le - i - son. Chri - ste e - lei - son, Chri - ste e - le - i - son. e - le -
son. Chri - ste e - le - i - son, Chri - ste e - le - i - son. Chri - ste e -
i - son. Chri - ste e - le - i - son, Chri - ste e -
i - son, Chri - ste e - le - i - son.
i - son, Chri - ste e - le - i - son.
lei - son, Chri ste - e - le - i - son.
le - i - son, Chri - ste Chri - ste e - le - i - son.


Ky - ri - e e - lei - son, Ky - ri - e e - lei - son. Ky -
Ky - ri - e e - le - - i son,
Ky - ri - e e - lei - son, Ky - ri - e e - le - - i - son,
Ky - ri - - - e Ky - ri - e e - lei - son,
ri - e e - lei - son. Ky - ri - e e - le - -
Ky - ri - e e - le - i - son, Ky - ri - e e - le - i - son, Ky -
Ky - ri - e e - lei - son. Ky - ri - e e - lei - son, Ky - ri - e
Ky - ri - e e - lei - - son, Ky - ri - e e - le -
- - i - son, Ky - ri - e e - lei - son, e - le - -
- ri - e e - le - - i - son Ky - ri - e e - le - - i - son, Ky -
e - lei - - son, Ky - ri - e e - le - i - son e - le -
- - - i - son, Ky - ri - e e - le - i - son, e - le -
- - - i - son.
ri - e e - le - - - i - son.
- - - i - son.
- - i - son. e - lei - son.

APPENDIX D

Definitions of Technical Terms[26]

CARD COLUMN. One of the vertical areas on a punched card in which a digit, letter, or symbol may be recorded.

COMPUTER PROGRAM. A series of instructions, in a form acceptable to the computer, prepared so as to achieve a certain result.

ENCODE. To apply a set of rules specifying the manner in which data may be represented such that a subsequent decoding is possible.

HARDWARE. A colloquialism applied to the mechanical, electrical, and electronic features of a data processing system.

INPUT. Information transferred into the internal storage of a data processing system, including data to be processed or information to help control the process.

KEYPUNCH. A keyboard-operated device that punches holes in a card to represent data.

OBJECT PROGRAM. A program in machine language; generally,

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[26]These definitions were taken from Robert R. Arnold, Harold C. Hill and Aylmer V. Nichols, Modern Data Processing, (New York: John Wiley & Sons, Inc., 1972), pp. 443-466.

one that has been converted from a program written in symbolic language.

OPTICAL SCANNER. A device that optically scans printed or written data and generates its digital representation.

OUTPUT. Information transferred from the internal storage of a data processing system to any device external to the system.

SOFTWARE. The programs and routines used to extend the capabilities of computers, such as compilers, assemblers, routines and subroutines.

SOURCE PROGRAM. A program usually written in some form of symbolic language and intended for translation into a machine-language program.

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