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Preface

The 1987 *Directory of Computer Assisted Research in Musicology* is significantly larger than its predecessors of 1985 and 1986. The main purpose of the *Directory* is to make information about current activities readily available. The Center collects technical information oriented towards academic use and reports of current and intended academic applications on an ongoing basis. Anyone engaged in an activity that seems compatible with the work reported here is invited to submit information for future inclusion. A few months before the publication of a new directory, the Center distributes a formal solicitation for contributions to everyone on its mailing list.

A great deal of academic activity related to musical research requires involvement with both text and music. We report on both these aspects of research. Because the technical challenge of dealing with musical information is so much greater than that presented by text, we include in each directory an article on some component of the complex process by which computers are increasingly being used to store and manipulate musical data. Input processes were considered in 1985. Music printing was the main topic in 1986. Ways of representing music provide the main focus of the current directory. We also continue our coverage of music printing with a provisional inventory of musical symbols desirable for critical editions of standard repertory, an update on music printing activities, a cumulative list of music encoding and printing systems and products (with a large number of illustrations), and a brief report on one effort of twenty years ago to print music by computer.

The balance of the directory consists of short news items (conferences, theses in progress, recently formed organizations and services), a log of current activities and applications, a brief dictionary of computer terminology in four languages (English, French, German, Italian), a short bibliography of recent and imminent publications of a comprehensive nature, and a series of address lists (individuals, businesses, agencies, and electronic mail users).

We are indebted to a great many contributors this year. We would like especially to extend our thanks to Stephen Dydo for compiling the inventory of musical symbols (which includes many suggestions made by respondents to one of our surveys) and for many other valuable contributions to the presentation of this directory; to Mario Baroni, Laura Callegari, Lelio Camilleri, Etienne Darbellay, and Christoph Schnell for their contributions to the four-language dictionary of computer terms; to Lelio Camilleri, Stephen Dydo, Michael Keller, Stephen Page, and Alastair Pearce for their efforts over the past year to expand our outreach; to the many software developers and other researchers who contributed examples of music printing and other illustrative materials; to all of those who contributed information about encoding systems and applications; to Jef Raskin for the photographs from his personal archives; and to Frances Bennion, Edmund Correia, Michael Flexer, and Esther Hewlett for their proofreading efforts and general assistance.

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The Representation of Musical Information in Machine-Readable Form

The use of the computer for research in musicology is becoming increasingly more common. For many types of applications, the effectiveness of the computer as a research tool depends upon the success with which relevant musical data can be represented in a form which is intelligible to the machine.

This problem of representation, which has challenged musicologists for more than twenty-five years, has no apparent simple or single type of solution. The methods for representing musical information that have been developed over this period of time are many and varied. Several large scale efforts such as DARMS and MUSTRAN have met with reasonably good success. They have received high marks for their utility and completeness, and have gone on to produce important secondary efforts in music printing and analysis. Yet the acceptance and use of such systems is far from universal. In fact, today, more than twenty years after the beginning of the development of DARMS, there are new systems still being devised, and in terms of numbers of projects, the use of custom or special encoding systems far outweighs the use of such major standard systems. In order to gain a better understanding of why this is so, and to find out more about the activities of scholars and system designers in this area, the Center has conducted a survey on methods of music representation, the results of which are reported in this article.

To collect information on music representation, the Center included a section on music encoding in its annual questionnaire on computer applications in musicology. Our objective was to gain some idea about the variety and number of different systems currently in use, how these systems dealt with the problems of organizing and storing information, and finally, what issues needed to be resolved in order for musical information to be transferred from one system to another. Scholars involved in actual projects in musicology (end users) were presented with two simple musical examples and asked to indicate how this music would be encoded in their system. As part of a music printing update, system and software developers were sent four examples of a more complex nature and asked to provide information on musical encoding as well as a description of the internal representation used for storing data and for preparing data for printed output.

The response to this part of the end-user questionnaire was reasonably complete. Of a total of 95 responses describing projects involving the encoding of musical information, 22 indicated the use of well established coding systems such as DARMS, MUSTRAN or Plaine and Easie; 48 indicated the use of more recent encoding systems or of custom designed systems; six indicated the use of commercial software and 19 gave no indication of the kind of system being used. Of the 48 respondents using more recent or custom design systems, 15 sent in descriptions of their systems and another six indicated the use of systems for which the Center has descriptions from other sources.

The response from system and software developers was more variable. While commercial system and software developers were generally eager to demonstrate the music printing capabilities of their systems, they seemed less interested in discussing how they represented their musical data internally. Nevertheless, the Center did receive good responses from some important members of this group. System and software developers working in an academic setting were generally more forthright in describing their input and internal representation systems.

Before proceeding with a description and analysis of the various encoding systems received by the Center, it is worth reviewing some of the factors of system design which influence the form that encoding systems take, their scope and versatility, their speed and ease of use as an input tool, and their suitability for various kinds of research and analysis.

1. **Level of completeness.** Some of the first people to work on the subject of music representation recognized the importance of distinguishing between a *code* and a *language*. In representing musical information there are many conceivable levels of completeness. Scholars working on a selected repertory for the purpose of answering defined questions may only need to consider information about pitch alone, about rhythm alone, or about pitch and rhythm without reference to dynamics or articulation. A simple code can be entirely adequate for a dedicated self-designed system. Encoding languages such as DARMS and MUSTRAN, on the other hand, seek to be able to encode any element of musical information from any repertory that is performed from common musical notation (CMN).

2. **Intended uses of the data.** Encoded musical information can in principle support many applications. It can be used to create sound, it can be used to create a score and/or parts for performance, and it can be used internally as a basis for analysis of perceived sound or of a notated composition. Schemes for representing music which are devised for specified purposes may contain elements of information that are irrelevant to other purposes. Beams offer a good example. A program for printing music must be able to deduce when a beam is necessary and determine from the internal representation the points where that beam starts and ends. Such information would be irrelevant to audio output. The MIDI representation offers another example of information that is adequately precise for one use but is too vague for another. The sounding pitch of the black note between F and G is represented in MIDI by a single integer derived from the chromatic scale. This representation is adequate for the purpose of audio output but does not carry sufficient information for printing or analysis, where discrimination between F# and Gb is a requirement.

3. **Provision for expanded use.** A particular system of encoding may be adequate for a dedicated task, but after a musical repertory is encoded, new uses for it may become apparent. Deciding which data attributes should be included to support unforeseen uses is a perennial responsibility of text-based projects. The incentive to avoid unnecessary encoding is based on considerations of storage space, processing time and ease of representation. The balance between these needs is sometimes difficult to strike in applications involving musical data.

4. **Inclusion of interpretative data.** In theory, scholars would normally prefer data that is "objective" or "unedited," but in practice many scholars enter into the computer data that is descriptive or already partly interpreted. Within the context of specific tasks, this can save encoding time and simplify analysis. Many encoding systems specify global accidentals in terms of a key or a key signature. Some systems also specify a "tonic" reference pitch. This information, which is sometimes difficult to deduce by computer, can be very helpful for certain types of analysis. In other cases, inclusion of such information is not helpful. For modal repertories in which a key signature is not related to a "key" in the

tonal sense and for some twentieth century repertories in which sharps and flats may be found in the same "signature," the simple declarations of "key" or "key signature" cannot be used without obscuring attributes that may be vital to analytical issues.

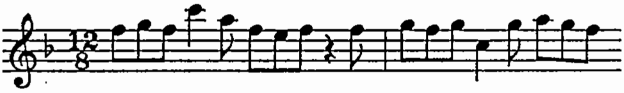
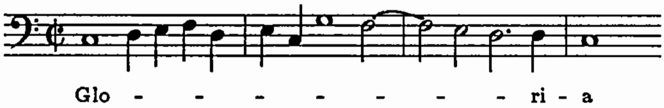
5. **Provision for shorthand representation**. A good deal of encoding time and storage space can be saved by allowing certain musical attributes to be defined relative to previous information. The degree to which musical attributes can be relatively defined is a property of system design. For example, where pitch notation is represented by the letters A through G and a pitch register, the register needs to be specified only in those places where it actually changes. If a key signature is declared at the start of a piece, pitches may be identified by letter name only, with affected letters assumed to be altered in accordance with the key signature unless accidentals are notated. These examples of shorthand notation can actually improve the readability of the code. Information on note duration can also be condensed by indicating duration only in cases where the rhythmic values change. A succession of eighth notes, for example, may be indicated by a single code element. Such methods of shorthand have many obvious advantages but also need to be employed with caution, since errors in initial declarations can cause havoc in retrieving and interpreting the data, thus limiting the value of the results.

6. **Methods of data organization**. In representing music in the computer, it is generally necessary to deal with musical attributes independently. There is no natural order among these attributes. Some systems give pitch information followed by durational information on a note-for-note basis. Other systems give duration first, followed by pitch. Some systems encode pitch information for an entire sequence of notes, and then encode durational information for the same sequence. This approach is often referred to as a "two-pass" system. When entering information from several musical parts which sound simultaneously, data may be encoded either vertically as a series of simultaneous events, or horizontally as a series of individual parts of specified length. In general, flexibility in the methods of encoding and representing data will contribute to the versatility of a representation system but will also add to its complexity.

Examples of Musical Encoding Systems

The descriptions of the user-designed encoding systems received by the Center are interesting not only for the information they provide on current methods for representing musical data in machine readable form but also for the detail they provide on the kinds of data scholars are finding useful to put into the computer. For this reason, we have chosen to display all of the encodings we received for the two musical examples in the questionnaire.

In taking this approach, we have not attempted to provide explanations on how the various encoding systems function, beyond the comments provided by the respondents themselves. From our own study, it appears that the methods used for each encoding system are self-evident and that part of the value to be gained from studying these systems is acquired in the process of trying to figure them out. In most cases, we have not listed the names of the designers/encoders, since the emphasis here is not on individual systems but on features of commonality and difference. The listing below pairs the various encoding systems with the letters of the alphabet for purposes of identification.

Example 1: 

Example 2: 

A: Example 1 not encoded

Example 2

0 1 2 3 1 2 0 4 3 2 1 1 0

* pitches represented in mode 1

B: **Example 1**

%KS 1- %TS 12:8 *=BAR 1=* =1= (F5 G5 F5) 72 C6 48 (A5 F5 E5 F5) 96 R 48 F5 24 / [other voices in Bar 1 would follow; then --] *=Bar 2=* =1= (G5 F5 F5) 72 C5 48 (G5 A5 G5 F5) 96 - - -

* Example is assumed to be Bar 1, and "voice" number 1 of a multi-part texture. Spaces are not significant.

Example 2

%KS 0 %TS 4:2 C3 192 (D3 E3 F3 D3) 192 / E3 48 C3 48 G3 192 F3 96 / J F3 96 E3 96 D3 144 D3 48 / C3 192

* Example is encoded as an isolated part. Bar numbers and voice numbers are not required.

C: **Example 1**

F 2 1 5 3 1 -2 1 2 1 2 -4 2 3 2 1

Example 2

C 2 3 4 2 3 1 5 4 3 2 1

* System is concerned only with pitch class incipits. Rhythm, duration, and octave are not included.

D: **Example 1**

[1%; 12/8; 3]: 3(f "q"f "), 2A(C"'a"), 3(f "e"f "), ?2A(f ") | 3(q"f "q"), 2A(c"q"), 3(a"g"f ")

Example 2

[; 4/2; 1]: 1(c), 4(defd) | 3B(ecg) - 2(gf) - | - 2(fe), 2A(dd) | 1(c)

E: **Example 1**

1 2 1 5 3 1 D7 U1 1 2 1 2 D5 U2 3 2 1

Example 2

1 2 3 4 2 3 1 5 4 3 2 1

F: Example 1

ff8 gg ff ccc4 aa8 ff ee ff r4 ff8 // gg ff gg cc4 gg8 aa gg ff

Example 2

c1 D4 E F D // E C G1 F2+ // F E D2. D4 // C1

* This code was worked out for short tunes of limited range, with ease of input for ordinary music readers a high priority.

G: Example 1

1 2 1 5 _ 3 1 - 7 1 0 ~ ~ 2 1 2 - 5 _ 2 3 2 1 ~ ~

* ~ = space. There is a headline for each song where the key-note (f) and the smallest duration of a tone (♪= 08) are coded.

Example 2

1 _ _ 2 3 4 2 ~ ~ 3 1 5 _ _ 4 _ ~ ~ ^ _ 3 _ 2 _ . 2 ~ ~ 1 _ _

* ~ = space. Key-note = c, smallest duration (♩ = 04).

H: Example 1

event(F,5,0,1). event(G,5,1,1). event(F,5,2,1). event(C,6,3,2). etc.

* Implied format: event(pitch class, register, attack point, duration). No clefs, key signature, time signature. Coding is very minimal; intended for specific kinds of analysis, not score representation.

Example 2

event(C,3,0,4). event(D,3,4,1). event(E,3,5,1) . . . event(G,3,10,4). event(F,3,14,4). event(E,3,18,2) . . .

I: Example 1

1,0,.5, 3,0,.5, 1,0,.5, 2,0,1, 5,0,.5, 1,0,.5, 6,0,.5, 1,0,.5, 0,1, 1,0,.5, 3,0,.5, 1,0,.5, 3,0,.5, 2,0,1, 3,0,.5, 5,0,.5, 3,0,.5, 1,0,.5,

Example 2

2,0,4, 4,0,1, 6,0,1, 1,0,1, 4,0,1, 6,0,1, 2,0,1, 3,0,4, 1,0,2, 1,0,2, 6,0,2, 4,0,3, 4,0,1, 2,0,4,

* where F = 1, C = 2, G = 3, . . . ; 0 indicates the following number is a duration value (measured in quarter notes); and the comma (,) denotes the use of data entry or "continue" key. [spaces added for clarity of presentation]

J: Example 1

/1/ =12:8= F48 G4 F4 C54 A48 F4 E4 F4 R4 F48 /2/ G4 F4 G4 C44 G48 A4 G4 F4

Example 2 not encoded

K: Example 1

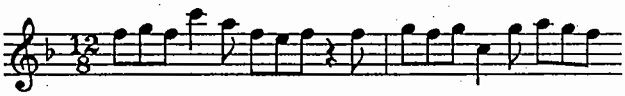
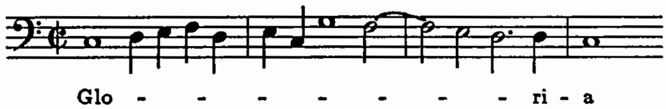
[^ F/G/F/ C^ A/F/E/F/ R F/ | G/F/G/ C G/A/G/F/]

* No key signature or time signature. ^ means up octave. [^ . . .] means all notes up octave. / = half duration. Quarter note is default.

Example 2

[v C00 D E F D | E C G00 (F0 F0) E0 D0. D | C00]

* [v . . .] means all notes down octave. 0 = double duration. (. . .) = tie.

Example 1: 

Example 2: 

L: **Example 1**

key = f1; timesig = 12 8. f g f c> a f ev f _> f |

* assuming automatic beaming

Example 2

--- clef = b a>> "Glo" b "-" c d "-" b | . . . . .

M: **Example 1**

$ G&B 12:4$ 8"FGF 4'"C8"A FEF 4-8F / GFG 4C8G AGF

Example 2

$ F4 2:2$ 1,C (Glo) 4DEFD/FC 1G 2F+/FE 2.D 4D (ri)/ 1C (a)

N: **Example 1**

Key F

P: F4 G F C5 A F E F R (F G)2 C G A G F

R: (8)3 (4 (8)4)3

Example 2

P: C2 D E F D E C G F E (D)2 C

R: 1 (4)6 (1)2 2 2. 4 1

O: **Example 1**

```
tonal(-1).
temp(12,8).
bar( [ [1, inst_id ], [ [f(4,e)], [g(4,e)], [f(4,e)], [c(5,q)], [a(4,e)],
                        [f(4,e)], [e(4,e)], [f(4,e)], [r( ,q)], [f(4,e)] ] ).
bar( [ [2], ints_id ], [ [g(4,e)], [f(4,e)], [g(4,e)], [c(4,q)], [g(4,e)],
                        [a(4,e)], [g(4,e)], [f(4,e)], . . . .
```

* This shows the format in database. Input is done using interactive system.

Example 2

```
tempo(8,4).
bar( [ [1], voice ], [ [c(2,w)], [d(2,q)], [e(2,q)], [f(2,q)], [d(2,q)] ] ).
bar( [ [2], voice ], [ [e(2,q)], [c(2,q)], [g(2,w)], [f(2),tie_start] ] ).
bar( [ [3], voice ], [ [f(2,h),tie_end], [e(2,h)], [d(2,dh)], [d(2,e)] ] ).
bar( [ [4], voice ], [ [c(2,w)], . . . .
```

P: **Example 1**

K = b T = 12/8 F+1 QJ G F C+2 CR A+2 QJ F+1 E F R CR

Example 2 not encoded

Q: **Example 1**

23!G !K1- !M12:8 (28ED 30ED 29ED) 33QD 31ED etc.
!G !K- !M12:8 (9 30 9) 33Q 31E (9 8 9) RQ 9 / (30 9 30) 26Q 30E (31 30 9)
!G !K- !M12:8 9E(10 9) 13Q 11E 9(8 9) RQ 9 / 10(9 10) 6Q 10E 11(10 9)
!G !K1- !M12:8 (9 30 9) 33Q 31E (9 8 9) RQ 9E / (30 9 30) 6Q 30E (31 30 9)

* DARMS encoded by Harry Lincoln, Bruce McLean, Stephen Dydo and Stefan Bauer-Mengelberg

Example 2

!F !MC| !&, 4W 5Q 6 7 5 / 6 4 8W 7HJ / 7 6 5. Q / 4W &,@Glo-,~/2WH.,ri-,~Q,a$ &$
!F !MC/ 4W,@Glo-$ 5Q 6 7 5 / 6 4 8W 7HJ / H 6 5. Q,@ri-$ / 4W,@a$
!F !M 4W,@ GLO-$ 5QD 6 7 5D / 6 4 8W 7HJ / 7 6 5.D QD,@RI-$ / 4W,@A$

* DARMS encoded by McLean, Dydo and Bauer-Mengelberg

Letter Q shows four different ways to encode the musical examples using DARMS. The design of DARMS actually permits many types of shorthand representation. The version submitted by Harry Lincoln for example 1 illustrates the unabridged or "canonical" version of the DARMS code. The other versions represent various possible condensations of this code. DARMS also offers considerable flexibility in the order of data entry. For the second musical example, Bruce McLean has chosen to enter the text after encoding the complete musical phrase, whereas Stephen Dydo and Stefan Bauer-Mengelberg have chosen to enter the text simultaneously with the music.

The flexibility of DARMS, as illustrated in these examples, is one of its strong points. However, the variety of representations made possible by this feature has made it difficult to write application programs which accept all versions of DARMS. Bruce McLean has been working on a program which will solve this problem by converting all shorthand and multiple pass representations into a three-dimensional data structure, which can then be collapsed down into the canonical version of the language.

Most of the other systems shown above fall into the category of music *codes* rather than music *languages*. They reflect the individual requirements of their designers and for the most part contain only the information needed for specific projects [see comments under F and H]. In some cases, researchers are interested only in melodic contours and ignore rhythmic attributes such as duration, rests and repeated notes [systems A, C and E]. Some encoding systems deal only with pitch class and ignore register or range [systems C and I]. Some systems are concerned only with absolute duration [H and N], while other systems are interested in the structure of ties [systems B, D, F, G, I, K, M, O, Q]. Some systems show a further interest in note groupings for beaming or other purposes [systems D, M and Q]. System D is particularly noteworthy in this respect, since in the interest of representing a particular rhythmic pattern, it actually inserts a tie (2nd example, 2nd measure) into the representation.

The attributes of pitch and duration are present in most music representation systems. There is, however, a wide variation in the way systems represent these basic attributes. This fact is well illustrated in our set of examples. Here we see two broad categories of pitch representation; representation by the musical letters, A -- G, and representation by numbers. Most of the systems that use letters [systems B, D, F, H, J, K, M, N and O] also indicate a register. This may be done by indications of register change [systems K and P], by repetition of characters [systems D, F and M], or by numbers [systems B, H, J, N, O]. The most common method of representing pitch by number is in relation to a "tonic" pitch [systems A, C, E and G]. The DARMS system represents pitch as a number relative to the staff lines.

For duration, there are at least six methods of representation; (a) letters indicating note types [systems O, P and Q], (b) numbers indicating note types, e.g. 0 = breve, 1 = whole note, etc. [no examples here], (c) numbers indicating inversions of the division of the whole note [systems F, J, M and N], (d) duration as a multiple of a fixed unit [systems B, I and K], (e) duration as a multiple of a variable unit [systems D, G and L], and (f) duration measured in absolute time values. For types d and e, the multiple may be indicated by a number or by other combinations of signs.

Most of the systems above employ some sort of shorthand for pitch and/or duration. Only two of the systems [L and Q] accommodate the presence of text. This is a reflection of the practical nature of these encoding systems and their focus on particular applications.

Internal Representations

The Center received several responses to its request for descriptions of internal representations of musical data. In most cases, respondents chose their own examples to illustrate their systems, rather than using the music printing examples sent out by the Center. This proved to be an advantage, since the examples sent in actually covered a greater range of music representation problems than the examples chosen by the Center. To illustrate some of the methods and techniques of representation currently in use, seven examples with musical excerpts and corresponding internal representations are presented. In some cases, an encoded input string or a second representation is also given. All illustrations of music and encoding are located at the end of the article.

It is important to make a distinction between musical encoding schemes and the input process itself. A stream of input code, once it has been entered into the computer, is actually a form of internal representation.

Internal representations can be divided into four broad classifications. For reference purposes, these may called music/ASCII-code, music/logical, music/parametric, and music/graphic. A possible fifth category, music/acoustic, is outside the scope of the current discussion. The distinction between these classifications is not totally precise, since the representation of musical notation in the computer is itself an abstract concept. The above classification is really an attempt to provide a framework for thinking about the various stages of musical data representation as the data moves from the input process to the various output processes of display, printing, analysis and sound.

The first classification, *music/ASCII-code*, covers musical encoding systems of the type discussed earlier in this article. What makes encoding schemes different from other kinds of internal representation is that most encoding schemes take the form of unstructured character strings. The *music/logical* form of representation is best described as an encoding scheme that has been organized into logical records. In this form, it closely represents the logical meaning of the musical score itself. The next stage of representation, *music/parametric*, includes all the information of the music/logical representation but presents this data as a list of objects (notes, rests, beams, etc.) whose attributes are described in terms of specified parameters. Data in this form is well suited for editing, since the parameters are easy to get at and change. Most music printing programs process their data in this form. The final stage (when moving toward music printing) is *music/graphic*. This form of representation is closely related to the actual printing process. Examples might include font-lists with X-Y coordinates or strings of redefined ASCII characters which translate directly into music graphics.

The first musical example, submitted by Stephen Dydo, is a two-measure excerpt of keyboard music with some unusual rhythmic properties. The first measure sets eighth-note triplets against regular eighth notes. The second measure has a ratio of five written eights in the time of three metric eights. The excerpt is represented as a DARMS string and also in music/parametric form. The parameters are closely related to the DARMS code. The first parameter signals what kind of musical object is being described. E = eighth note; Q = quarter note, H = half note, / = bar line, & = marker and R = ratio designator. The parameters for notes include the horizontal coordinate, the vertical position on the staff, accidental signs (if any) and their horizontal placement, stem direction and beaming information.

The second example, representing the SCORE system of Leland Smith, shows the first two measures of J. S. Bach's sonata for solo violin in A minor, BWV 1003. Special problems of interest in this example include the shifting of various characters to aviod overstriking, the complexity of the beam structures, the placement of five thirty-second notes in the time of one eighth (measure 1) and the shape and placement of the slurs. The input code is given for the top line only and consists of three passes: for pitch, for duration, and for beams and ties. Like the previous example, the internal representation is of the music/parametric type. The first parameter indicates the nature of the musical object being described: 1 = note, 5 = slur or tie, and 6 = beam. In the case of notes, the remaining parameters provide information about staff number, the horizontal displacement, the vertical position, the stem direction and accidental, the type of note (white or black), the note's rhythmic value (1.00 = quarter note), the extension of stem length, and other types of descriptive information. Parameters for beams indicate start and stop points as well as the number and placement of secondary beams.

The third example, submitted by the Ohteru group at Waseda University in Japan, includes such special features as fingerings for the notes and indications of dynamics and articulation. The representation belongs to the music/logical type. It consists of a list of data records organized according to the logical structure of the music. In comparison to the previous two examples, the representation provides less descriptive information about the placement of musical notes, beams and slurs. The computer would be expected to calculate this extra information as part of the process of printing the musical example. In so doing, a parametric list similar to those shown above would be created.

The fourth example is one of the musical excerpts sent out for music printing by the Center. The internal representation, as well as the printed result, were offered by Armando Dal Molin. According to Dal Molin's description, the input process is based on a protocol called PCS (for Pitch, Character, Space), where the Y-coordinate of a notational object is provided by the "pitch attribute," and information on the object itself is provided by the character. The X-coordinate is advanced to the right by successive taps of the space bar; one tap for the smallest metric unit of the line, two taps for the next higher value and so on for each increment of meter. The internal representation achieved by this method is extremely compact. It is also difficult to decipher, if one is unfamiliar with the system. The representation shown in the example is a "hex dump," with each pair of characters representing one byte of information.

The fifth example, provided by Kurt Hebel at the University of Illinois, shows a representation in the OPAL music language, which was developed at Illinois as part of the Interactive Music System. This language, which is used to create, edit and prepare music for printing or for playback, can also function as a representation system on its own. The representation is a good example of the music/logical type. It is versatile and compact, easy to read and understand. The program that prints music from the OPAL representation makes several passes through the data, gathering information and storing it in temporary nodes linked to the main data structure. This process is equivalent to building a parametric data list for the various musical events to be represented.

The sixth example shows two of the internal representations in use at CCARH. The representations are for pitch and duration only. The first representation, a music/logical type, shows the first seven measures of Bach's fugue in E-flat, BWV 852, from the first book of the *Well-Tempered Clavier*. The three voices of the fugue are stored in separate files. Each file has its own "header" containing information about the piece and defining the internal parameters of the file. As a data structure, the design is quite crude, but the information is clearly represented and easy to read and edit, if necessary. The second representation, which is of the music/parametric type and is for the top voice only, was generated directly from the data on the preceding page as a first step to printing out the top voice as shown.

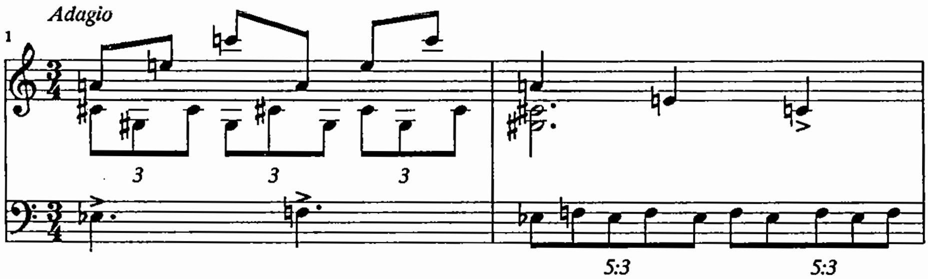
The seventh example, provided by Lelio Camilleri, shows the TELETAU representation for the Bach fugue used in example 6. Like the previous system, the representation covers pitch and duration only. While the musical data represented in the two systems are identical, the TELETAU representation does not organize the data into logical records based on the structure of the music itself. It is basically a series of ASCII strings, broken up into fixed lengths and terminated by semicolons. It is a good example of the music/ASCII-code type of representation.

The representation systems described above are but a small sample of the work that has been done in this area. The MIPS committee [see p. 77], which has been convened to examine various aspects of the problem of the communication of musical information in machine-readable form, has compiled an impressive library of publications and other documents on the subject. The problem of communication does not seem as severe for music scholars as it does for publishers and commercial system and software developers. This is because scholars are more willing to share information about how their systems work. The amount of information on representation collected by the Center and reported in this article is a testimony to scholars' willingness to explain their procedures. The principles of music representation for most applications of interest to scholars are actually quite simple and straightforward, as the examples of encoding systems show. For more advanced applications such as music printing, such open systems as DARMS and MUSTRAN provide excellent vehicles for the input and communication of music. Only a small percentage of respondents to the Center's questionnaire indicated the use of commercial software for their research. While the work of the MIPS committee is extremely important and the benefits to be gained from a standard language for music representation are tremendous, scholars fortunately do not need to wait for this work to be completed before attempting to exchange musical data. Current methods of representation, when adequately explained, will serve the purpose admirably.

Illustration 1

Music Representation -- 1
DARMS

Musical example:



Input code:

```
 !I1 !G,!F !M3:4,18@\40\Adagio$ !& !U 4*E( 8*) 13*( 4) 8( 13) / 4*Q 1* -1* > /
& !D !R3 -1#E( -4#,-14@\66\3$ -1) -4( -1#,-14@3$ -4) -1( -4,-14@3$
-1) $R / -1#H.,-4#. / $& $D !-50
!M3:4 6-Q.> 7*Q.> / !R5 6-E( 7* 6,-4@5:3$ 7 6) 7( 6 7,-4@5:3$ 6 7) /
```

Principles of encoding:

1. Pitch and register: in DARMS pitch is encoded purely by identifying (a) clef and (b) staff position [bottom line = 21, top line = 29]. The tens digit is commonly suppressed.
2. Duration: represented by capital letters [W = whole, H = half, R = rest].

Information and example provided by Stephen Dydo

Internal representation:

```
      SAM3.SPA
  1:  999    |    257|   0    0|   1   0|    G   3|     1 0|   1440
  2:  M      |     68|   0    0|   0   0|    3   0|   4   0|  0   0
  3:       @|     88|  18    0|   A   d|    a   g|   i   o|
  4:  &      |      0|   0    0|       0|    0   0|   1   0|     0
  5:  E     N|    136|   4    0|   *  20|   85   0|   1   0|      0
  6:  E     N|    246|   8    0|   *  20|   85   0|  -1   0|      0
  7:  E     N|    348|  13    0|   *  20|   85   0|   1   0|      0
  8:  E     N|    458|   4    0|       0|   85   0|  -1   0|      0
  9:  E     N|    560|   8    0|       0|   85   0|   1   0|      0
 10:  E     N|    662|  13    0|       0|   85   0|  -1   0|      0
 11:  /      |    764| 999    0|   0   0|  -50   0|       2|  0   0
 12:  Q     N|    824|   4    0|   *  20|   85   0|   0   0|      0
 13:  Q     N|   1033|   1    0|   *  20|   85   0|   0   0|      0
 14:  Q     N|   1241|  -1    0|   *  20|   85   0|   0   0|      0
 15:  O      |   1241| 999    0|   >    |        |        |
 16:  /      |   1440| 999    0|   0   0|  -50   0|       3|  0   0
 17:  &      |      0|   0    0|       0|    0   0|   1   0|     0
 18:  R      |      2|   3    0|       0|    0   0|   0   0|      0
 19:  E     N|    136|  -1    0|   #  20|   68   0|   1   0|      0
 20:  E     N|    203|  -4    0|   #  20|   68   0|   0   0|      0
 21:       @|    203| -14    0|   3    |        |        |
 22:  E     N|    289|  -1    0|       0|   68   0|  -1   0|      0
 23:  E     N|    348|  -4    0|       0|   68   0|   1   0|      0
 24:  E     N|    415|  -1    0|   #  20|   68   0|   0   0|      0
 25:       @|    415| -14    0|   3    |        |        |
 26:  E     N|    501|  -4    0|       0|   68   0|  -1   0|      0
 27:  E     N|    560|  -1    0|       0|   68   0|   1   0|      0
 28:  E     N|    619|  -4    0|       0|   68   0|   0   0|      0
 29:       @|    619| -14    0|   3    |        |        |
 30:  E     N|    705|  -1    0|       0|   68   0|  -1   0|      0
 31: 'R      |      1|   1    0|       0|    0   0|   0   0|      0
 32:  /      |    764| 999    0|   0   0|  -50   0|       2|  0   0
 33:  H     N|    824|  -4    0|   #  36|   68   0|   0   0|      1
 34: -H     N|    824|  -1    0|   #  20|   68   3|   0   0|  0
 35:  /      |   1440| 999    0|   0   0|  -50   0|       3|  0   0
 36:  999    |    513|   0    0|   1   0|    F   7|     1 0|   1440
 37:  M      |     68|   0    0|   0   0|    3   0|   4   0|  0   0
 38:  Q     N|    136|   6    0|   -  20|    0   0|   0   0|      1
 39:  O      |    136| 999    0|   >    |        |        |
 40:  Q     N|    458|   7    0|   *  20|    0   0|   0   0|      1
 41:  O      |    458| 999    0|   >    |        |        |
 42:  /      |    764| 999    0|  50   0|    0   0|       2|  0   0
 43:  R      |      3|   5    0|       0|    0   0|   0   0|      0
 44:  E     N|    824|   6    0|   -  20|   68   0|   1   0|      0
 45:  E     N|    889|   7    0|   *  20|   68   0|   0   0|      0
 46:  E     N|    946|   6    0|       0|   68   0|   0   0|      0
 47:       @|    946|  -4    0|   5   :|    3    |        |
 48:  E     N|   1003|   7    0|       0|   68   0|   0   0|      0
 49:  E     N|   1080|   6    0|       0|   68   0|  -1   0|      0
 50:  E     N|   1137|   7    0|       0|   68   0|   1   0|      0
 51:  E     N|   1194|   6    0|       0|   68   0|   0   0|      0
 52:  E     N|   1271|   7    0|       0|   68   0|   0   0|      0
 53:       @|   1271|  -4    0|   5   :|    3    |        |
 54:  E     N|   1328|   6    0|       0|   68   0|   0   0|      0
 55:  E     N|   1384|   7    0|       0|   68   0|  -1   0|      0
 56:  /      |   1440| 999    0|  50   0|    0   0|       3|  0   0
```

Illustration 2

Music Representation -- 2
SCORE

Musical example:

Input code:

```
IN 1 0 0 .8
2 200 1
SU/TR/T99 1/PA3:A4:C:E/GS3/F5/E/D/C/B/A//GS/A///B/C/D/E//M/
F/E/D/C/B//A/GS/A/GS/FS/E/DN/FN/E/D/C/D/B/M;
Q/32///64//S////E/S/40X5/S/S./32/S/32//E/
32//S/E/S//S./32X4/64/;
TR 7 25 28;
2B;
3 8/11 +12/13 18/22 23/24 +25/29 30/32 37;
```

Principles of encoding:

1. Pitch and register: pitch and register are encoded using letter name and octave number respectively.
2. Duration: represented in a separate pass (here, lines 5 and 6) using both letters and numbers (Q = quarter, 32 = 32nd note), with a '/' for repetition.

Information and example provided by Leland Smith

Internal representation:

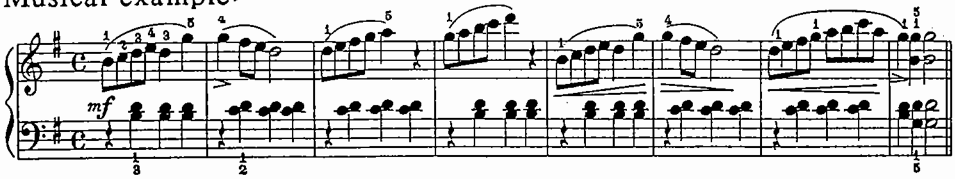
```
8. 3.  .000   7.00   .60
3. 3.  1.376
18. 3.  8.523   .00  99.00   1.00
1. 3. 13.450  -1.00  10.00   .00   1.00   .00   .00   1.30
1. 3. 13.450   6.00  10.00   .00   .00   .00   .00   .90
1. 3. 13.450   8.00  10.00   .00   .00   .00   .00   .40
1. 3. 13.450  10.00  10.00
1. 3. 24.243  -2.00  12.00   .00   .13  15.20   .00
6. 3. 24.243  13.20  13.20  46.80  12.00   .00   .00  21.00  24.24  38.40  31.00  35.70  38.40
1. 3. 28.061  11.00  10.00   .00   .13   2.20   .00
5. 3. 28.061   8.00   4.00  46.80  -3.10  -1.00
1. 3. 31.880  10.00  10.00   .00   .13   3.20   .00
1. 3. 35.699   9.00  10.00   .00   .06   4.20   .00
1. 3. 38.399   8.00  10.00   .00   .06   5.20   .00
1. 3. 41.099   7.00  10.00   .00   .25   6.20   .00   .00  20.00
1. 3. 46.796   6.00  10.00   .00   .25   7.20   .00
1. 3. 52.492   6.00  10.00   .00   .25   .00   .00
6. 3. 52.492   6.00   6.00  63.92  11.00   .00   .00  11.00  52.49  58.22
1. 3. 52.492   4.00  20.00   .00   .00   -.50   1.00
1. 3. 58.224   5.00  12.00   .00   .25   1.00   .00
1. 3. 63.920   6.00  10.00   .00   .50   .00   .00
5. 3. 63.920   6.60   6.60  72.43   1.19  -2.00
2. 3. 63.920  -6.00   1.00
1. 3. 72.434   6.00  10.00   .00   .25   4.60   .00
6. 3. 72.434  10.60  10.60  94.93  12.00   .00   .00  21.00  78.13  91.57
1. 3. 72.434   3.00  20.00   .00   .00   -.50   1.00
1. 3. 78.131   6.00  10.00   .00   .10   4.60   .00
5. 3. 78.131   4.00   8.00  94.93  -1.75  -1.00
1. 3. 81.490   7.00  10.00   .00   .10   3.60   .00
1. 3. 84.849   8.00  10.00   .00   .10   2.60   .00
1. 3. 88.208   9.00  10.00   .00   .10   1.60   .00
1. 3. 91.567  10.00  10.00   .00   .10   .60   .00
1. 3. 94.926  10.00  10.00   .00   .25   .60   .00
14. 3. 100.644   1.00
1. 3. 104.514  11.00  10.00   .00   .38   1.60  10.13
6. 3. 104.514  12.60   8.60  125.10  12.00   .00   .00  21.00   .00  111.76  21.00  121.28  125.10
1. 3. 104.514   2.00  20.00   .00   .00   -.50   1.00
1. 3. 104.514   6.00  10.00   .00   .00   -.50   1.00   .80
1. 3. 111.764  10.00  10.00   .00   .13   1.19   .00
1. 3. 115.583   9.00  10.00   .00   .25   1.45   .00
2. 3. 115.583  -6.00   1.00
1. 3. 121.280   8.00  10.00   .00   .13   1.34   .00
5. 3. 121.280   5.60   4.30  125.10  -1.21  -1.00
1. 3. 125.099   7.00  10.00   .00   .13   1.60   .00
5. 3. 128.610   8.50   7.80  138.71   1.13  -2.00
1. 3. 128.917   7.00  10.00   .00   .50   1.60   .00
6. 3. 128.917   8.60   7.60  145.45  11.00   .00   .00  11.00  137.43  145.45  21.00  137.43  141.63
1. 3. 128.917   2.00  22.00   .00   .00   -.50   1.00
1. 3. 137.431   6.00  10.00   .00   .13   2.09   .00   .00  20.00
2. 3. 137.431  -6.00   1.00
1. 3. 141.631   5.00  12.00   .00   .13   2.83   .00
1. 3. 145.450   6.00  10.00   .00   .25   1.60   .00
1. 3. 151.181   5.00  12.00   .00   .50   .00   .00   .00  20.00
6. 3. 151.181   5.00   3.00  165.43  11.00   .00   .00  11.00  159.73  165.43
1. 3. 159.730   4.00  12.00   .00   .25   -.20   .00
5. 3. 159.730   2.00   1.00  165.43  -1.23  -1.00
1. 3. 165.427   3.00  10.00   .00   .25   .00   .00
1. 3. 171.158   2.00  13.00   .00   .38   4.20  10.00
```

Illustration 3

Music Representation -- 3
Waseda University:
Automatic Translation of Printed Music into Braille

Waseda University has two representation systems. The one shown here from the Braille music system, serves the functions of performance, score display, and music editing.

Musical example:



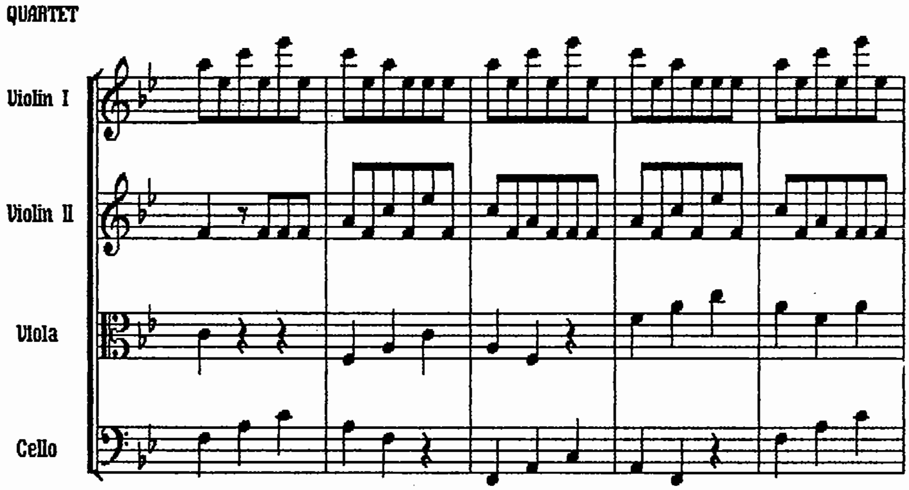
Internal representation:

```
/* Note: Words between '/*' and '*/' are remarks. */
/* Characters 'p' and 'm' are indicators for 'parallel' and 'measure' */
/* 00 = (........), ff = (11111111) */

        /* Every parallel consist of 1 bar, 2 line */
p m 00 00                /* 1st bar */
        a0 01 01 00 00           /* G clef */
        a0 02 01 00 00           /* key signature */
        a0 03 00 01 00           /* time signature */
        c0 11 00 00 00           /* mezzo forte */
        b0 11 01 00 00           /* beginning of slur */
        47 11 00 00 (..1.....)   /* 4th octave, B: 8th note: finger 1 */
        51 11 00 00 (.1......)   /* 5th octave, C: 8th note: finger 2 */
        52 11 00 00 (.11.....)   /* 5th octave, D: 8th note: finger 3 */
        53 11 00 00 (1.......)   /* 5th octave, E: 8th note: finger 4 */
        52 12 00 00 (.11.....)   /* 5th octave, D: 4th note: finger 3 */
        b0 11 80 00 00           /* end of slur */
        55 12 00 00 (1.1.....)   /* 5th octave, G: 4th note: finger 5 */
  m 00 01
        a0 01 03 00 00
        a0 02 01 00 00
        a0 03 00 01 00
        00 12 00 00 00           /* quarter rest */
        37 12 80 00 (.11.....)   /* 3rd octave, B: quarter chord: finger 3 */
        42 12 00 00 (..1.....)   /* 4th octave, D: quarter note: finger 1 */
        37 12 80 00 (........)   /* 3rd octave, B: quarter chord */
        42 12 00 00 (........)   /* 4th octave, D: quarter note */
        37 12 80 00 (........)   /* 3rd octave, B: quarter chord */
        42 12 00 00 (........)   /* 4th octave, D: quarter note */
p m 00 00                /* 2nd bar */
        a0 01 01 00 00
        a0 02 01 00 00
        b0 11 01 00 00
        55 12 00 (..1.....) (1.......)  /* note with accent */
        54 11 00 00 (........)
        53 11 00 00 (........)
        b0 11 80 00 00
        52 14 00 00 (........)
  m 00 01
        a0 01 03 00 00
        a0 02 01 00 00
        00 12 00 00 00
        41 12 80 00 (.1......)
        42 12 00 00 (..1.....)
        41 12 80 00 (........)
        42 12 00 00 (........)
        41 12 80 00 (........)
        42 12 00 00 (........)
```


Example and information supplied by the Ohteru group (Waseda University)

Illustration 4

Music Representation -- 4
Musicomp Terminal Entry System

Musical example:

Internal representation:

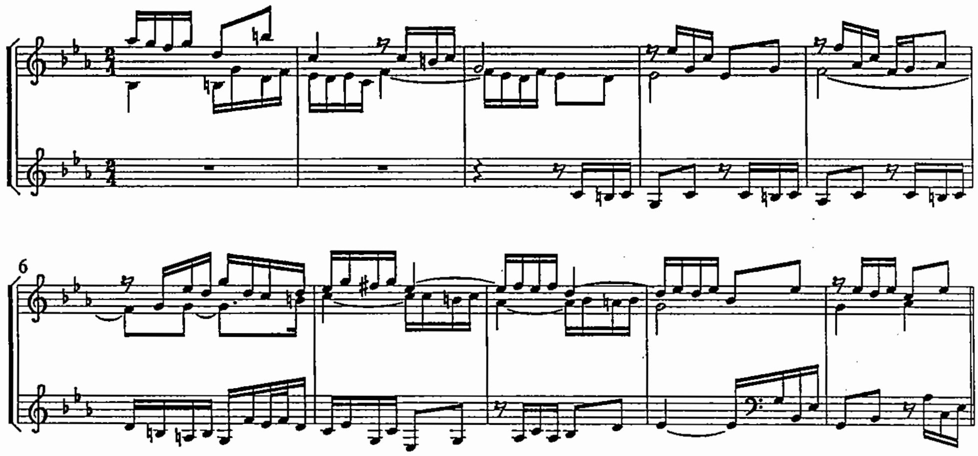
```
1B2F:8000   08 21 99 F0 95 68 81 20-98 68 81 20 99 5E 99 F0
1B2F:8010   95 68 81 20 98 68 81 20-99 5E 99 F2 94 68 81 20
1B2F:8020   97 68 81 20 99 5E 99 F1-93 68 81 20 96 68 81 20
1B2F:8030   99 5E 96 1E 99 24 99 24-81 20 A3 7F A3 1B 51 55
1B2F:8040   41 52 54 45 54 1B 81 20-94 7F 94 1B 56 69 6F 6C
1B2F:8050   69 6E 20 49 1B 81 20 98-2D 9B 6D 82 20 98 6D 82
1B2F:8060   20 9D 6D 82 20 98 6D 82-20 9F 6D 82 20 98 6D 98
1B2F:8070   2D 82 20 99 7C 99 70 82-20 98 2D 9D 6D 82 20 98
1B2F:8080   6D 82 20 9B 6D 82 20 98-6D 82 20 98 6D 82 20 98
1B2F:8090   6D 98 2D 82 20 99 7C 99-70 82 20 98 2D 9B 6D 82
1B2F:80A0   20 98 6D 82 20 9D 6D 82-20 98 6D 82 20 9F 6D 82
1B2F:80B0   20 98 6D 98 2D 82 20 99-7C 99 70 82 20 98 2D 9D
1B2F:80C0   6D 82 20 98 6D 82 20 9B-6D 82 20 98 6D 82 20 98
1B2F:80D0   6D 82 20 98 6D 98 2D 82-20 99 7C 99 70 82 20 98
1B2F:80E0   2D 9B 6D 82 20 98 6D 82-20 9D 6D 82 20 98 6D 82
1B2F:80F0   20 9F 6D 82 20 98 6D 98-2D 82 20 98 7C 99 70 99
1B2F:8100   0D 9A 24 81 20 9A 7F 94-1B 56 69 6F 6C 69 6E 20
1B2F:8110   49 49 1B 81 20 81 20 92-2C 82 20 82 20 96 72 82
1B2F:8120   20 92 3D 92 2C 82 20 92-2C 82 20 92 2C 92 3D 82
1B2F:8130   20 99 7C 9A 70 82 20 98-3D 94 2C 82 20 92 2C 82
1B2F:8140   20 96 2C 82 20 92 2C 82-20 98 2C 82 20 92 2C 92
1B2F:8150   3D 82 20 99 7C 9A 70 82-20 96 3D 96 2C 82 20 92
1B2F:8160   2C 82 20 94 2C 82 20 92-2C 82 20 92 2C 82 20 92
1B2F:8170   2C 92 3D 82 20 92 7C 9C-70 82 20 98 3D 94 2C 82


1B2F:8180   20 92 2C 82 20 96 2C 82-20 92 2C 82 20 98 2C 82
1B2F:8190   20 92 2C 92 3D 82 20 92-7C 9A 70 82 20 96 3D 96
1B2F:81A0   2C 82 20 92 2C 82 20 94-2C 82 20 92 2C 82 20 92
1B2F:81B0   2C 82 20 92 2C 92 3D 82-20 92 7C 9A 70 99 0D 9A
1B2F:81C0   24 81 20 9A 7F 94 1B 20-56 69 6F 6C 61 1B 81 20
1B2F:81D0   81 20 95 6D 82 20 82 20-95 79 82 20 82 20 95 79
1B2F:81E0   82 20 82 20 95 7C 9A 70-82 20 91 2C 82 20 82 20
1B2F:81F0   93 2C 82 20 82 20 95 6D-82 20 82 20 95 7C 9A 70
1B2F:8200   82 20 93 2C 82 20 82 20-91 2C 82 20 82 20 95 79
```

Example and hexadecimal representation supplied by Armando Dal Molin

Illustration 5

Music Representation -- 5
Interactive Music System

Musical example:



Principles of representation:

The music is entered from an electronic keyboard with a metronome. The resulting file contains data that has been automatically interpreted. Each "event" has three components: octave specification (numerical), pitch name (lower case letter), and duration (numerical). Numbers are not reiterated when there is no change from the preceding event.

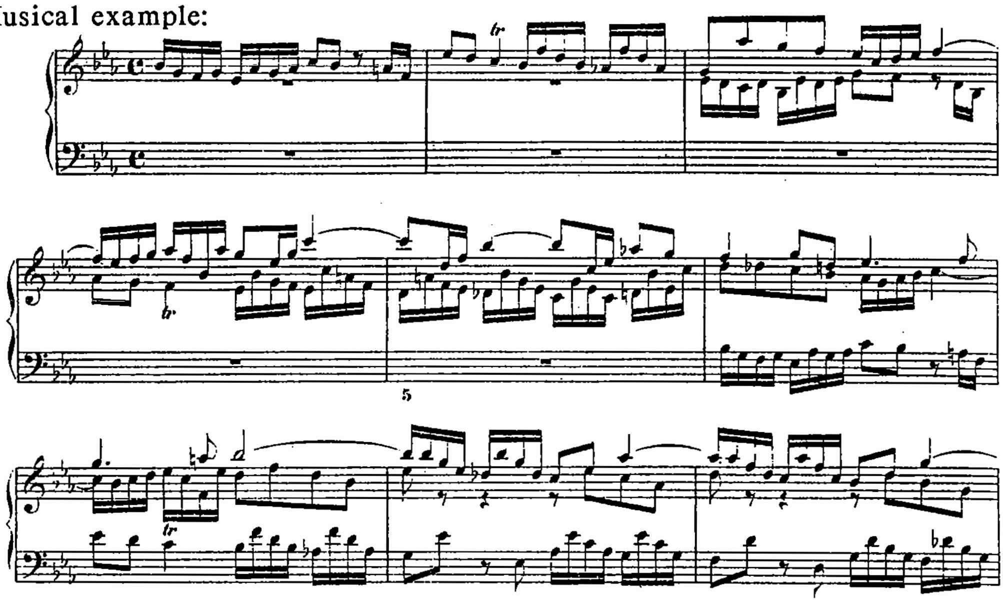
Information and example provided by Kurt Hebel

OPAL source code:

```
staff   s
staff   a
staff   b
s:      treble key c minor
a:      treble key c minor
b:      treble key c minor
time    2,4
tempo   72,4
*
*
measure 1
format  systems 1,6
print   (s,a),b
s:      5a16 g f g d8 bn
a:      3b4 bn16 4g d f
b:      r2
measure 2
s:      5c4 r16 c 4bn 5c
a:      4e16 d e c f4t
b:      r2
measure 3
s:      4g2
a:      4f16 e d f e8 d
b:      r4 r16 4c 3bn 4c
measure 4
s:      r16 5e 4g 5c 4e8 g
a:      4e2
b:      3g8 4c r16 c 3bn 4c
measure 5
s:      r16 5f 4a 5c 4f g a8
a:      4f2t
b:      3a8 4c r16 c 3bn 4c
measure 6
s:      r16 4g 5e d g d c d
a:      4f8 gt g8d bn16
b:      4d16 3bn an b g 4f e32 f d16
measure 7
s:      5e16 g f+ g e4t
a:      5c4t c16 c 4bn 5c
b:      4c16 e 3g 4c 3e8 g
measure 8
s:      5e16 f e f d4t
a:      4a4t a16 b an b
b:      r16 3a 4c 3a b8 4d
measure 9
s:      5d16 e d e 4b8 5e
a:      4g2
b:      4e4t e16 bass 3g 2b 3e
measure 10
s:      r16 5e d e c8 e
a:      4g4 a
b:      2g8 b r16 3a c e
```

Illustration 6

Music Representation -- 6
CCARH

Musical example:

Logical representation of keyboard input:

```
852    2
Kalmus/Bisch
off 1883

3 1
37 -3 16 4
4 4 0 1    2
measure 1
Bf4    1
G4     1
F4     1
G4     1
Ef4    1
Af4    1
G4     1
Af4    1
C5     2
Bf4    2
rest   2
A4     1
F4     1
measure 2
Ef5    2
D5     2
C5     4
Bf4    1
F5     1
D5     1
Bf4    1
Af4    1
F5     1
D5     1
Af4    1
measure 3
G4     2
Af5    2
G5     2
F5     2
Ef5    1
C5     1
D5     1
Ef5    1
F5     4-
measure 4
F5     1
Ef5    1
F5     1
G5     1
Af5    1
F5     1
Bf4    1
Af5    1
G5     2
Ef5    1
G5     1
C6     4-
measure 5
C6     2
D5     1
F5     1
Bf5    6
C5     1
Ef5    1
Af5    2
G5     2
measure 6
F5     4
G5     2
D5     2
Ef5    6
F5     2
measure 7
G5     6
A5     2
Bf5    8-
 .
 .
 .
```

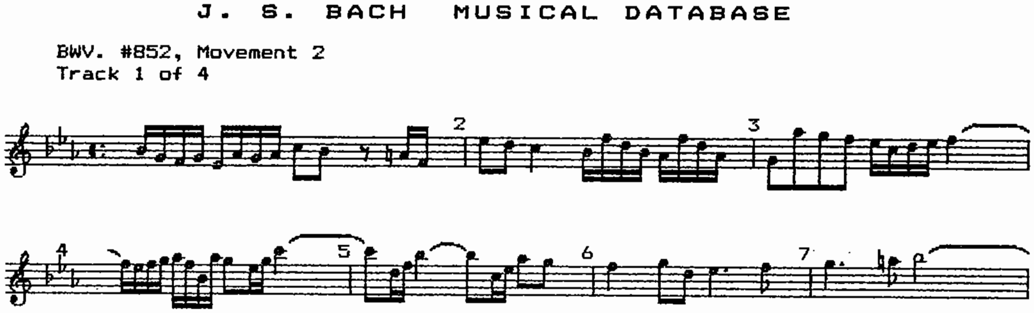
```
852    2
Kalmus/Bisch
off 1883

3 2
37 -3 16 4
4 4 0 1    2
measure 1
rest 16
measure 2
rest 16
measure 3
Ef4    1
D4     1
C4     1
D4     1
Bf3    1
Ef4    1
D4     1
Ef4    1
G4     2
F4     2
rest   2
D4     1
Bf3    1
measure 4
Af4    2
G4     2
F4     4
Ef4    1
Bf4    1
G4     1
F4     1
Ef4    1
C5     1
A4     1
F4     1
measure 5
D4     1
A4     1
F4     1
Ef4    1
Df4    1
Bf4    1
G4     1
Ef4    1
C4     1
G4     1
Ef4    1
C4     1
D4     1
Bf4    1
Ef4    1
C5     1
measure 6
D5     2
Df5    2
C5     2
Bf4    2
Af4    1
G4     1
Af4    1
Bf4    1
C5     4-
measure 7
C5     1
Bf4    1
C5     1
D5     1
Ef5    1
C5     1
G4     1
Ef5    1
D5     2
F5     2
D5     2
Bf4    2
 .
 .
 .
```

```
852    2
Kalmus/Bisch
off 1883

3 3
37 -3 16 4
4 4 1 1    2
measure 1
rest 16
measure 2
rest 16
measure 3
rest 16
measure 4
rest 16
measure 5
rest 16
measure 6
Bf3    1
G3     1
F3     1
G3     1
Ef3    1
Af3    1
G3     1
Af3    1
C4     2
Bf3    2
rest   2
A3     1
F3     1
measure 7
Ef4    2
D4     2
C4     4
Bf3    1
F4     1
D4     1
Bf3    1
Af3    1
F4     1
D4     1
Af3    1
 .
 .
```

Principles of logical representation:

1. Pitch is represented by letter, register by the number immediately following.
2. Representation of duration depends on the meter; here 4 = quarter, 2 = eighth, 1 = sixteenth, etc.

Musical example:



Parametric representation of top voice only:

Internal Represention of Measures 1 -- 7

measure 1									
28	0	1	3	0	0	0	2	25	1
26	0	1	3	0	0	0	3	23	1
25	0	1	3	0	0	0	3	22	1
26	0	1	3	0	0	0	1	23	1
24	0	1	3	0	0	0	2	21	1
27	0	1	3	0	0	0	3	24	1
26	0	1	3	0	0	0	3	23	1
27	0	1	3	0	0	0	1	24	1
29	0	2	4	0	1	0	2	26	2
28	0	2	4	0	1	0	1	25	2
100	0	2	4	0	1	0	0	0	0
27	1	1	3	0	0	0	2	24	1
25	0	1	3	0	0	0	1	22	1
measure 2									
31	0	2	4	0	1	0	2	28	2
30	0	2	4	0	1	0	1	27	2
29	0	4	5	0	2	0	0	26	2
28	0	1	3	0	0	0	2	25	2
32	0	1	3	0	0	0	3	29	2
30	0	1	3	0	0	0	3	27	2
28	0	1	3	0	0	0	1	25	2
27	0	1	3	0	0	0	2	24	2
32	0	1	3	0	0	0	3	29	2
30	0	1	3	0	0	0	3	27	2
27	0	1	3	0	0	0	1	24	2
measure 3									
26	0	2	4	0	1	0	2	23	2
34	0	2	4	0	1	0	3	31	2
33	0	2	4	0	1	0	3	30	2
32	0	2	4	0	1	0	1	29	2
31	0	1	3	0	0	0	2	28	2
29	0	1	3	0	0	0	3	26	2
30	0	1	3	0	0	0	3	27	2
31	0	1	3	0	0	0	1	28	2
32	0	4	5	0	2	1	0	29	2

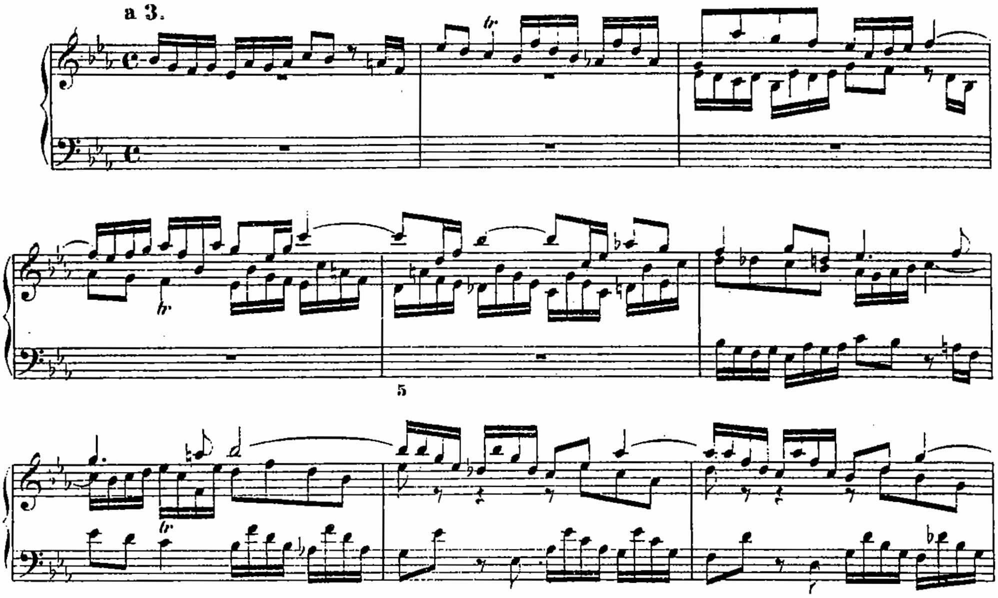
measure 4									
32	0	1	3	0	0	0	2	29	2
31	0	1	3	0	0	0	3	28	2
32	0	1	3	0	0	0	3	29	2
33	0	1	3	0	0	0	1	30	2
34	0	1	3	0	0	0	2	31	2
32	0	1	3	0	0	0	3	29	2
28	0	1	3	0	0	0	3	25	2
34	0	1	3	0	0	0	1	31	2
33	0	2	4	0	1	0	2	30	2
31	0	1	3	0	0	0	3	28	2
33	0	1	3	0	0	0	1	30	2
36	0	4	5	0	2	1	0	33	2
measure 5									
36	0	2	4	0	1	0	2	33	2
30	0	1	3	0	0	0	3	27	2
32	0	1	3	0	0	0	1	29	2
35	0	4	5	0	2	1	0	32	2
35	0	2	4	0	1	0	2	32	2
29	0	1	3	0	0	0	3	26	2
31	0	1	3	0	0	0	1	28	2
34	0	2	4	0	1	0	2	31	2
33	0	2	4	0	1	0	1	30	2
measure 6									
32	0	4	5	0	2	0	0	29	2
33	0	2	4	0	1	0	2	30	2
30	0	2	4	0	1	0	1	27	2
31	0	6	5	1	2	0	0	28	2
32	0	2	4	0	1	0	0	29	2
measure 7									
33	0	6	5	1	2	0	0	30	2
34	1	2	4	0	1	0	0	31	2
35	0	8	6	0	4	1	0	32	2

Principles of parametric representation:

P1 = pitch (diatonic), P2 = accidental, P3 = duration, P4 = note type P5 = dot, P6 = space code, P7 = tie, P8 = beam code, P9 = position on staff, P10 = stem direction

Illustration 7

Music Representation -- 7
TELETAU

Musical example:

Input code:

```
DIVISIONE MUSICOLOGICA DEL CNUCE/C.N.R.
CONSERVATORIO DI MUSICA "L. CHERUBINI" FIRENZE
J.S.BACH  - THE WELL TEMPERED CLAVIER - FUGUE NO. 7 VOL. I -
;
;
!1!  T52  V100  -3 4B.24  G F G E A G A 5C.48 4B P  AN.24  F
5E.48 D C.96 4B.24 5F D 4B A 5F D 4A G.48 5A.48 G F E.24 C D
E F1.20 E.24 F G A F 4B 5A G.48 E.24 G 6C1.44 5D.24 F  B1.44
C.24  E A.48 G F.96 G.48 D E1.44 F.48 G1.44 AN.48 B2.16 B.24
G E DF B G DF C.48 E A1.20
;
!2! T52 V100 (P3.84)2 4E.24 D C D 3B 4E D E G.48 F P D.24 3B
4A.48 G F.96 E.24 B G F E 5C 4AN F D AN F E DF B G E C G E C
D B E 5C D.48 DF C 4B A.24 G A B 5C1.20 4B.24 5C D E C 4F 5E
D.48 F D 4B 5E P1.92 E.48 C 4A
;
!3!  T52 V100 (P1.92)10 3B.24 G F G E A G A 4C.48 3B P AN.24
F 4E.48 D C.96  3B.24 4F D 3B A 4F D 3A G.48 4E.48 P 3E A.24
4E C 3A G 4E C 3G
```

Principles of encoding:

1. Pitch by letter; register by number preceding pitch but suppressed when redundant.

2. Duration by number (96 = quarter, 48 = eighth, 24 = sixteenth, etc.) preceded by period; suppressed when redundant.

Information provided by Lelio Camilleri.

An Inventory of Musical Characters

Compiled by Stephen Dydo

We have focused elsewhere on the variety of work going on toward the development of comprehensive internal data structures. The issue of a vocabulary for musical hard copy has, however, received scant attention. Often the notion of common music notation (or CMN) is invoked, with the assumption that it is a clearly defined structure which may be plugged in at the output stage. However, it would seem that the case is otherwise. Not only is our notational system evolving, but there is as yet no satisfactory codification of the system which, in a consistent way, represented the music of Bach and Webern. Such texts as exist on the subject are incomplete and often erroneous in crucial areas. Software developers, without a standard reference, are left to create fonts and rules for their placement on their own. Experts on engraving practice have, with few exceptions, not been involved in this very difficult process. We may be faced in the future with very powerful music processing systems which will still be unable to approach the quality of music printing available to Brahms.

So severe is this lack of standardization that one cannot even be sure what comprises the minimal symbol set needed for music printing. Thus, the present situation for, *e.g.*, someone programming a musical database system, is very like that of someone programming an on-line dictionary without being really sure of what the elements of the alphabet are. The problems confronting designers of high-quality music printing systems are greater, since their task involves not only the use of a complete symbol set but also a definition of the spatial relationships among the symbols.

A step forward has been made by Adobe Systems with the introduction of the Sonata music font. This symbol set, which has been generally favorably received from the design point of view, has the benefit of the flexibility of size and output device of the PostScript family. The positioning of the symbols is defined in the most general graphical fashion, rather than in terms of the staff. This gives great flexibility, but may lead to mispositioning of some symbols when moving from one device to another. The font set has been seen to be redundant in some areas and deficient in others. However, its very existence has been an important stimulus to discussions of what a minimal symbol set for music should contain.

Last year, we made up a questionnaire with a proposal for a provisional description of a musical font. This proposal, although in a very preliminary form, generated some reponses which have been most helpful in our efforts toward a minimal font description. We would like to thank those who have responded to the questionnaire. Further, it should be noted that the inquiry is still open, and additional comments will be gratefully received.

With the help of these respondents, we have compiled the following list of musical characters in an effort to reach some definition of what is needed to represent music on the printed page. A symbol set containing all such symbols could then be characterized as a complete musical font. Our definition is limited by several factors:

1. The definition of "music" is that "serious" music which falls, very roughly, in the period between the 16th century and the present. It is further limited to that which is printed on a staff.

2. We have ignored symbols which appear primarily in the music of a single composer, or in a specialized repertory. Thus, certain ornamentation symbols typical of French baroque keyboard music do not appear here, nor do many contemporary symbols.

3. Symbols which are functionally, but not graphically, equivalent generally appear here in only one guise. An example of this is the variety of glyphs which form the *segno* referenced by repeat indications. The assumption in these cases is that the designer of a font will pick the version which is most appropriate to the "look and feel" of the overall font.

4. To our best knowledge, a complete font in a given size should also be accompanied by at least one complete font in a significantly smaller size, for cues and editorial additions. The only exceptions to this which we have noted so far are (perhaps) figured bass and fingering numbers, which tend to appear in fewer sizes than the full range of staff sizes (*i.e*, rastral 0 through 8).

5. We assume a complete text font, in an appropriate size, in addition to the symbols listed below. Thus, the only text symbols included in the list are those which are traditionally created from within the music font to differentiate them from the prevailing text font. An example of this is the italic "8" positioned below the G tenor clef. "*D.S.*", set ordinarily with the medium italic set of the prevailing text font, is an example of something we have not included.

6. There are a number of crucial symbols of variable extent, including slurs, ties, beams, crescendos and diminuendos, and stems, which we have also omitted. Such symbols correspond roughly to those which a plate engraver would draw with a graver, rather than punch with his dies. We have not included these symbols in our inventory because they are usually created by a graphic algorithm, rather than from a character description.

We have also solicited information from users on the outer limits of duration and dynamics indications in the standard repertory. In the minimal duration category, Vivaldi and Telemann both provide instances of integral 256th notes (that is, notes that occur directly in the score, not in editorial explanations of proper execution). With regard to dynamic range, examples of *pppppp* can be found in the works of Tchaikovsky and Verdi; examples of *ffff* occur in the works of Tchaikovsky and Stravinsky.

Clefs:

(for changes; cue size:)

Noteheads:

Accidentals:

(for grace notes:)

Flags:

(for grace notes:)

Rests:

Meters: 1 2 3 4 5 6 7 8 9 0 C ¢

Dynamics: p m f s r z

Articulations:

Ornaments: tr

Performance indications:

Repetition symbols:

Tuplet numbers: 1 2 3 4 5 6 7 8 9 0 :

Octaves: 8 15 8 -------

Fingering, figured bass: 0 1 2 3 4 5 6 7 8 9

Barlines:

Brackets, rehearsal boxes:

Stress:

Arrows: ↑ ↓ ← →

(for arpeggios, accidentals):

Chord frames:

Chant symbols:

Examples of concatenation of font elements:

tr + + ♮ + (+) = tr(♮)

+ + 1 + 7 = 17

Music Printing: An Update

Music printing was the major focus of the 1986 *Directory*. The main approaches to computer-based music printing were examined, and two dozen examples from diverse systems were presented. The continued growth of interest in this field has encouraged us to present a new series of examples this year; for an overview of the field, readers should consult the previous volume. The majority of music printing contributions in the current *Directory* are either from systems that have not been represented before or have increased their capabilities since they were last shown.

We have separated contributions into four categories: (1) proprietary systems, (2) commercial systems, (3) software for printing music, and (4) user contributions. All examples in the first three categories were contributed by system developers, whose names are given in parentheses. User contributions may not show off a system's capabilities to best advantage, in that the hardware used may be quite basic; conversely, patient users sometimes extract mileage from particular systems with which they have become highly familiar that developers have failed to display. Proprietary systems are not available for sale. Commercial systems are for sale but require the purchase of dedicated hardware as well as software. The software category represents programs specifically devoted to music printing that run on widely available microcomputers. Potential users should check with developers (whose addresses are listed in the back of this volume) to determine what specific hardware configurations (including memory requirements, graphics cards, interfaces, etc.) may be necessary for their programs.

To facilitate comparison of systems, we distributed a set of musical examples to all the software developers on our mailing list. These examples -- a Bach chorale, the opening bars of a Bach harpsichord prelude, and excerpts from Mozart's clarinet quintet -- were selected to elicit information both about music printing capabilities and about music representation and file structures. The original examples are represented by the first three pages of music shown (Toppan Scan-Note System). For music printing, some particular areas of interest were text underlay and basso continuo figuration (Ex. 1), subtleties of part differentiation, slurs, and fingering (Ex. 2), and accurate representation of transposing parts and ornamentation (Ex. 3). A fourth example was one with no notable printing complexities and has not been reproduced in the printing section. Several developers contributed their versions of all four examples; we have tried to select those examples that best illustrate the range of capabilities of individual systems. We have also reproduced examples of other repertories and material related to special capabilities or personalities of individual systems. Other developers preferred to submit examples of their own choosing. All examples have been reduced 20% from the versions we received, unless otherwise indicated. Material that was still too wide to be shown horizontally has been rotated 90 degrees in preference to reducing it further. The order is random.

Comparisons can be deceptive, since no two products used exactly the same hardware. Stephen Dydo graciously provided printouts of the Bach chorale from both a dot matrix and a laser printer to illustrate how spacing control is affected by hardware capabilities and restraints (both versions were produced from the same data, the same program, and the same music font). The Byrd/Stickney examples illustrate the more subtle differences between a typesetter (Linotronics) and a laser printer (Apple), again using the same data, the same program, and the commercially available Adobe 'Sonata' font. The printing devices used range in price from under $500 to as much as $50,000. Program prices range from under $100 to nearly $1,000. The range of prices for complete systems is from around $10,000 to well above $50,000.

Comparison of the output from similar printers driven by different programs ignores the important question of input methods, which was the main subject of the 1985 *Directory*. Alphanumeric code is the usual method for IBM PC and compatible computers, including the Hewlett Packard, Tandy, and Texas Instruments microcomputers represented in the illustrations. Apple Macintosh and Atari ST systems tend to use MIDI (electronic keyboard) data with graphic icons. The division between code-intensive and sound-and-graphics oriented systems is less distinct than it was a year ago in that some cross-over technology is beginnning to appear: Apple and IBM products or features may be combined in systems designed especially for musical purposes.

Still at issue is the tradeoff between memory requirements and speed of processing. Systems of long standing tend to encode as much information as possible in as little space as possible. Dal Molin's Music Writer, written in assembly language to deal with a hexadecimal code generated by hardware specially designed for the purpose, uses less than 16K of memory. Programs of more recent vintage produce their own decisions on spacing, beaming, stem direction and so forth. This lengthens programs written in high level languages (some for the IBM PC exceed 256K) but reduces the bulk of the data. (As points of reference, one user submitted a single page of a Renaissance chanson that had consumed more than 32K of memory with a commercial music printing program, while DARMS users maintain that enough data to print a symphony can be encoded on one floppy disc. Since 1981, hard disc prices have dropped from $100 per megabyte to $10 per megabyte, and disc size has increased proportionally.) The underlying rationale of play-in systems is quite different: they capture pitch and duration data but may require extensive editing to produce a printed score.

Almost all software developers regard their current versions as incomplete. Some are still implementing such features as slurs, ornaments, and other performance-related refinements. Some are adapting mainframe or dedicated hardware systems to microcomputers. Many are seeking to broaden their hardware base to support a larger number of both microcomputers and printing devices. Some are working on user interfaces (programs to relieve users of the need to become computer experts in order to run programs). Some are adapting existing programs to make use of commercially available fonts, such as Adobe Systems' 'Sonata' font, while others are devising custom fonts. Some are developing libraries of special symbols to handle the markedly different needs of notationally unusual repertories, such as music from the later Middle Ages and the later twentieth century. Some are building provisions into their systems to enable users to devise their own list of recallable symbols.

Cumulative List of Music Encoding and Printing Systems and Products

The following list of music printing and related encoding systems is in alphabetical order, with references to previous descriptions and illustrations. The quantity of information provided here is greater for systems that have not previously been listed but should not be used as a gauge of merit. The systems marked with an asterisk accept work on a contractual basis.

Commercial products that either do not currently support printing of classical music or which have not made samples available for reproduction are not included in this listing, but the Center would like to acknowledge with gratitude the information about such systems that their developers from time to time submit.

ALMA. See **Plaine and Easie.**

ALPHA/TIMES. Commercially available system by Christoph Schnell of input, indexing, storage, and retrieval for Apple microcomputers. ALPHA is a database system originally designed for the Apple ///. TIMES-DB (previously called IRMA), an adaptation for the Macintosh, is a kernel of TIMES (Total Integrated Musicological Editing System), which combines a graphic editor, a text processor, a font editor, and a professional music editor for conventional notation. Input by voice recognition device generates DARMS code. Printing capability for standard, early and recent repertories (in conjunction with Professional Composer, using Apple dot matrix and laser printers). Description, **1986.** Illustrations, **1986, 1987** [#45].

AMADEUS MUSIC SOFTWARE.* Kurt Maas of Munich has made his originally proprietary music printing system commercially available. It is based on a DEC PDP-11 computer, accepts MIDI input, and supports dot matrix printers, plotters, and laser printers and phototypesetters. The programs require a UNIX (or IDRIS) operating system. The user must pay license fees in addition to the purchase price of the system. Amadeus prepares scores for publication by such enterprises as B. Schotts Söhne.

A-R Editions, Inc.* Proprietary system for music printing developed by Thomas Hall using a Data General mainframe, with a Versatec plotter for preliminary drafts and a Mergenthaler Linotron 202 typesetter for finished copy. The music is encoded in a DARMS dialect. Besides producing its own editions, which have been computer-generated for ten years, A-R sets musical examples for numerous journals including that of the American Musicological Society. Illustrations, **1987** [#13, #14].

CCARH. In-house system originally designed for the HP 1000 with an IBYCUS operating system (description **1985**; illustrations **1985** and **1986**). Experimental musical character cartridge for the HP LaserJet; downloadable characters for the LaserJet Plus and LaserJet II. Research on font design in progress.

CODEX. Printing program (Macintosh) for white mensural notation. Reported in **1986.**

(The) Copyist. Software product for the Atari ST sold by Dr. T's. There is also an IBM PC version. This is a synthesizer-oriented product. Illustrations (dot matrix), **1987** [#27, #28]. Laser printing (HP LaserJet Plus), plotter output (HP-GL plotter); HP InkJet also supported. Epson printer compatibility.

Dal Molin. Armando Dal Molin has devoted a lifetime to the challenge of automating music printing. Inventor of the first musical typewriter, he has devised a series of systems that have generally been used under proprietary labels and in production-oriented environments. His **Musicomp** terminal, a custom product with separate keypads for pitch (6 octaves) and other aspects of notation as well as text (128 redefinable characters), in conjunction with an Omnitech laser printer, has been producing roughly 1,000 pages of music a month for almost a decade. Belwin Mills Publishing Corp., a subsidiary of Columbia Pictures, is an active user of this technology. A photograph of the Musicomp terminal appears in *The New Grove Dictionary of Music and Musicians* (1980), **15**, 258. It is described in "A Terminal for Music Manuscript Input," *Computers and the Humanities*, **12**, 287-9. More recent developments and a description of his "pitch-character-space" code are given in a paper he presented in Zurich in October 1986 (copies available from the author). Illustrations, **1987**.

Under the name **The Music Writer**, Dal Molin is currently adapting his system to run on an IBM PC and other 8088 or 80286 microcomputers. Currently, his program provides access to one music and one text font; he plans for two music and four text fonts in the completed product. This directory shows examples of a finished product from his main system [#15] and work in progress towards an adaptation for microcomputers [#37, #38].

DARMS. This is an encoding system, not a printing product (descriptions, **1985** and **1986**), once known as the Ford-Columbia music representation language, after its original benefactor and university setting. First used on IBM mainframes, DARMS code has been used for dedicated printing purposes by Lincoln and Morehen (illustrations, **1986**). Subsets of DARMS code have been used by many others for diverse purposes. DARMS manual (1976) available from Raymond Erickson; revision by McLean planned. Completion of microcomputer software for three-dimensional representation (DARMS 'cube') of formal ('canonical') DARMS by McLean intended for August 1987. DARMS code is used by Stephen Dydo in his printing program, **The Note Processor**.

Deluxe Music Construction Set. Software product for the Macintosh (alternative versions for other microcomputers) developed by Geoff Brown. Illustrations, **1986** (Apple LaserWriter and Linotronics typesetter) and **1987** (Linotronics typesetter; #39, #40).

ETH. The Eidgenössische Technische Hochschule [Swiss Federal Institute of Technology] has under development at its Institut für Informatik in Zurich a research prototype for an interactive editor of complex musical notation. This effort involves the use of an abstract representation of certain features of musical notation. The system is implemented in Modula-2 and runs on a LILITH workstation. Giovanni Müller is the principal investigator. Illustration, **1987** [#44].

FASTCODE. An encoding language (middle and late '70's) derived from the still earlier IML-MIR (early 1970's); both versions originated at Princeton University. Printing capability for white mensural notation partially developed by Thomas Hall. A modified version of the code is currently used by Leeman Perkins (Columbia University) for the Busnois edition. The proprietary system used by A-R Editions* is indebted in a general way, through the work of Thomas Hall, to this system. Descriptions, **1985** and **1986**; illustration, **1985**.

Grawemeyer Industries.* Current users of the system previously developed by **MusiGraph**.

GUIDO. A music learning system oriented toward classroom use for music theory, ear training, and music appreciation. There are Macintosh and IBM PC versions, although the development work was done on the PLATO system. A series of video discs is now available. No music printing capability has been reported. Description, **1986.**

Graphic Notes. Commercial software from Australia for Macintosh-based music printing. Release expected in the last quarter of 1987. The developer is Trevor Richards.

Gregory's Scribe. Printing program for Gregorian chant for the Apple //; hardware component no longer in manufacture. Description, **1985**; also in the *Computer Music Journal* VII/1 (1983).

H-Score. Software from Hybrid Arts for the IBM PC. Synthesizer-oriented. User-created examples submitted but not reproduced.

High Score. Music printing software for the Macintosh, using the PostScript 'Sonata' font. Still under development. Described, **1986 Supplement**, and in the popular press as a joint venture by Kimball Stickney and Don Byrd doing business as Advanced Music Notation Systems. Illustrations, **1987** [#41, #42].

The partnership is now dissolved. Stickney retains the product name; his version will be released by Southworth Music Systems. Byrd retains the company name and is working on a user interface for his product, which will be called **Nightingale** and is designed to work in a number of graphics environments. The program is a derivative of SMUT (see **MUSTRAN**).

IML-MIR. Linked encoding (Intermediary Musical Language) and query (Music Information Retrieved) languages developed at Princeton. See **FASTCODE.**

IMS (Interactive Music System). A PLATO-based system developed over many years at the University of Illinois. Broad capabilities for transcription, screen editing, playback, and printing. Input by alphanumeric code or from synthesizer. Adaptations of the printing system for use with NEC, IBM, and Macintosh microcomputers, the Toshiba P1350 dot matrix printer, and the HP LaserJet series are currently in progress. An associated program, LIME, is a graphic screen editor. OPAL is a language for music description and algorithmic manipulation of scores. Stand-alone version for the Apple Macintosh with a large screen and a MIDI keyboard under development. Descriptions **1985** and **1986**; illustrations **1985, 1986, 1987** [#46]. Revised manual (January 1987) by Lippold Haken and Valerie Schmid; article by Carla Scaletti in the *Computer Music Journal* 9/1 (1985). [For other work at Illinois, see also **NEWNOTE** and **OLDNOTE.**]

IRMA (Information Retrieval for Multiple Musicological Applications). See **ALPHA/TIMES.**

Laffangraff. See **The Music Editor.**

Lasergraphics. Proprietary system. See **Dal Molin.**

LIME. See **IMS.**

McLeyvier. David McLey's McLeyvier system was oriented towards the needs of composers. Its sophisticated graphics were said to be comparable with those of the Mockingbird system. The system is now the property of Syntronics in Toronto and is not in active use for music typography.

MEG (Music Editing and Graphics). Developed in Rome, originally for the Apple //, later adapted to the IBM PC. Some scores published by Universal Edition in Vienna. Description, illustration **1986**. See *ICMC Proceedings 1984*.

Mockingbird. An interactive editor and printing system for musical notation (primarily keyboard music) developed in 1980 at the Palo Alto Research Center (supported by the Xerox Corp). Experimental in nature, the programs (in Mesa) ran on the Xerox 1132 computer and accepted keyboard input. No commercial versions have been made available. Description, **1985**.

music. A music preprocessor for the **troff** typesetting system; operates in a UNIX environment. Under development at Nottingham University (U.K.) by Eric Foxley. Custom language for description of musical scores; custom music fonts work with Chelgraph laser printer. Documentation from the author. Listed, **1986**.

(The) Music Editor. Music printing program by John Laffan for the IBM PC. Description, **1985**; illustrations, **1985** and **1986**.

(The) Music Factory*. Service using software for the IBM PC by Stephen Dydo. (See description for **The Note Processor.**) Listed, **1986**. Forthcoming publications with musical examples from The Music Factory include two Schirmer books, Kerala Snyder's *Buxtehude: Organist at Lübeck* and Glenn Watkins' *Soundings: Music in the Twentieth Century*.

(The) Music Processor. Program by Etienne Darbellay for the Texas Instruments Professional and Business Pro computers. Handles numerous special notations (ligatures, black and white mensural notation), piano reductions, and three sizes of symbols; permits user-defined graphics. Conversion for the IBM PC underway. Descriptions, **1985**, **1986**; illustrations, **1985**, **1986**, **1987** [#21-#23].

(The) Music Writer. IBM PC version of Dal Molin's system for entering and printing music. See **Dal Molin.**

MUSICA. A language for musical encoding used at the University of Padua. Alphanumeric system completed in 1981. Described in *Interface* **11**/1, 1-27.

MUSICODE and MUSICODE/A. Fred T. Hofstetter developed MUSICODE as part of his M.A. thesis at Ohio State University in 1970. It is an alphanumeric encoding system. A revised version by Ann Blombach is called MUSICODE/A.

Musicomp Terminal. See **Dal Molin.**

Musicprinter. Program by Jack Jarrett for printing music with the Apple //+. Illustration, **1986**.

Musicsys 3600. A proprietary system for editing and sound with a music printing capability. Based on the Symbolics 3600, a LISP-based machine; designed by Bernard S. Greenberg. Description, illustration, **1985**.

MusiGraph. A proprietary system for music printing originally developed by William Watkins. The system is now owned by Grawemeyer Industries* in Lexington, KY. The original MusiGraph system generated notational descriptions from a Tandy TRS-80 microcomputer and printed them on a typesetter; beams and slurs were added by hand. The system provides musical examples for the *Journal of Musicology* and scores for a number of music publishers including C. F. Peters (New York).

MusPrint. Music printing program by Keith Hamel for the Macintosh. Illustration, **1986**.

MusScript. Successor to MusPrint. It uses the Postcript 'Sonata' font. Illustration, **1987** [#32].

MUSTRAN. An encoding language originated by Jerome Wenker at Indiana University in the 1960's. Original focus on ethnomusicology. Used as a basis for the development of analytical and instructional capabilities, especially by Dorothy Gross and Gary Wittlich, and for music printing by Donald Byrd. MUSTRAN programs have been run on the IBM PC. SMUT, a plotter notation program in FORTRAN by Byrd, ran on some Indiana University mainframes. No MUSTRAN-based printing capability for microcomputers has been reported.

Byrd's current commercial interest is in developing sophisticated music editing capabilities for Macintosh computers and for Sun and Apollo workstations. He is also taking a position at Princeton University in the autumn of 1987 that entails developing a music printing capability for twentieth-century music using the 'C' language in a UNIX environment.

NEWNOTE and OLDNOTE. Programs developed by L. Rumery at the University of Illinois in *c.* 1980 to encode and print sixteenth-century vocal music in both modern and mensural notation. Designed for the PLATO system (see also **IMS**).

Nightingale. Macintosh-based program for music printing, under development by Donald Byrd. See **High Score, MUSTRAN.**

(The) Note Processor. IBM PC-based program for printing music by Stephen Dydo. Input by DARMS code or mouse. The program runs on IBM PC and compatible microcomputers and supports Toshiba, Epson, and NEC dot matrix printers as well as the HP LaserJet II. Illustrations, **1986, 1987** [#24-#26]. See also **The Music Factory.**

Notepro. A system of encoding used at the University of Illinois by James Beauchamp and others. Synthesis-oriented. Reference manual.

Noteprocessor. Music printing program for the Apple //. Developed by Piero de Berardinis, one of the first to devise a way of playing music directly into a microcomputer (1983); also the founder of the Italian review *Informatica musicale* (1982--). Illustration, **1987** [#30].

Oberon Systems. Oberon's System I* was developed in 1981 and is based on the Hewlett Packard 1000 microcomputer. Oberon offers a fully tested package of current hardware and software tools (for approximately $10,000) that more or less duplicates its own capabilities. It also offers typesetting services and data storage backup. Its System II music font for the HP Vectra and other IBM PC compatibles can be used with any screen editor that allows keying of characters in the font and control characters in the text. Musical files can be excerpted and merged with text files (created with such programs as Memomaker, Wordperfect, and MS Word). Oberon professes a commitment to keeping upgrades compatible with existing products. It is currently engaged in efforts to improve its software for choral music. Illustrations, 1987 [#35, #36].

OLDNOTE. See **NEWNOTE.**

OPAL. See **IMS.**

ORPHEUS. See **IMS.**

Oxford Music Processor. IBM PC-based program for printing music announced by Oxford University Press; not yet released. Input involves redefinition of the keyboard. Supports both dot matrix and plotter output. Derived from a mainframe program by Richard Vendome,* the original version of the OMP has been in active use for setting recent performing editions by OUP and musical examples for Oxford journals such as *Early Music* and *Music and Letters*. Description, 1986; illustrations, 1986, 1987 [#43].

Personal Composer. IBM PC-based music printing program by Jim Miller. Synthesizer-based. PostScript 'Sonata' font for the Apple LaserWriter. Illustrations, 1986, 1987 [#29].

Plaine and Easie. Plaine and Easie is a melodic input code developed by Barry Brook and Murray Gould in the late 1960's. It has been especially widely used for thematic indexing and has also been central to the manuscript cataloguing efforts of RISM Series A projects. ALMA, an extension by Gould, accepts chordal notation. Programs for plotter output of musical notation were developed in the 1970's by Norbert Böker-Heil. Description, 1985, 1986. Illustration, 1986.

Professional Composer. Screen editing and printing program for the Macintosh. Synthesizer-based. Currently in use for the preparation of musical editions by Garland Press. Illustrations, 1986, 1987 [#31].

SCAN-NOTE System. This proprietary system for printing music was designed by Mogens Kjaer and developed in the late 1970's by Dataland ApS in Aarhus, Denmark. It was subsequently sold"to the Japanese firm Toppan and has undergone further development. See **Toppan.**

SCORE. Music printing program for the IBM PC and compatibles derived from **SCORE/MS.** SCORE was scheduled for release by Passport Designs in June 1987. Several sublibraries of symbols for special repertories and accommodation of user-defined symbols are provided. An Apple LaserWriter is currently supported and versions compatible with other printers are currently under development. Illustrations, 1987 [#18-#20].

SCORE/MS. A music printing system developed (in FORTRAN) at Stanford University for the PDP-10 computer and a Versatec plotter in the early '70's by Leland Smith. Many special capabilities for early and recent music as well as standard repertories. Descriptions and illustrations, **1985**, **1986.**

SCRIBE. A system for transcribing, editing, and analysis of early music (through the Renaissance) under development on a DEC VAX at La Trobe University in Australia. Facsimiles in neume or pitch notation use a Houston plotter. Description, **1986.**

Synclavier. A music printing option for the well-known synthesizer called a Synclavier has been offered by New England Digital Corporation since 1982. Three versions have appeared; the third of these, supporting laser printing, has been available for a year. To print music a user needs a Synclavier system, a graphics terminal, proprietary software, and one of seven printers that the system supports. These include a 300-dots-per-inch Dataproducts printer, the Apple LaserWriter, and the Linotronics 100 and 300 (2540 dots per inch). Illustration, **1987** [#16].

The Synclavier music printing option is used by a number of professonal music copying services, including that of Ted Petrosky [#17], whose Symphony Reproductions, Inc., is "engraving" the complete works of Gordon Getty.

TAUMUS. Original name of **TELETAU.**

TELETAU. An integrated system combining a repository of musical data and software for management, analysis, and telecommunications. Initially developed at CNUCE in Pisa and now maintained jointly with the Florence Conservatory. Active research program. No musical printing at present. Library of 800 encoded pieces. Manual available from Pietro Grossi (CNUCE) and Lelio Camilleri (CNUCE; Florence Conservatory). Description, **1986.** Electronic addresses: *MUSIC3@ICNUCEVM* and *CHERU@IFIIDG* [both *BITNET*].

THEME: The Music Editor. IBM PC-based software by Mark Lambert for music printing. Input involves redefinition of QWERTY (standard typewriter) keyboard. Permits mensural notation. Version 3.0 for Epson-compatible dot matrix printers supports incorporation of musical examples in text using PC-Write. Illustrations, **1987** [#33, #34].

TIMES. See **ALPHA/TIMES.**

Toppan Scan-Note System.* A highly evolved system for quality music "engraving" serving the Japanese and European markets since 1983. It uses the **Scan-Note** system originally developed in Denmark. In its current configuration, the system uses a CRT terminal for entering layout information and lyrics, a piano keyboard for entering pitch, and a laser phototypesetter. Toppan Printing Co., Ltd., contracts with major music publishers, such as Bärenreiter Verlag, for whom it prepared a recent volume of the *Neue Mozart Ausgabe* -- the *Divertimenti und Serenaden für Blasinstrumente* (Ser. VII, N. 17). Illustrations, **1987** [#8-#12].

troff. See **music.**

Waseda University. See **Log: Facilities - Toyko.**

Illustration 8

Proprietary Systems -- 1a
Toppan Scan-Note System

Hardware: unidentified host computer, CRT, and electronic keyboard
Software: custom, in 'C'
Printing device: unidentified laser phototypesetter

Unreduced

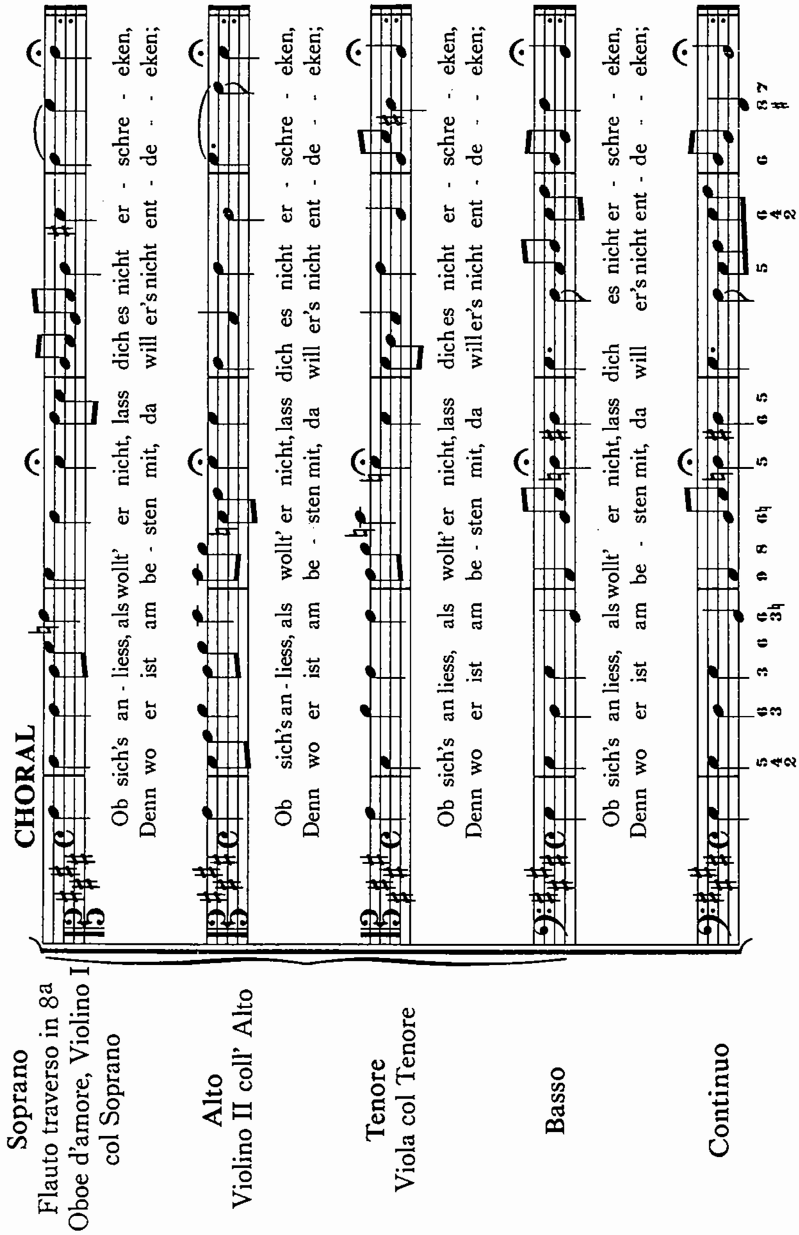



Illustration 9

Proprietary Systems -- 1b
Toppan Scan-Note System

Hardware: unidentified host computer, CRT, and electronic keyboard
Software: custom, in 'C'
Printing device: unidentified laser phototypesetter

Unreduced

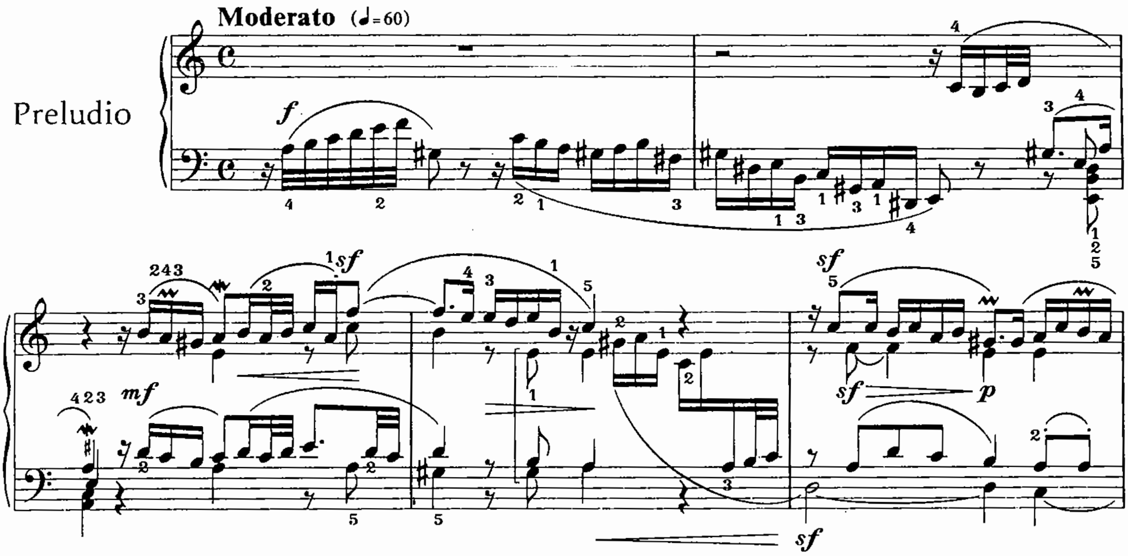


Illustration 10

Proprietary Systems -- 1c
Toppan Scan-Note System

Hardware: unidentified host computer, CRT, and electronic keyboard
Software: custom, in 'C'
Printing device: unidentified laser phototypesetter

Unreduced

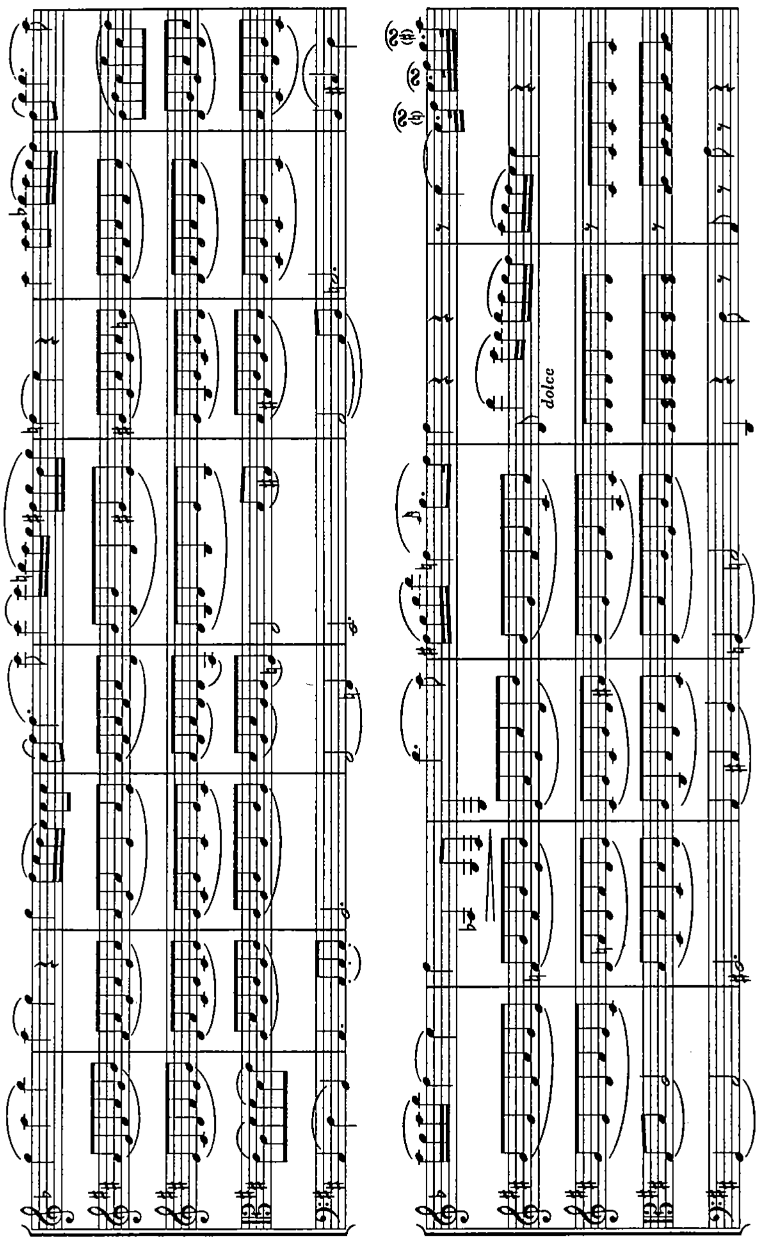


Illustration 11

Proprietary Systems -- 1d
Toppan Scan-Note System

Hardware: unidentified host computer, CRT, and electronic keyboard
Software: custom, in 'C'
Printing device: unidentified laser phototypesetter

Unreduced

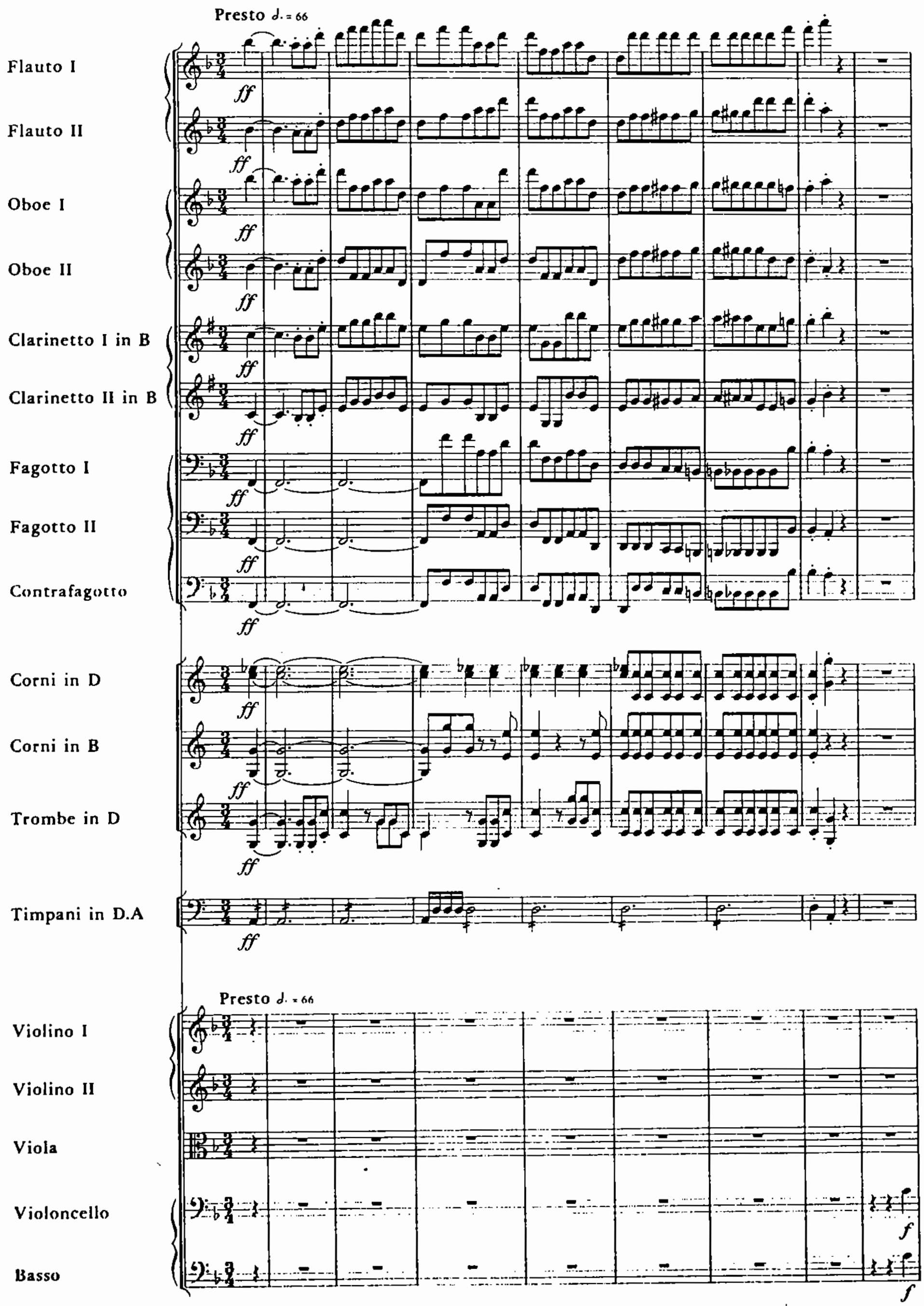



Illustration 12

Proprietary Systems -- 1e
Toppan Scan-Note System

Hardware: unidentified host computer, CRT, and electronic keyboard
Software: custom, in 'C'
Printing device: unidentified laser phototypesetter

Unreduced

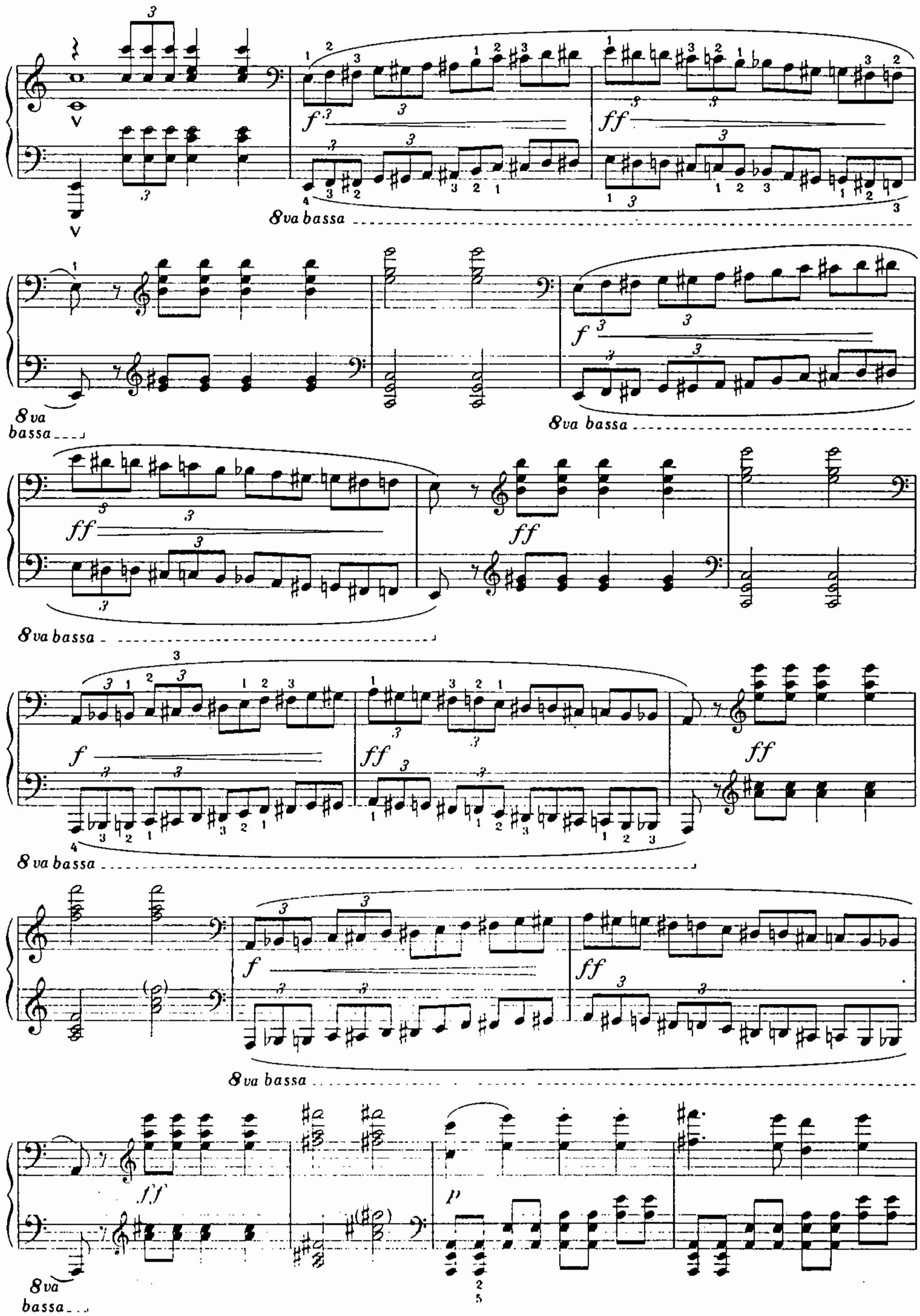



Illustration 13

Proprietary Systems -- 2a
A-R Editions, Inc. (Thomas Hall)

Computer: Data General mainframe
Printing device: Mergenthaler (Linotron) 202 typesetter

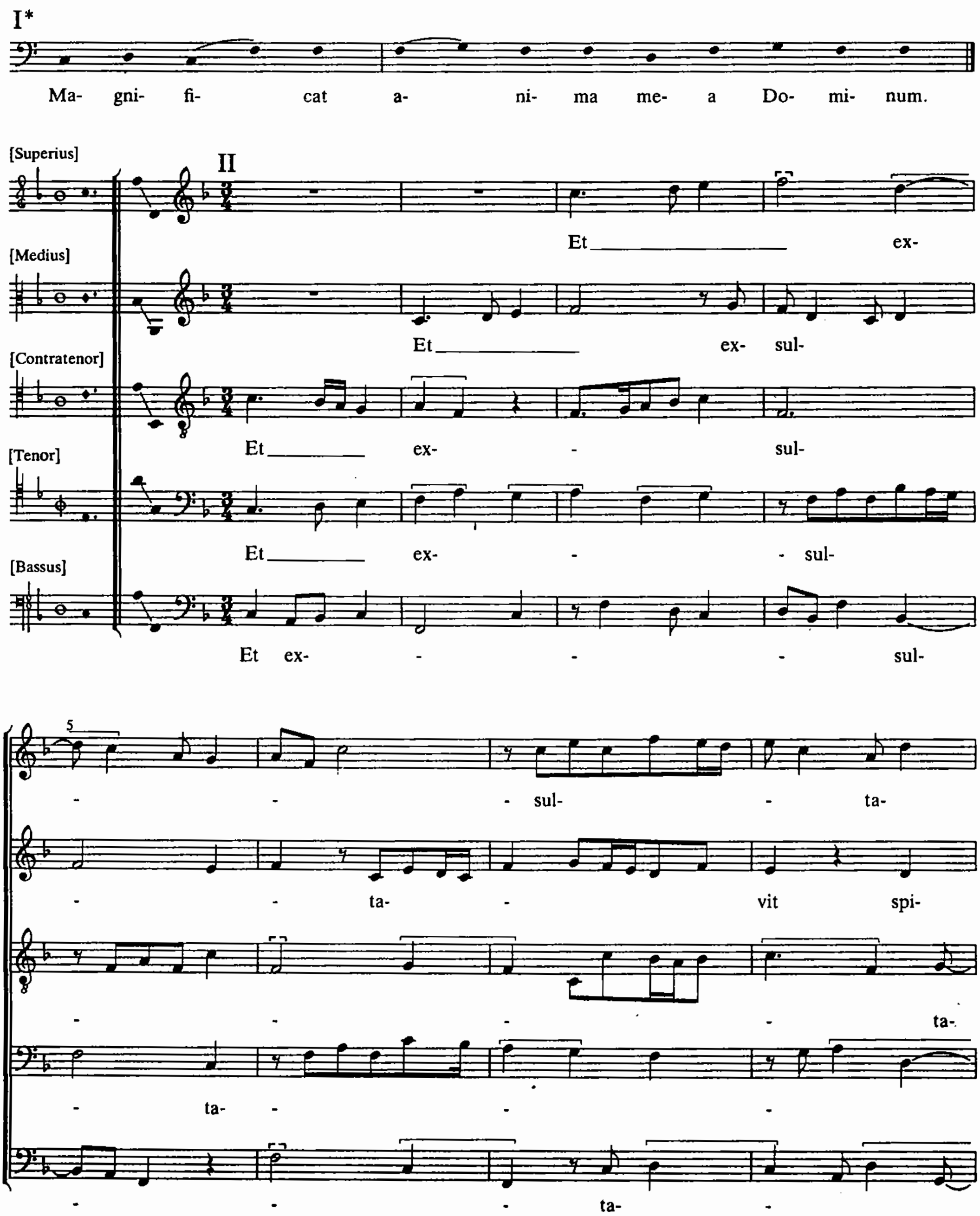
Magnificat *"Regale"*

*Plainsong on Tone VIII for the odd-numbered verses has been supplied from the Sarum Tonale in *The Use of Sarum*, ed. Walter H. Frere (1901), Appendix, ii.

Illustration 14

Proprietary Systems -- 2b
A-R Editions, Inc. (Thomas Hall)

Computer: Data General mainframe
Printing device: Mergenthaler (Linotron) 202 typesetter

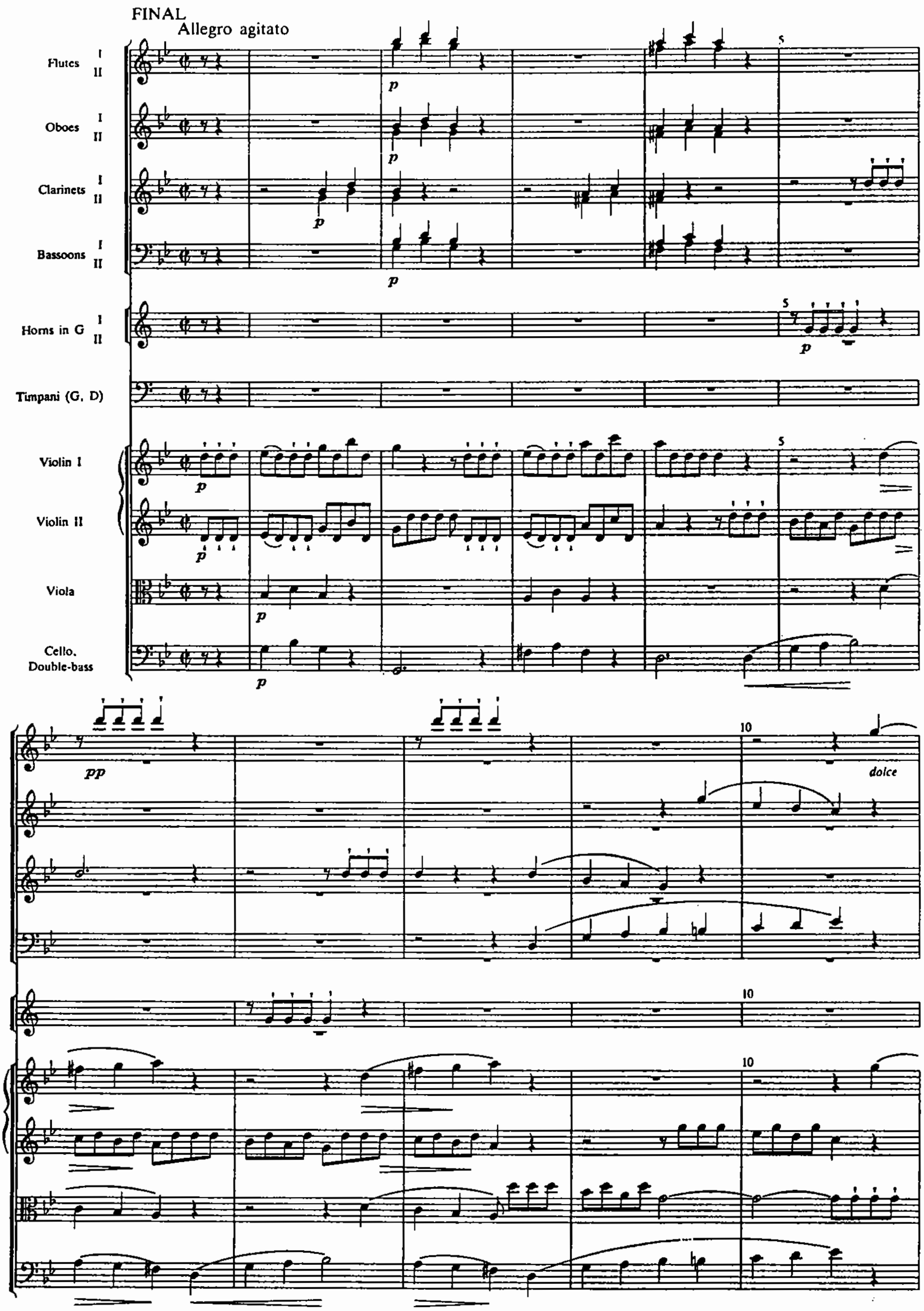



Illustration 15

Proprietary Systems -- 3
Lasergraphics (Armando Dal Molin)

Input device: PCS-500 Musicomp terminal
Printing device: Omnitech laser printer
[This system is currently in use by Belwin Mills, a subsidiary of Columbia Pictures]

551 A Mighty Fortress Is Our God

87.87.66.667

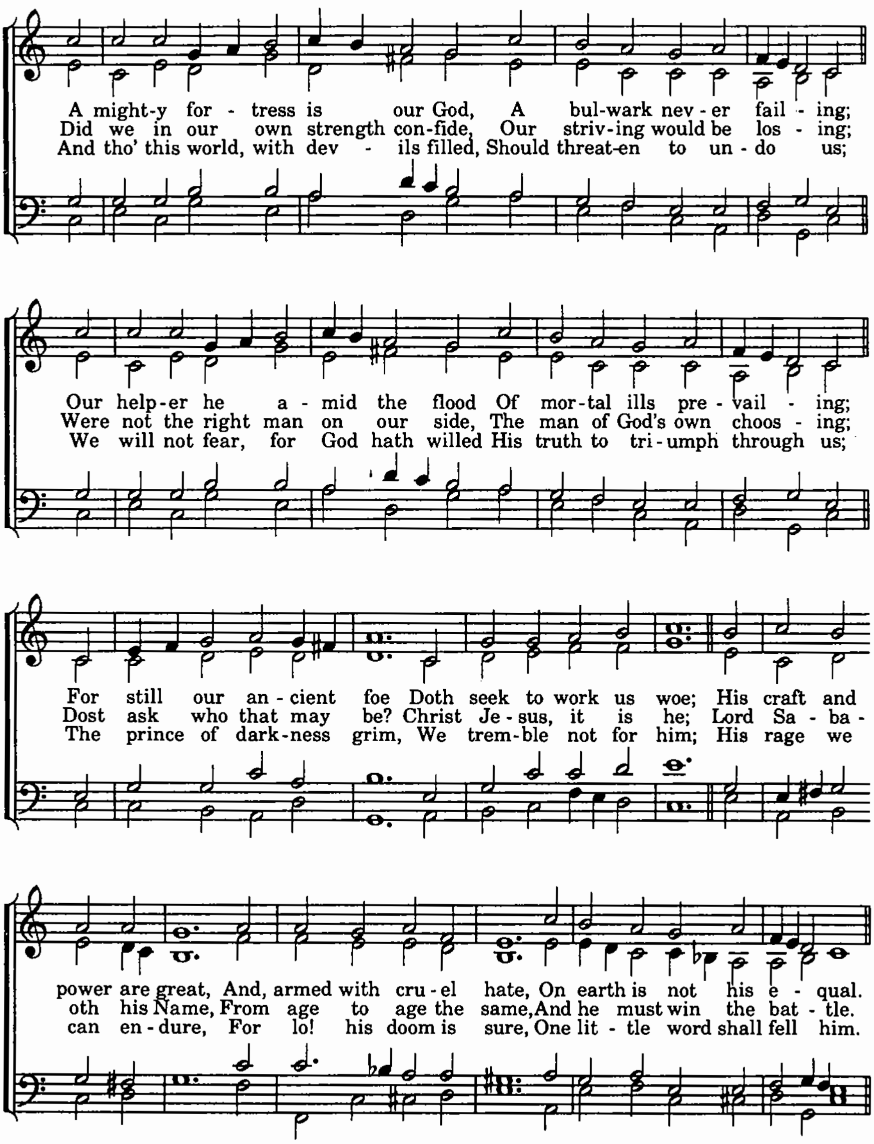
EIN' FESTE BURG — Melody, MARTIN LUTHER, 1529

dal molin - lasergraphics (1984)

Illustration 16

Commercial Systems -- 1a
Synclavier Music Engraving System

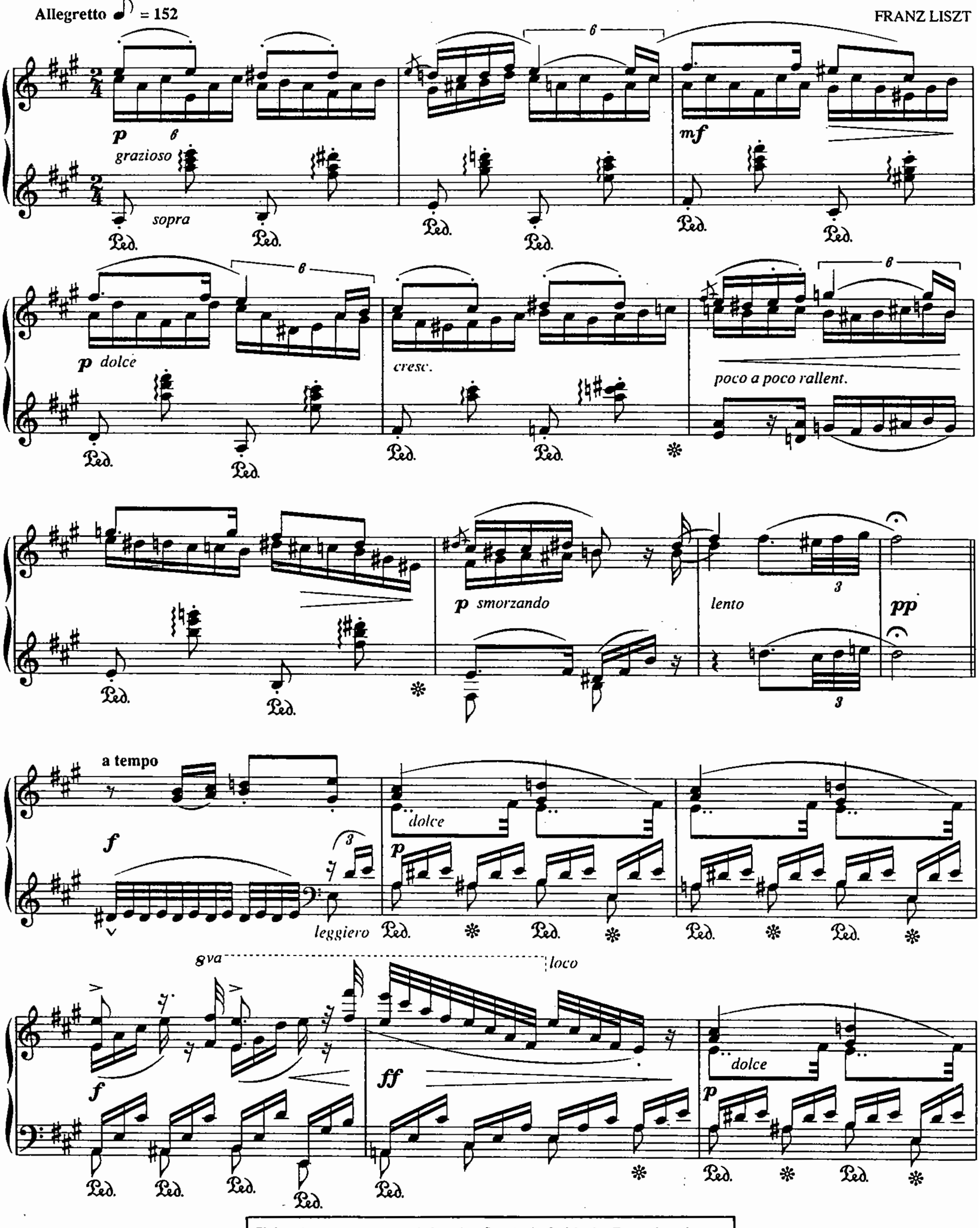
Input device: Synclavier
Printing device: Linotype L300, driven by PostScript image processor
Font: custom; original resolution = 2540 dots per inch

This piece was engraved by the Synclavier® Music Engraving System
New England Digital Corporation • White River Jct., Vermont 05001

Illustration 17

Commercial Systems -- 1b
Synclavier Music Engraving System

Editor: Symphony Reproductions, LTD. (Ted Petrosky)

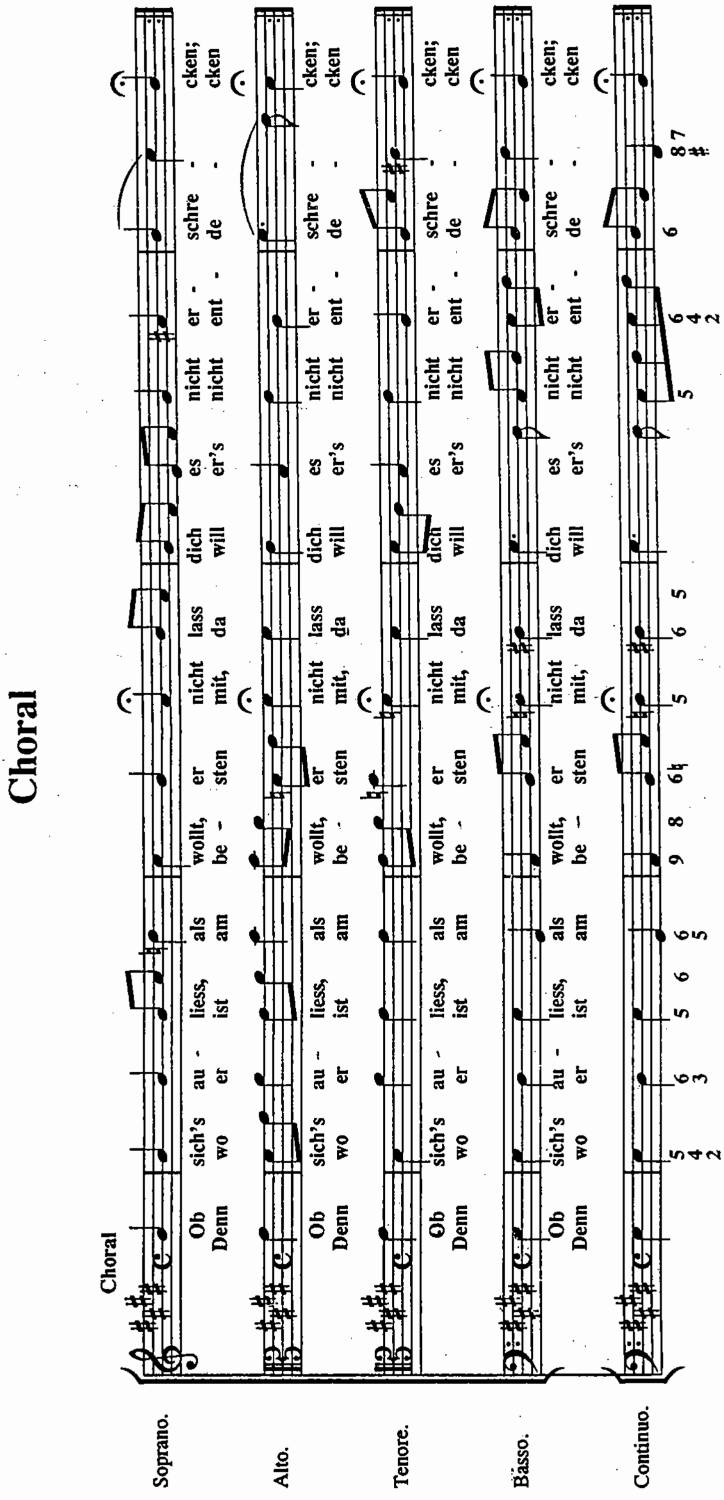


Illustration 18

Software for Printing Music -- 1a
SCORE (Leland Smith)

Computer: Tandy 2000 (IBM PC compatible)
Printing device: Apple LaserWriter
Software vendor: Passport Designs

Part extraction from score (or score assembly from parts) showing size differentiation

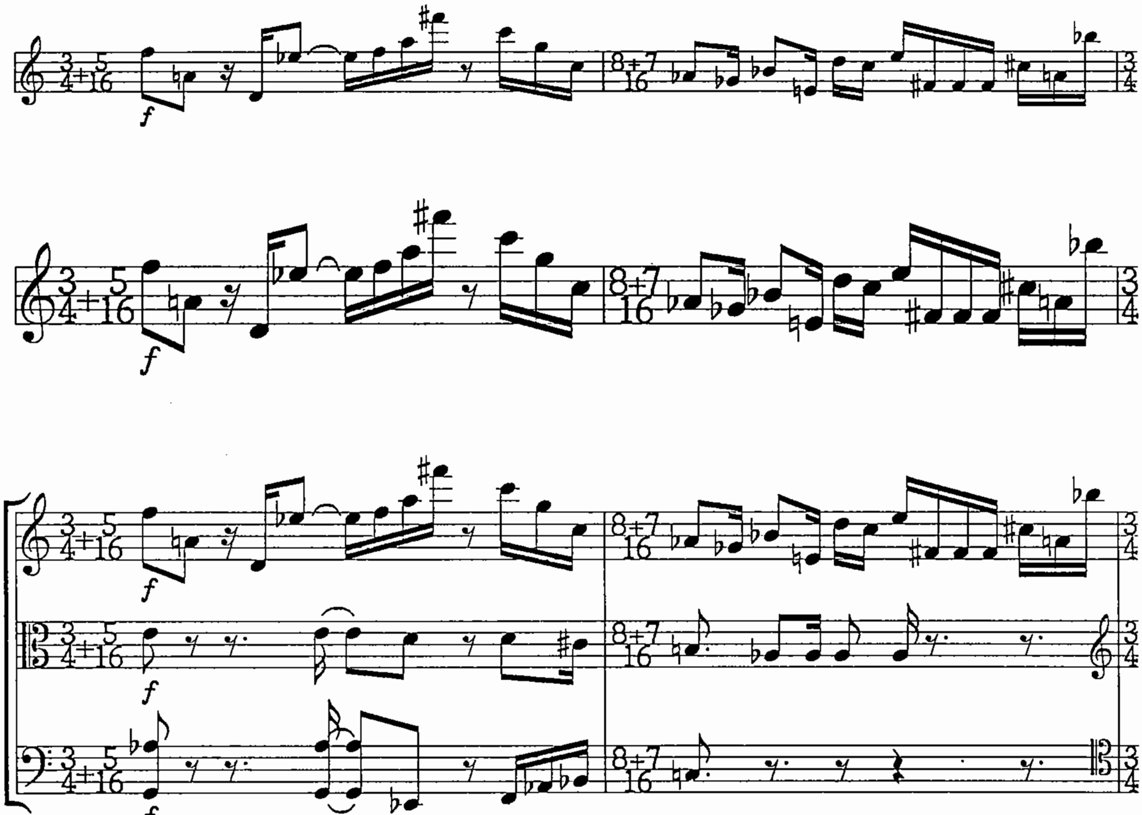
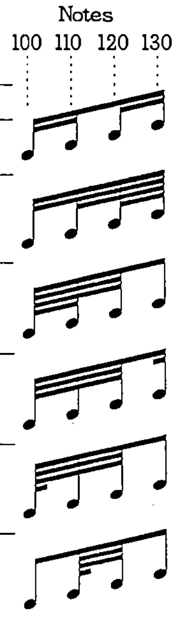



Illustration 19

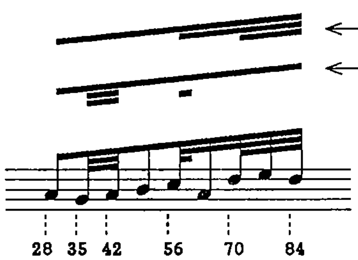
Software for Printing Music -- 1b
SCORE (Leland Smith)

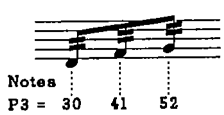
Computer: Tandy 2000 (IBM PC compatible)
Printing device: Apple LaserWriter
Software vendor: Passport Designs

Parameters for contol of spacing

	P7	P10	P11	P12	P13	P14	P15
9	11	11	100	110	11	120	-1
10	12	21	110	-1	31	120	-1
11	11	12	-1	120	31	-1	110
12	11	12	-1	120	11	0	-1
13	11	12	-1	120	31	-1	0
14	11	12	110	120	31	110	0

P7 = 11

P10	P11	P12	P13	P14	P15
11	56	-1	21	70	-1
12	35	42	21	56	0





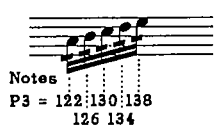
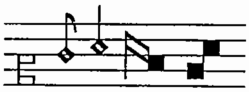
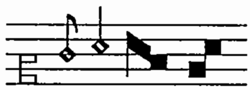
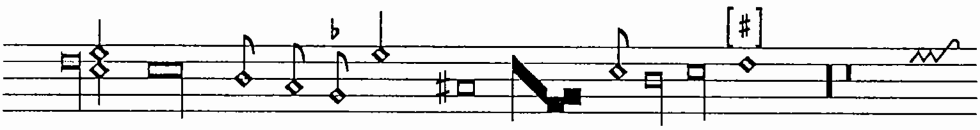
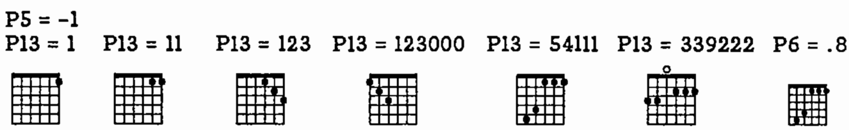


Illustration 20

Software for Printing Music -- 1c
SCORE (Leland Smith)

Computer: Tandy 2000 (IBM PC compatible)
Printing device: Apple LaserWriter
Software vendor: Passport Designs

Special libraries for early music notation, guitar tablature, percussion



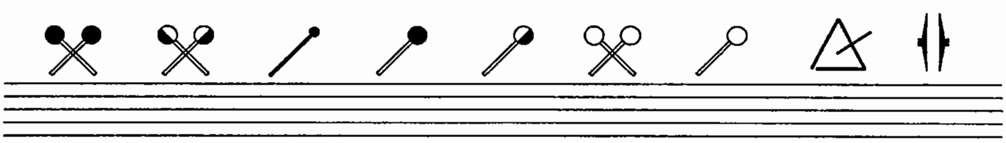
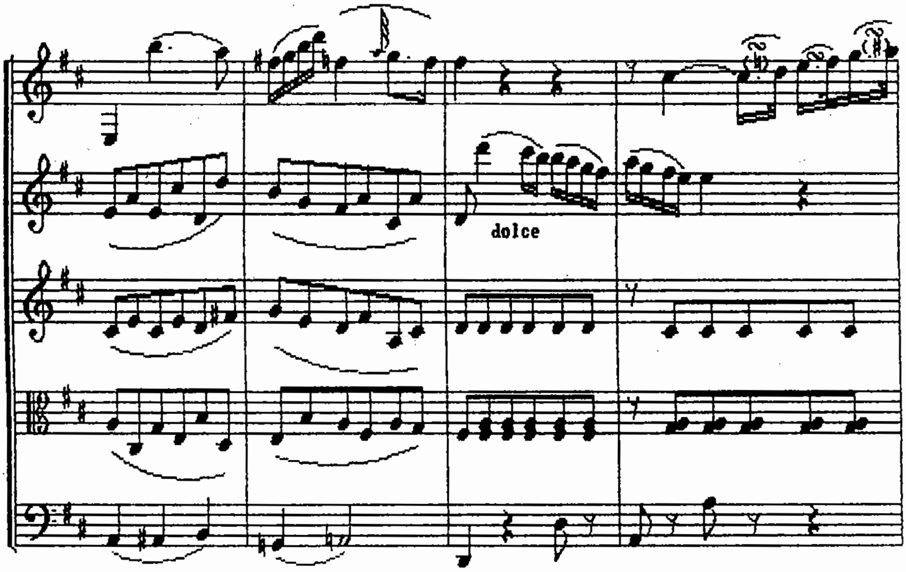


Illustration 21

Software for Printing Music -- 2a
Music Processor (Etienne Darbellay)

Computer: Texas Instruments Professional
[alternative version for IBM PC under development]
Printing device: Star Gemini--10X; Citizen MSP15

CHORAL.

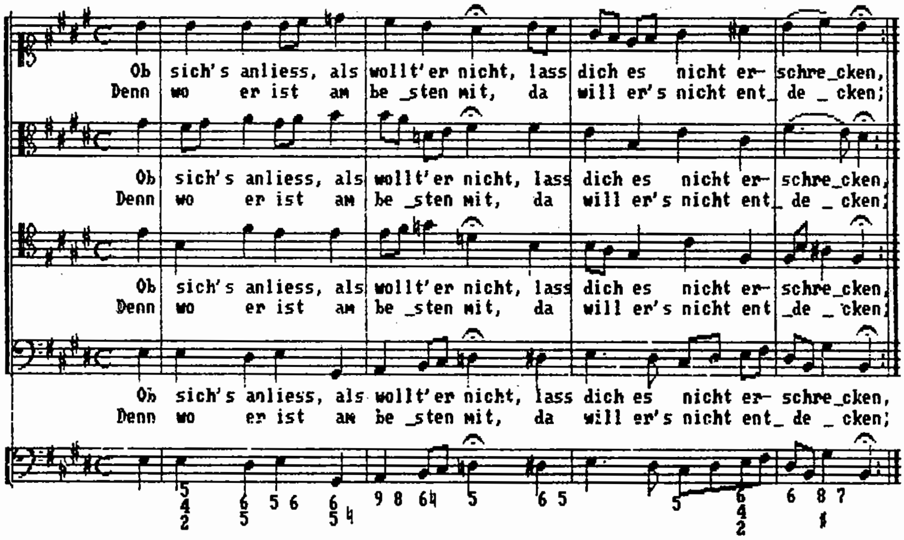



Illustration 22

Software for Printing Music -- 2b
Music Processor (Etienne Darbellay)

Computer: Texas Instruments Professional
[alternative version for IBM PC under development]
Printing device: Star Gemini--10X; Citizen MSP15

Creation of two-stave reduction from five-part score

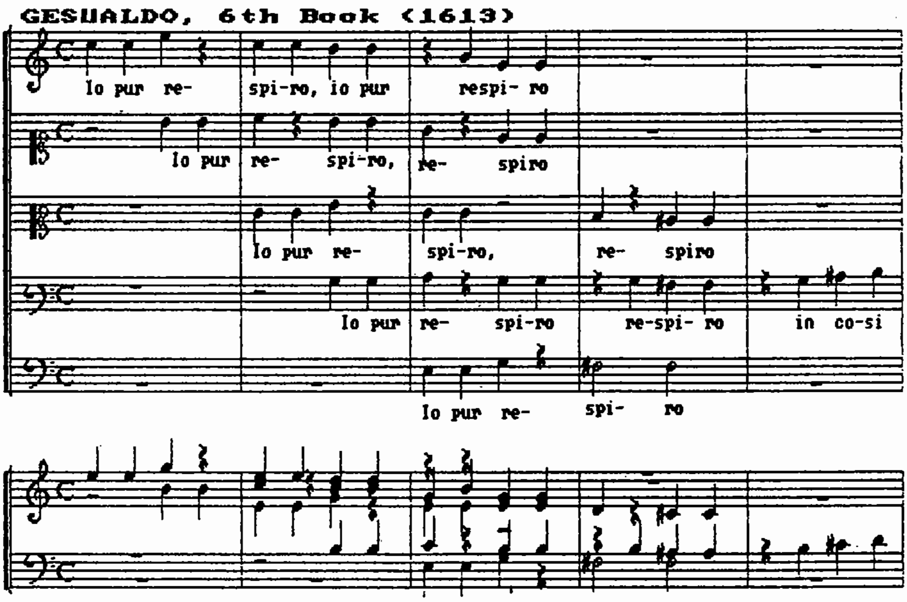
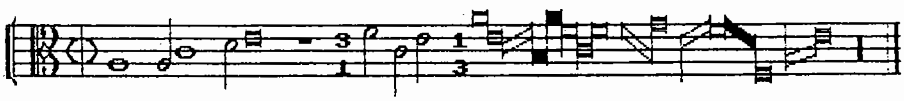
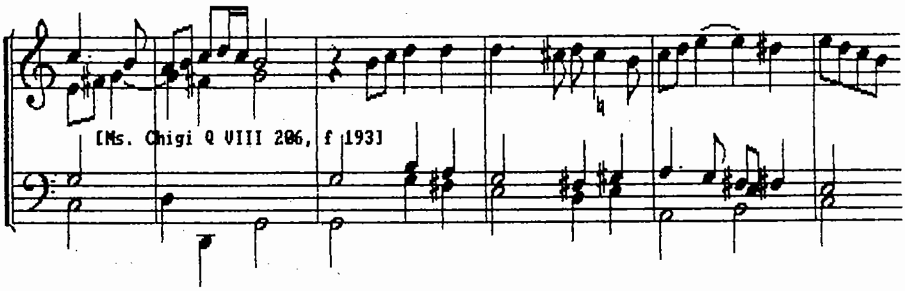



Illustration 23

Software for Printing Music -- 2c
Music Processor (Etienne Darbellay)

Computer: Texas Instruments Professional
[alternative version for IBM PC under development]
Printing device: Star Gemini--10X; Citizen MSP15

Early music, editing, and drawing capabilities

Sample for some possibilities in complex contexts (chords and beaming)

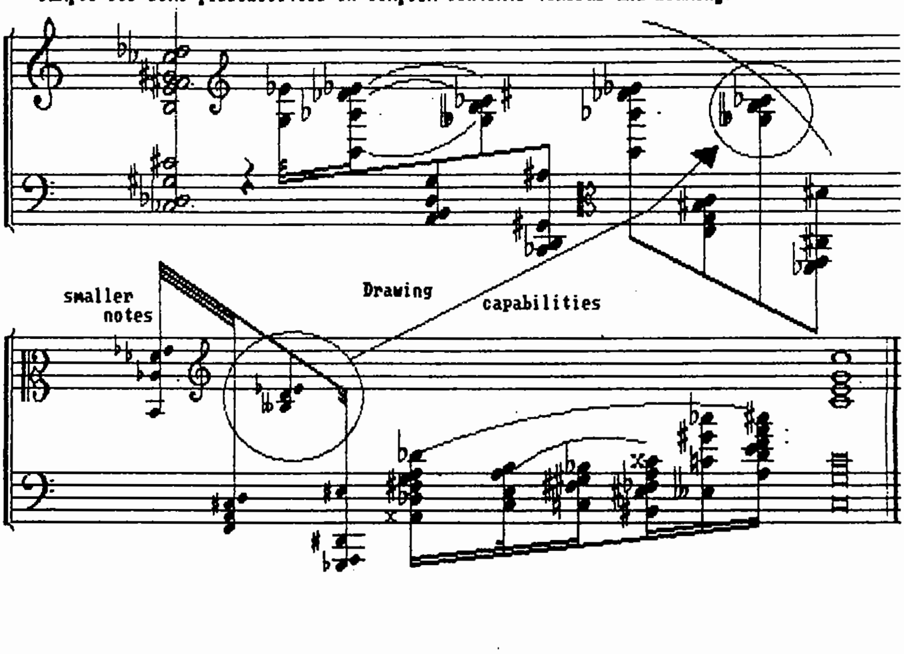
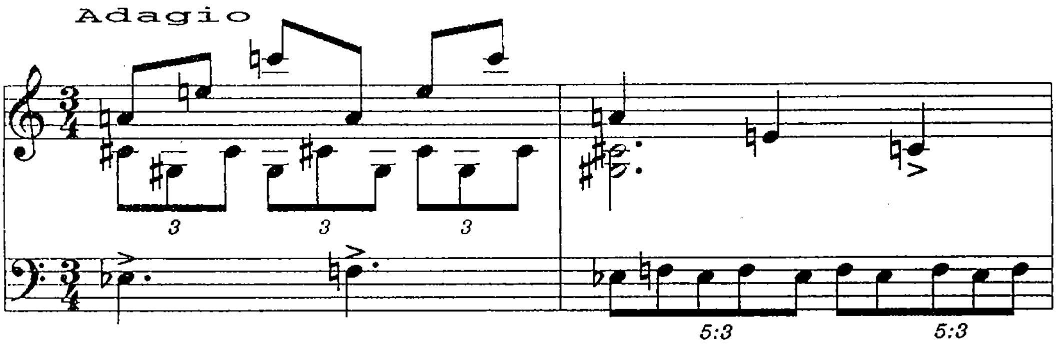


Illustration 24

Software for Printing Music -- 3a
The Note Processor (Stephen Dydo)

Computer: IBM PC
Printing device: NEC P6 dot matrix printer (180 dots per inch)
Font: custom

Music by Stephen Dydo



Computer: IBM PC
Printing device: NEC P6 dot matrix printer (180 dots per inch)
Font: custom

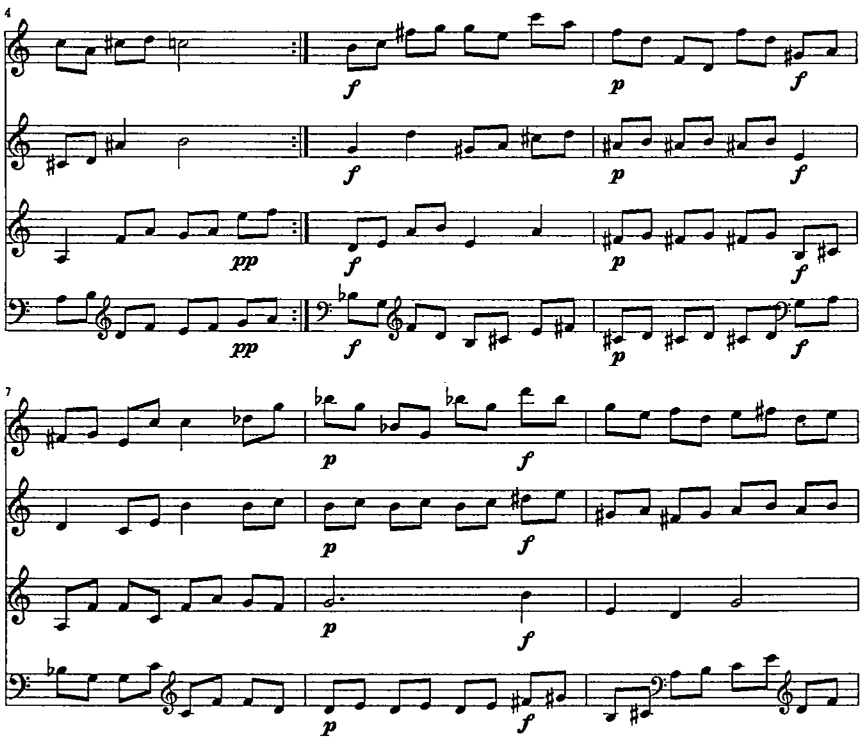



Illustration 25

Software for Printing Music -- 3b
The Note Processor (Stephen Dydo)

Computer: IBM PC
Printing device: NEC P6
Font: custom

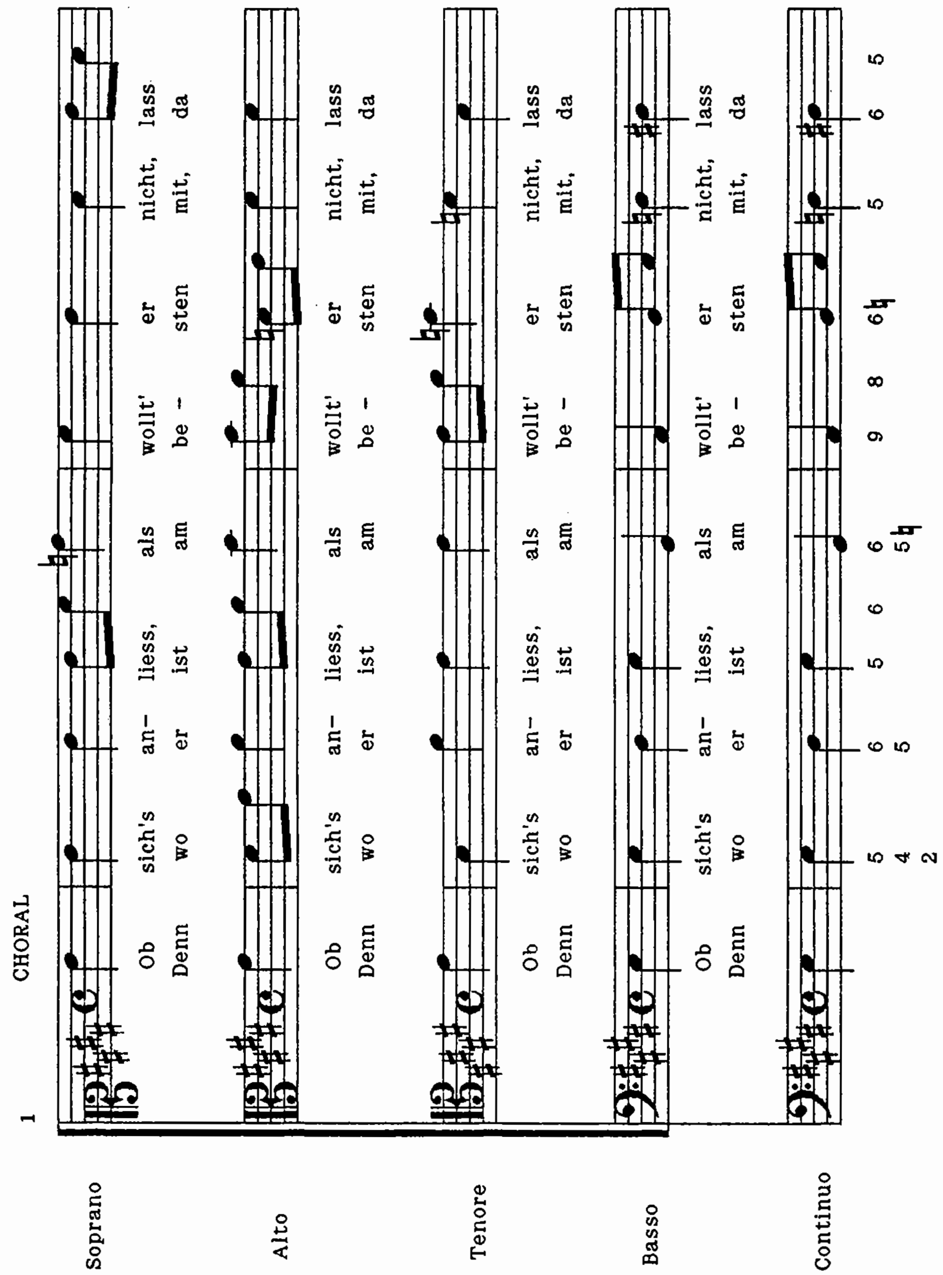


Illustration 26

Software for Printing Music -- 3c
The Note Processor (Stephen Dydo)

Computer: Hewlett Packard Vectra (IBM PC compatible)
Printing device: HP LaserJet II (300 dots per inch)
Music font: custom
Text font: HP 8 pt. Times Roman Softfont

Unreduced

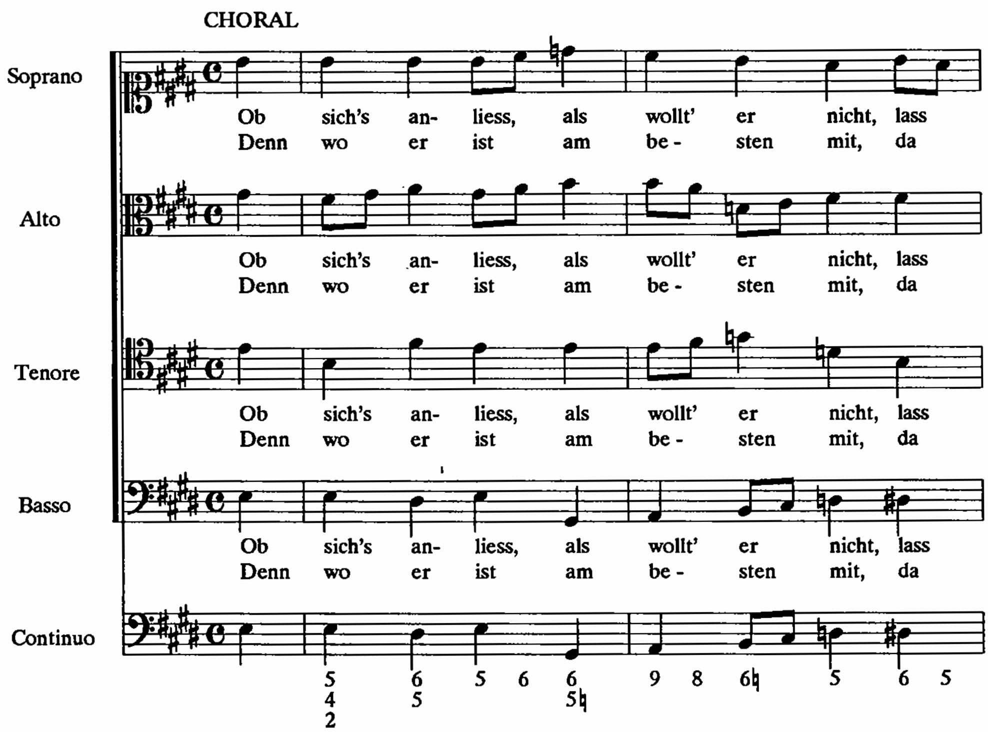


Illustration 27

Software for Printing Music -- 4a
The Copyist (Cris Sion)

Computer: Atari ST (with sequencer software)
[alternative version for IBM PC with sequencer software]
Printing device: Panasonic KX-P1091 (Epson compatible)
[HP Inkjet, GL plotter, and Laserjet Plus also supported]
Vendor: Dr. T's Music Software

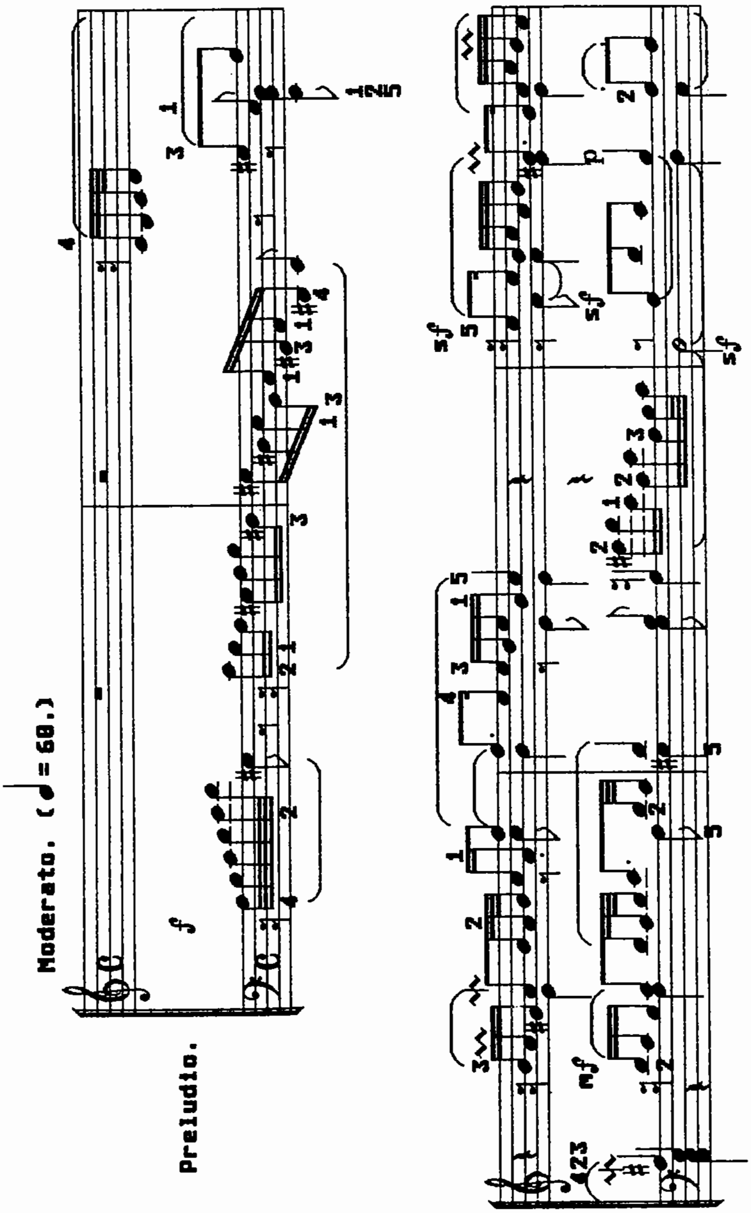


Illustration 28

Software for Printing Music -- 4b
The Copyist (Cris Sion)

Computer: Atari ST (with sequencer software)
[alternative version for IBM PC with sequencer software]
Printing device: Panasonic KX-P1091 (Epson compatible)
[HP Inkjet, GL plotter, and Laserjet Plus also supported]
Vendor: Dr. T's Music Software

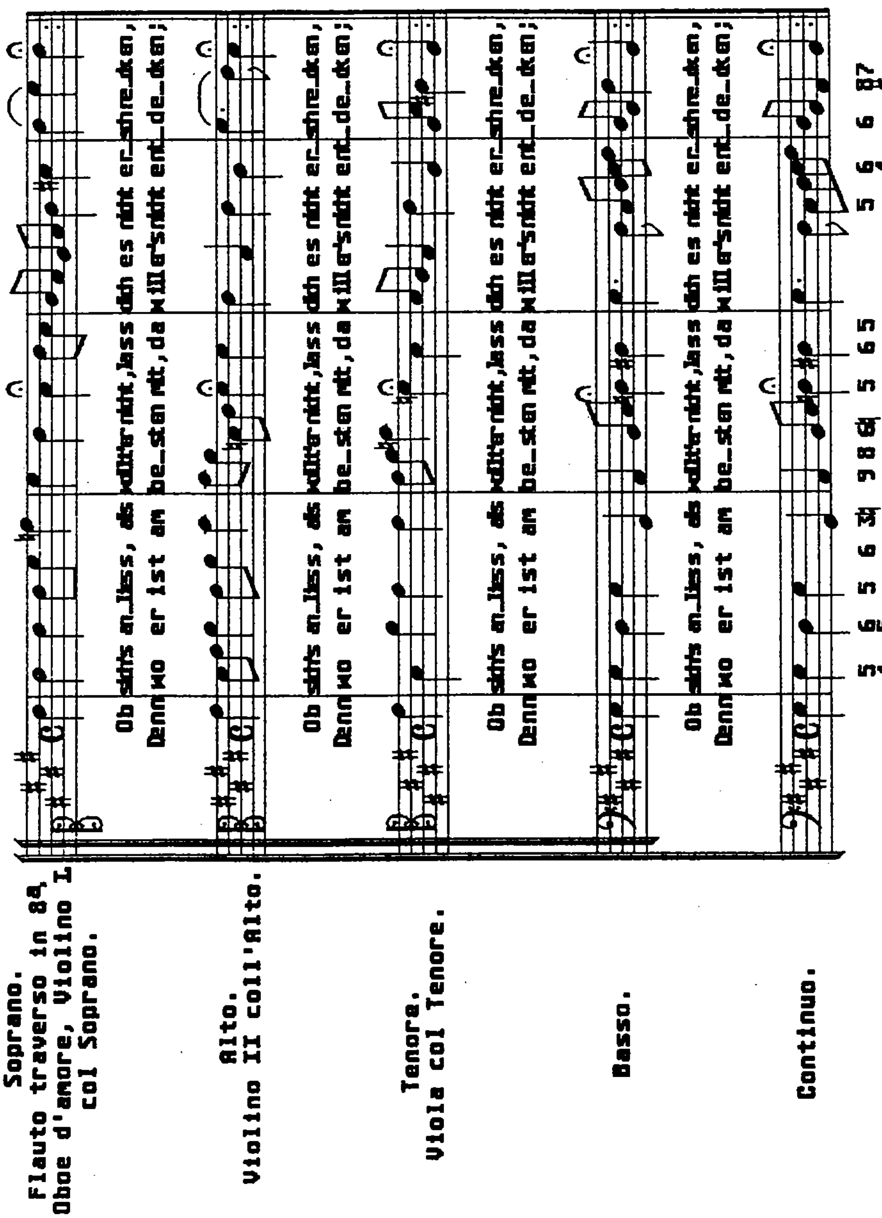


Illustration 29

Software for Printing Music -- 5
Personal Composer System II (Jim Miller)

Computer: IBM PC compatibles
Printing device: Apple LaserWriter
Font: PostScript 'Sonata' by Adobe Systems

Personal Composer, PO Box 648, Honaunau, HI 96726

String Quartet in C# Minor, Opus 131

Ludwig van Beethoven
(1826)

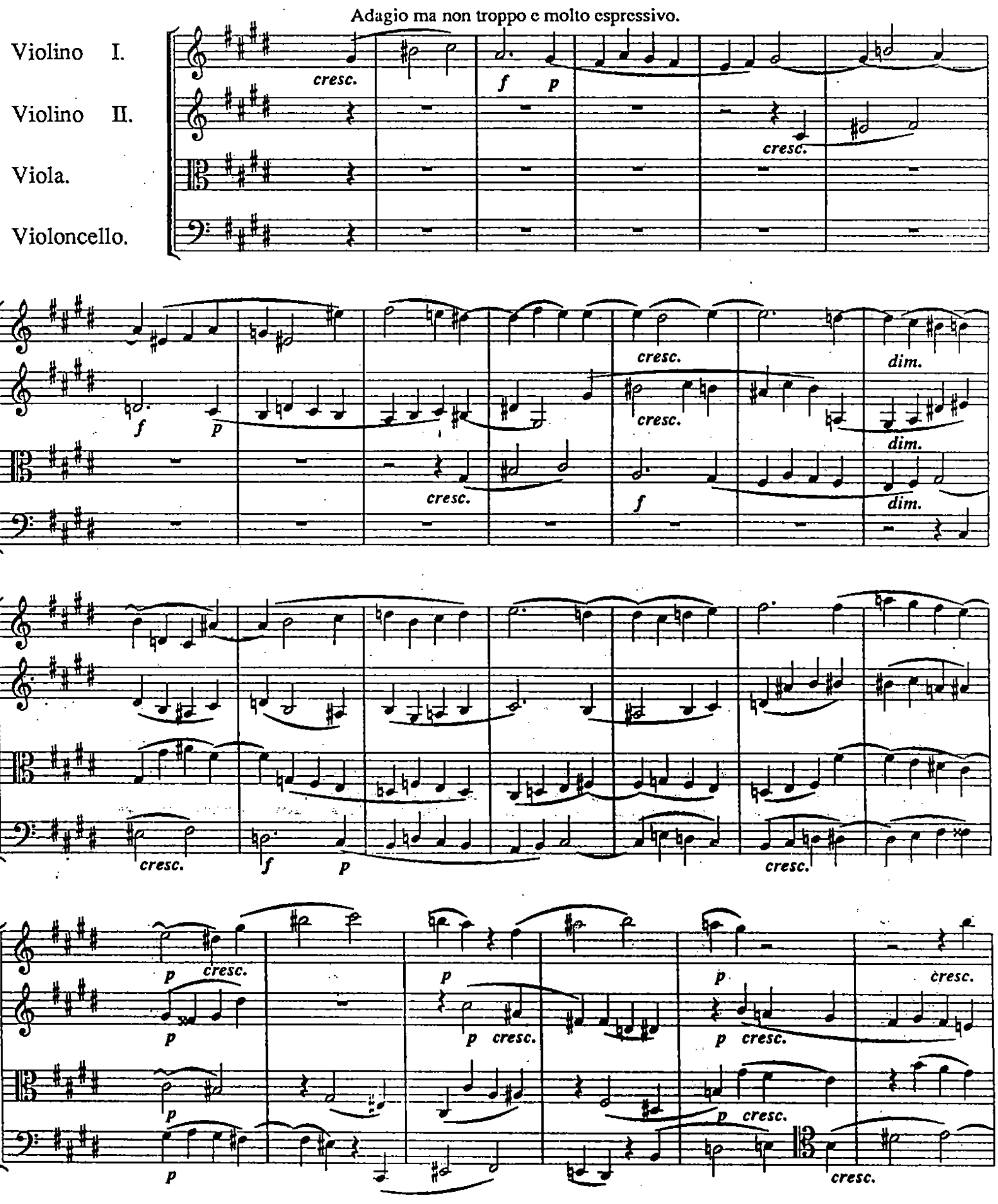



Illustration 30

Software for Printing Music -- 6
Noteprocessor (Piero De Berardinis)

Computer: Apple II
Printing device: C.ITOH 8510A with Apple interface #85APL-II

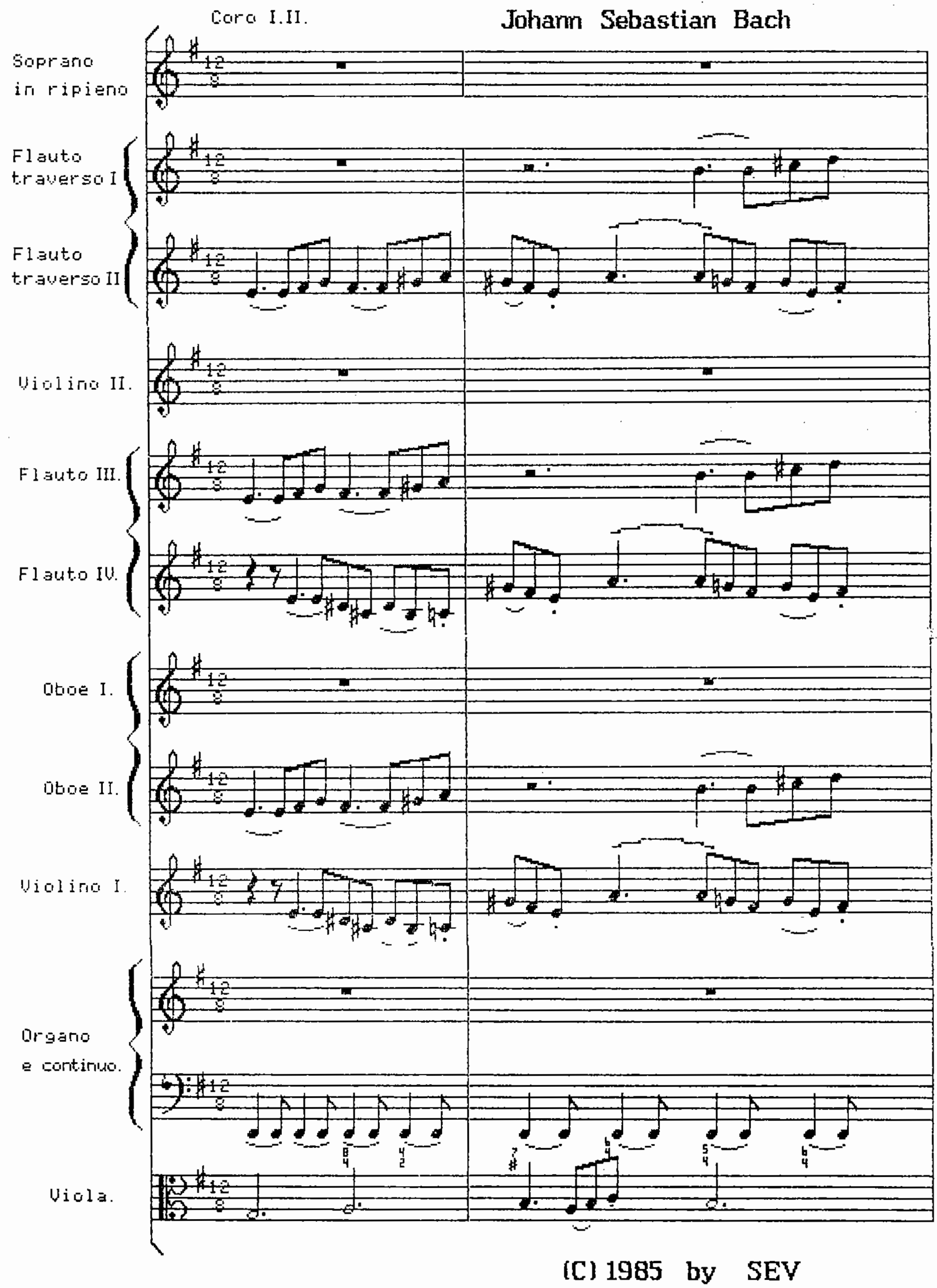



Illustration 31

Software for Printing Music -- 7
Professional Composer

Computer: Apple Macintosh
Printing device: Apple LaserWriter
Vendor: Mark of the Unicorn

FLOSSIE L. HEYWOOD
Darmstadt Gesangbuch, 1698

GLUCK ZU KREUZ 8.7.8.7.
HARMONIZED BY CHARLES WOOD

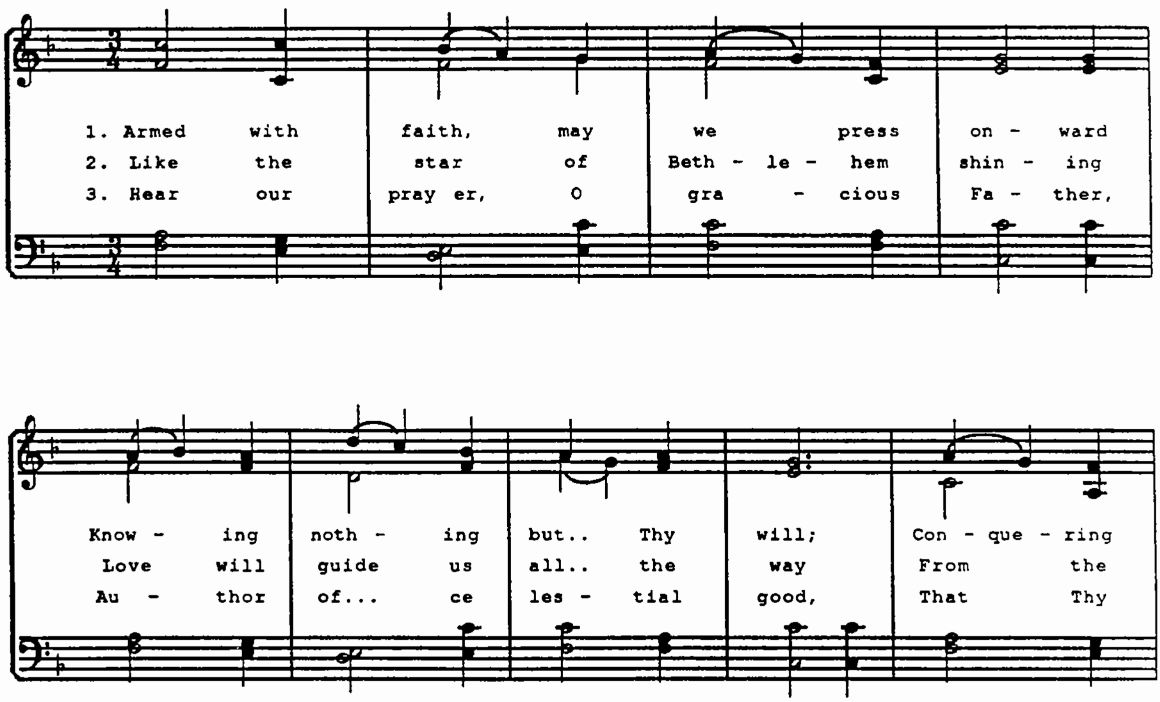


Illustration 32

Software for Printing Music -- 8
MusScript (Keith Hamel)

Computer: Apple Macintosh
Printing device: Apple LaserWriter
Font: PostScript 'Sonata' by Adobe Systems

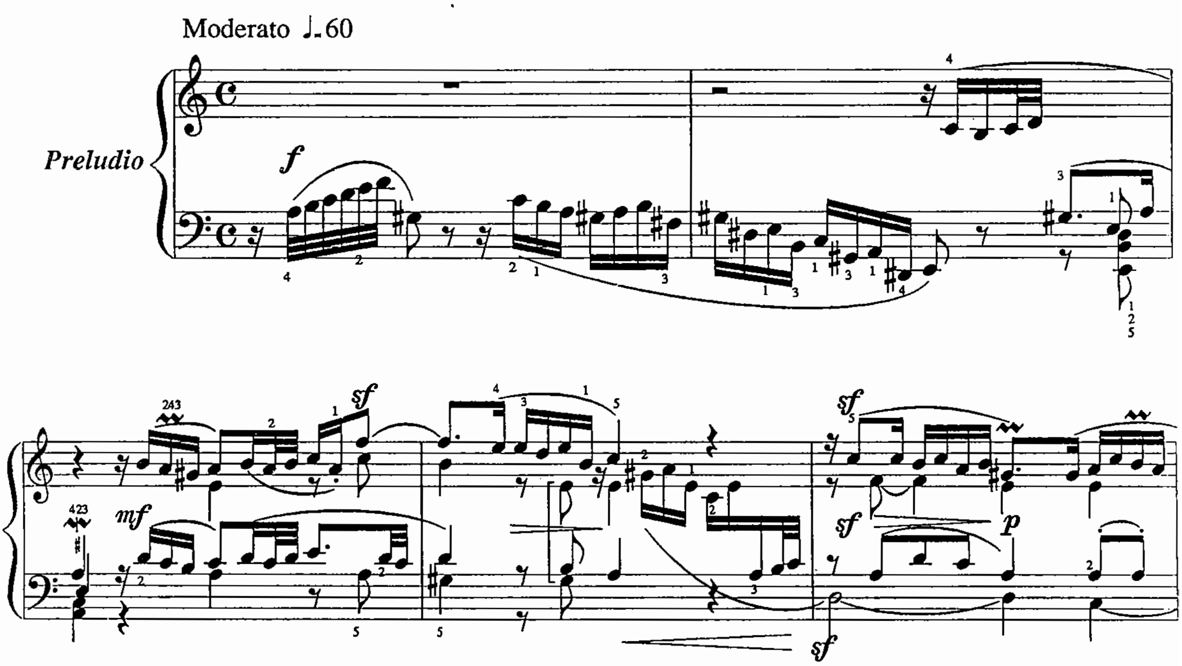


Illustration 33

Software for Printing Music -- 9a
Theme: The Music Editor (Mark Lambert)

Computer: IBM PC-compatible Zenith Z-158
Printing device: Star Micronics Gemini 10X dot-matrix printer

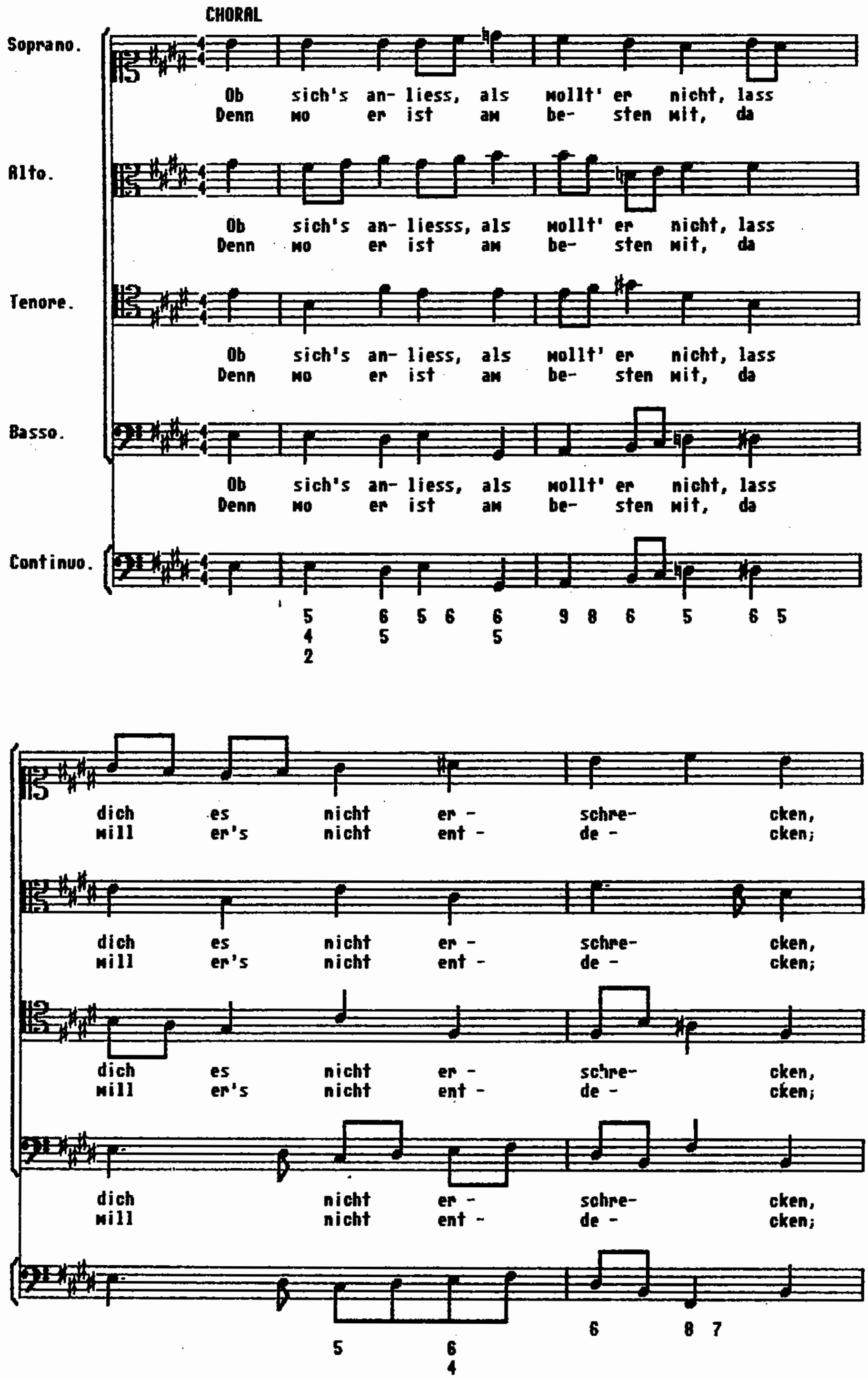


Illustration 34

Software for Printing Music -- 9b
Theme: The Music Editor (Mark Lambert)

Computer: IBM PC-compatible Zenith Z-158
Printing device: Star Micronics Gemini 10X dot-matrix printer

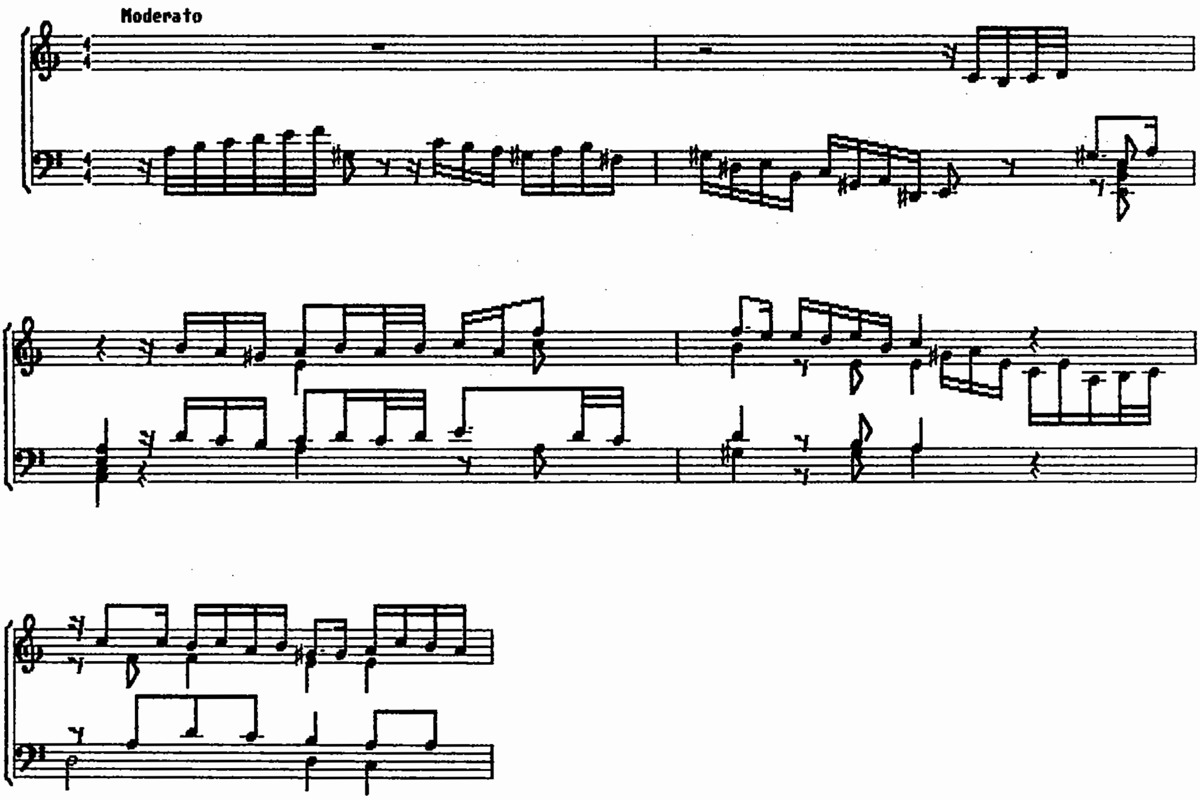



Illustration 35

Software for Printing Music -- 10a
Oberon System II (Nancy Colton)

Computer: Hewlett Packard Vectra (IBM PC compatible)
Printing device; HP LaserJet Plus
Font: Oberon Music Font

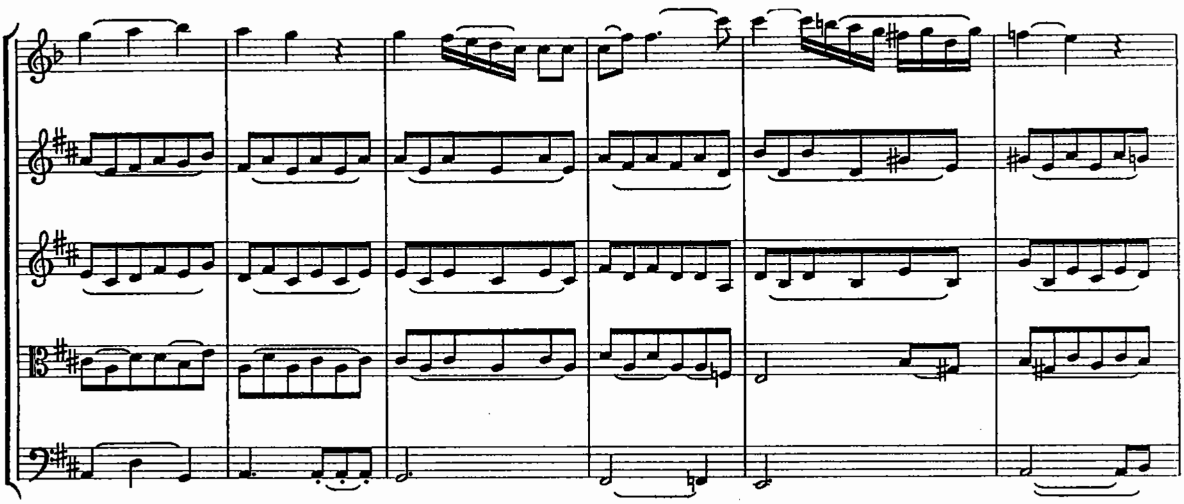
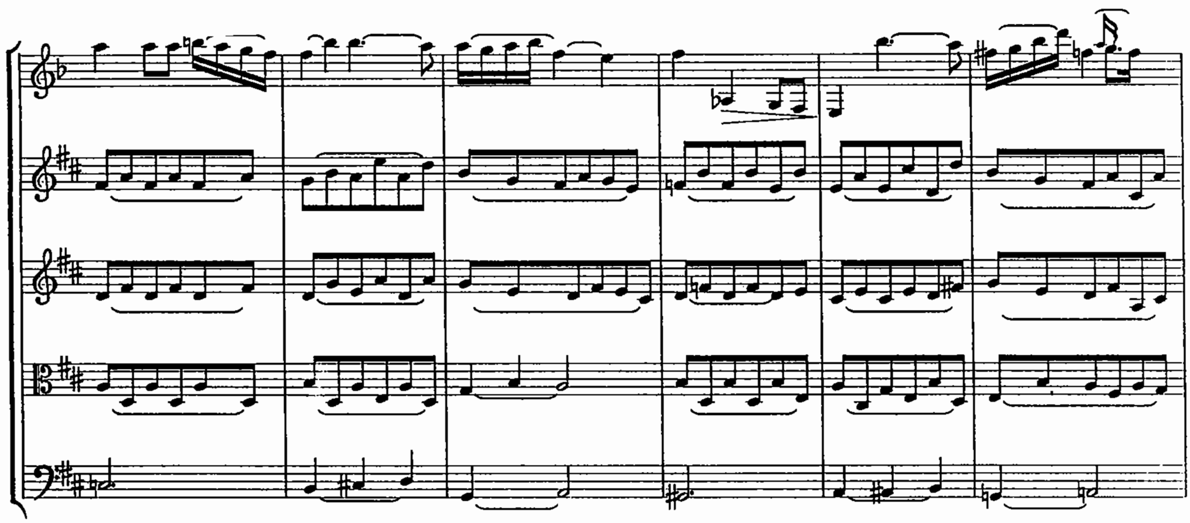



Illustration 36

Software for Printing Music -- 10b
Oberon System II (Nancy Colton)

Computer: Hewlett Packard Vectra (IBM PC compatible)
Printing device; HP LaserJet Plus
Music font: Oberon Music Font
Text: Word Perfect

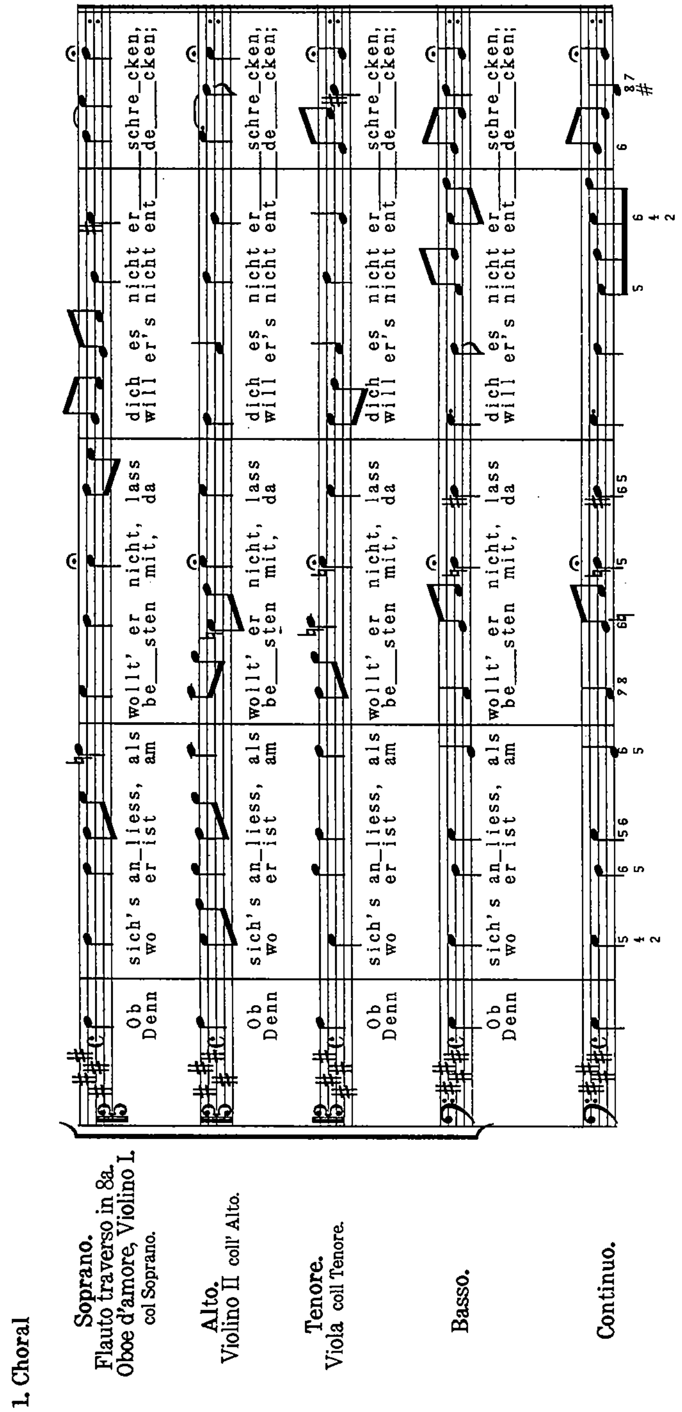


Illustration 37

Software for Printing Music -- 11a
Music Writer (Armando Dal Molin)

Computer: IBM PC with custom 'piano keyboard' peripheral
Printing device: Okidata 192 dot matrix printer
[Epson and IBM dot matrix printers also supported]

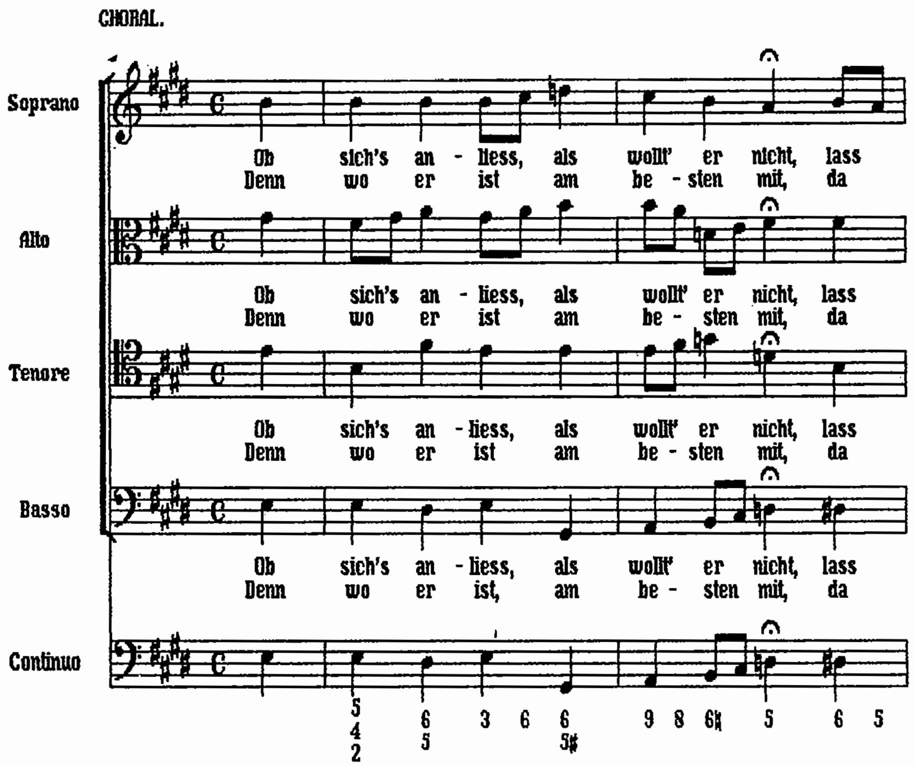



Illustration 38

Software for Printing Music -- 11b
Music Writer (Armando Dal Molin)

Computer: IBM PC with custom 'piano keyboard' peripheral
Printing device: Okidata 192 dot matrix printer
[Epson and IBM dot matrix printers also supported]

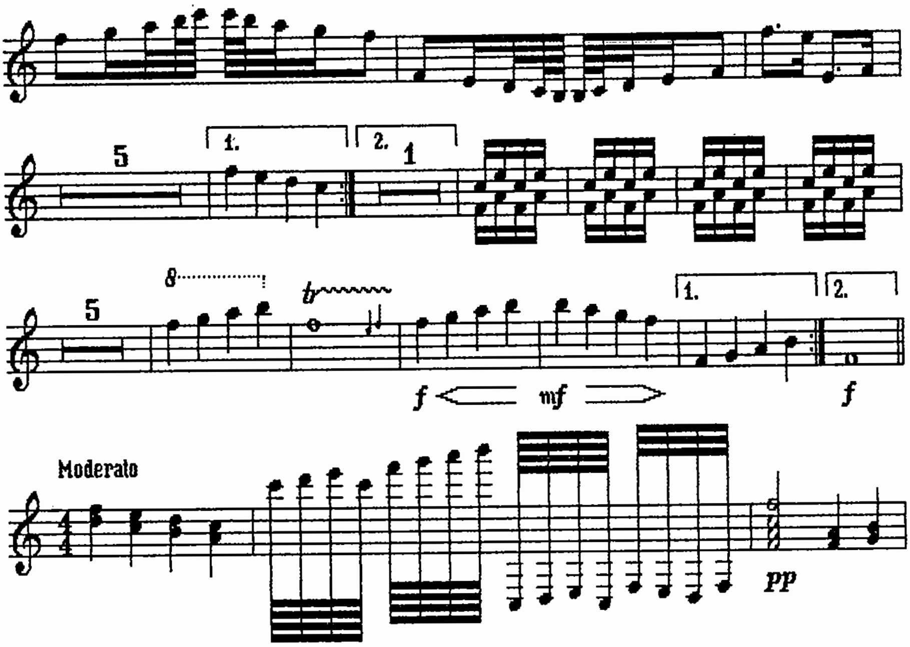


Illustration 39

Software for Printing Music -- 12a
Deluxe Music Construction Set, Version 2.0 (Geoff Brown)

Computer: Apple Macintosh
Printing device: Linotronics typesetter
Font: PostScript 'Sonata' by Adobe Systems
Vendor: Electronic Arts

Unreduced

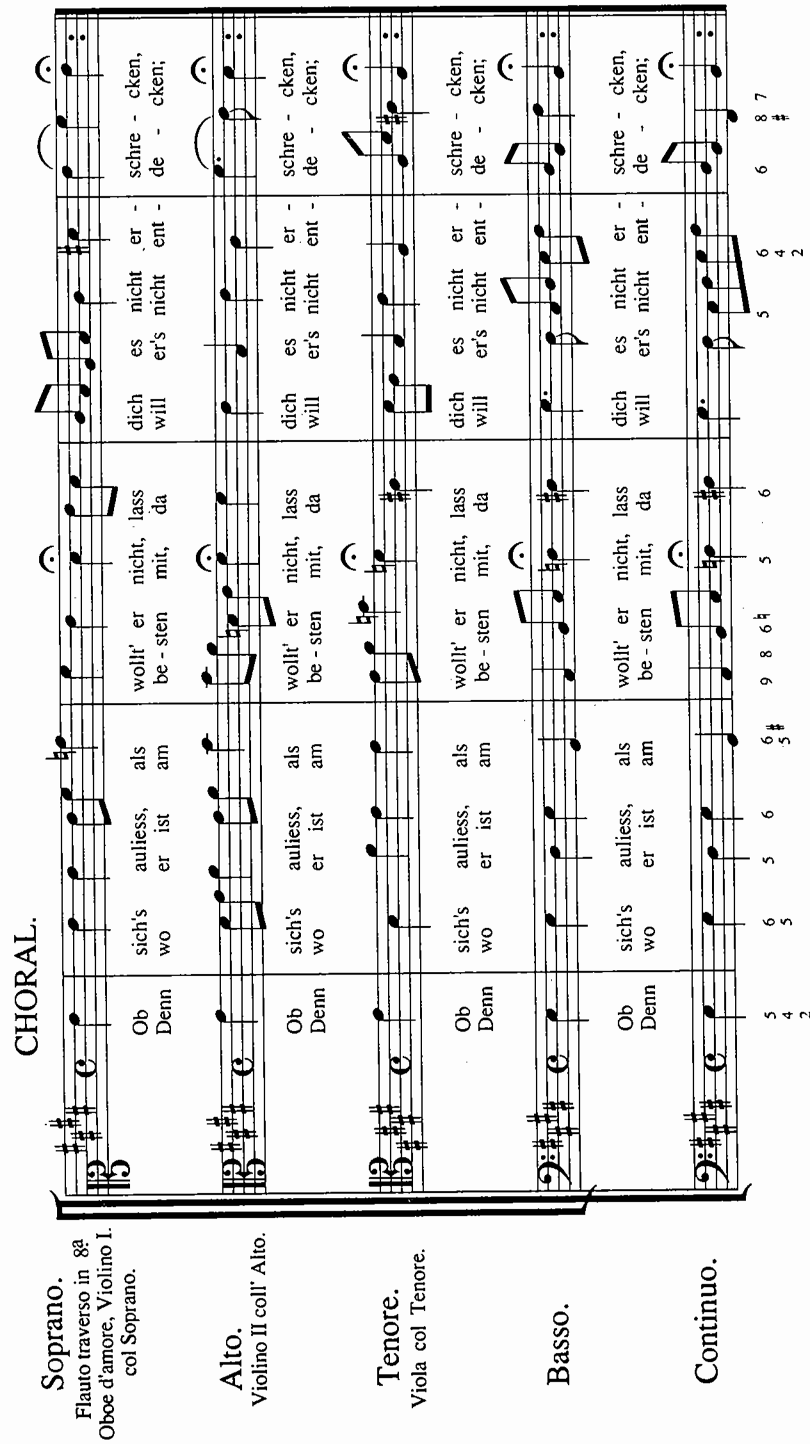


Illustration 40

Software for Printing Music -- 12b
Deluxe Music Construction Set, Version 2.0 (Geoff Brown)

Computer: Apple Macintosh
Printing device: Linotronics typesetter
Font: PostScript 'Sonata' by Adobe Systems
Vendor: Electronic Arts

Unreduced

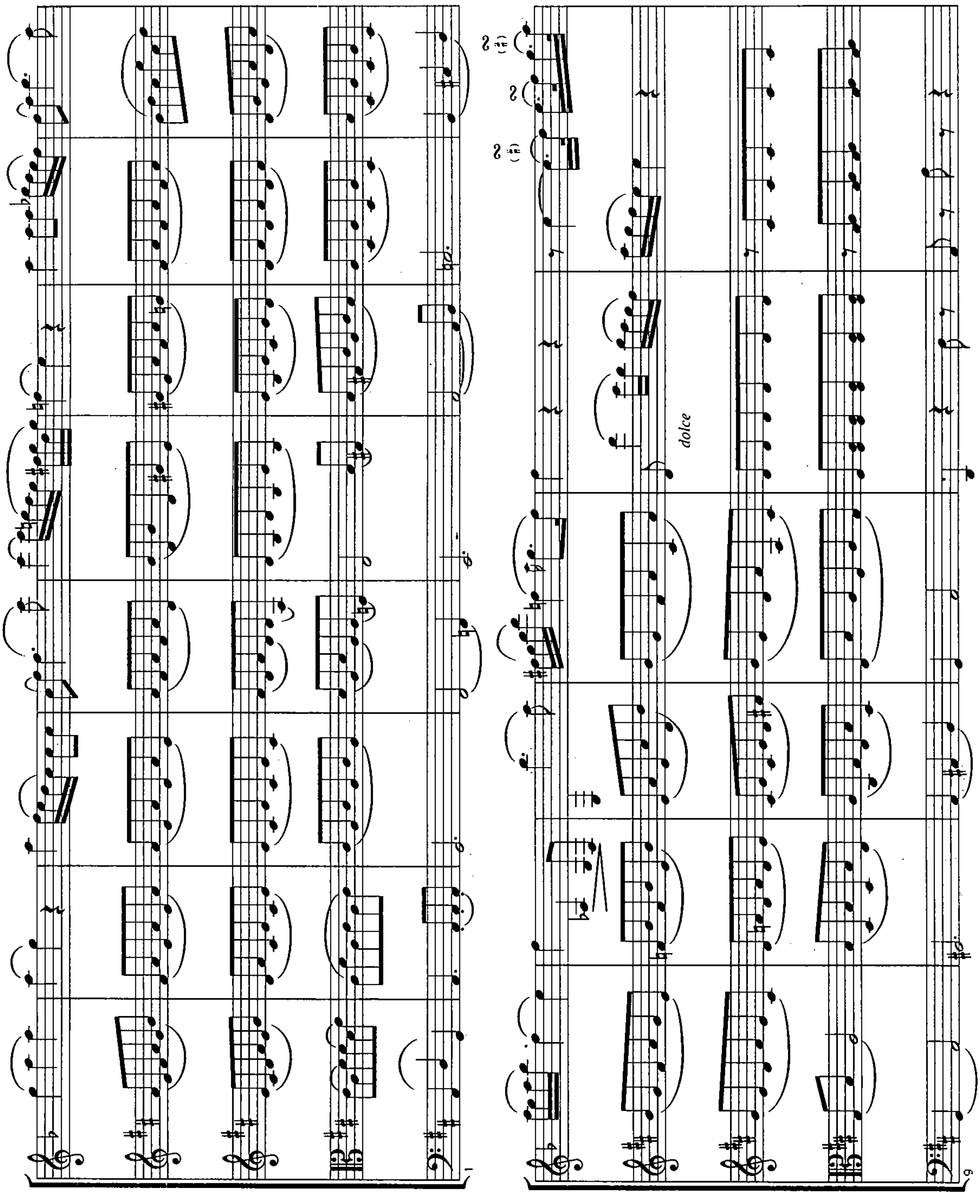


Illustration 41

Software for Music Printing -- 13a
High Score (Donald Byrd and Kimball Stickney)

Computer: Apple Macintosh
Printing device: Linotronics 100 typesetter
Font: PostScript 'Sonata' by Adobe Systems

Fourth String Quartet

BELA BARTOK

(1928)

I.

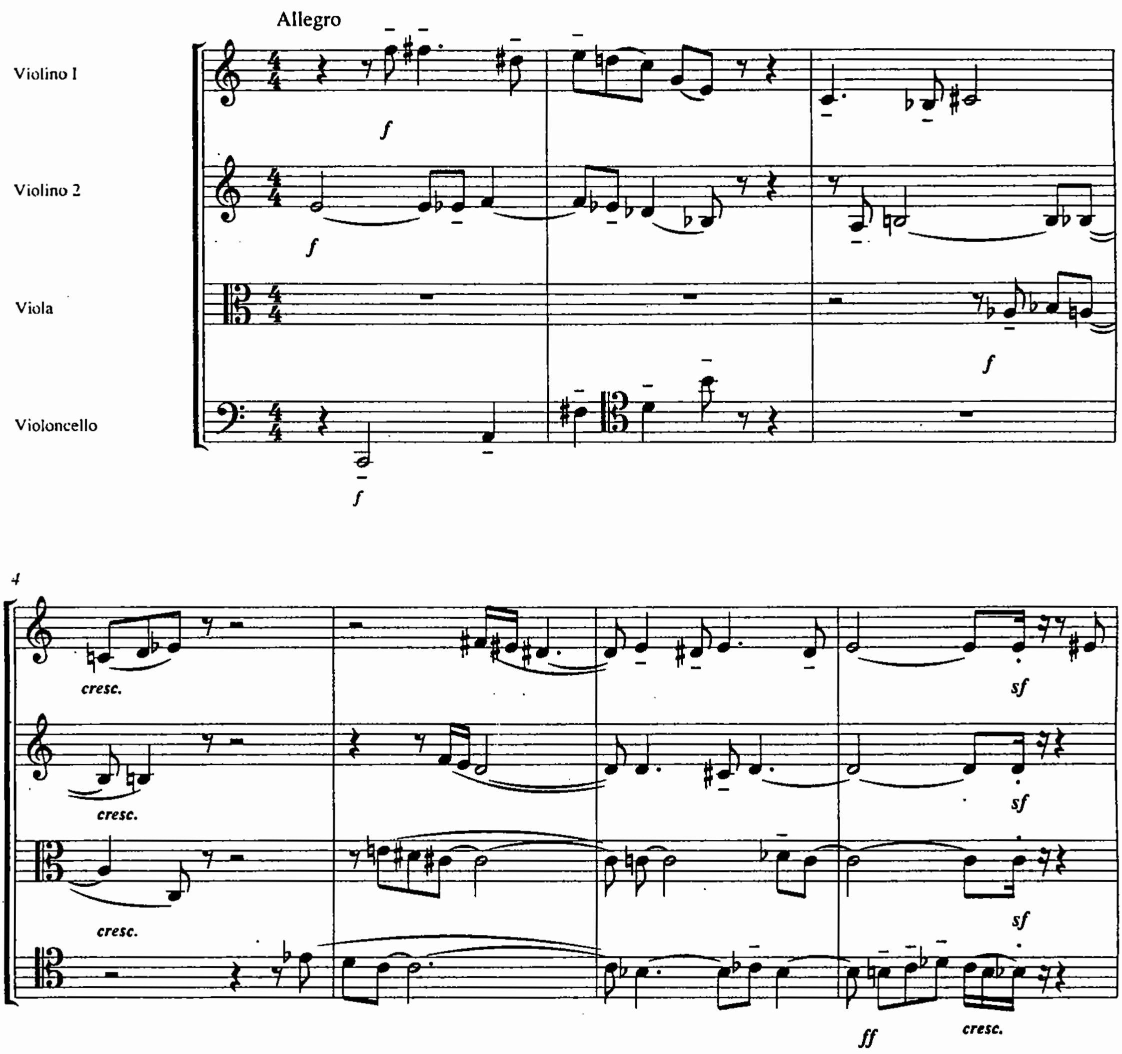



Illustration 42

Software for Music Printing -- 13b
High Score (Donald Byrd and Kimball Stickney)

Computer: Apple Macintosh
Printing device: Apple LaserWriter
Font: PostScript 'Sonata' by Adobe Systems

Fourth String Quartet

BELA BARTOK

(1928)

I.

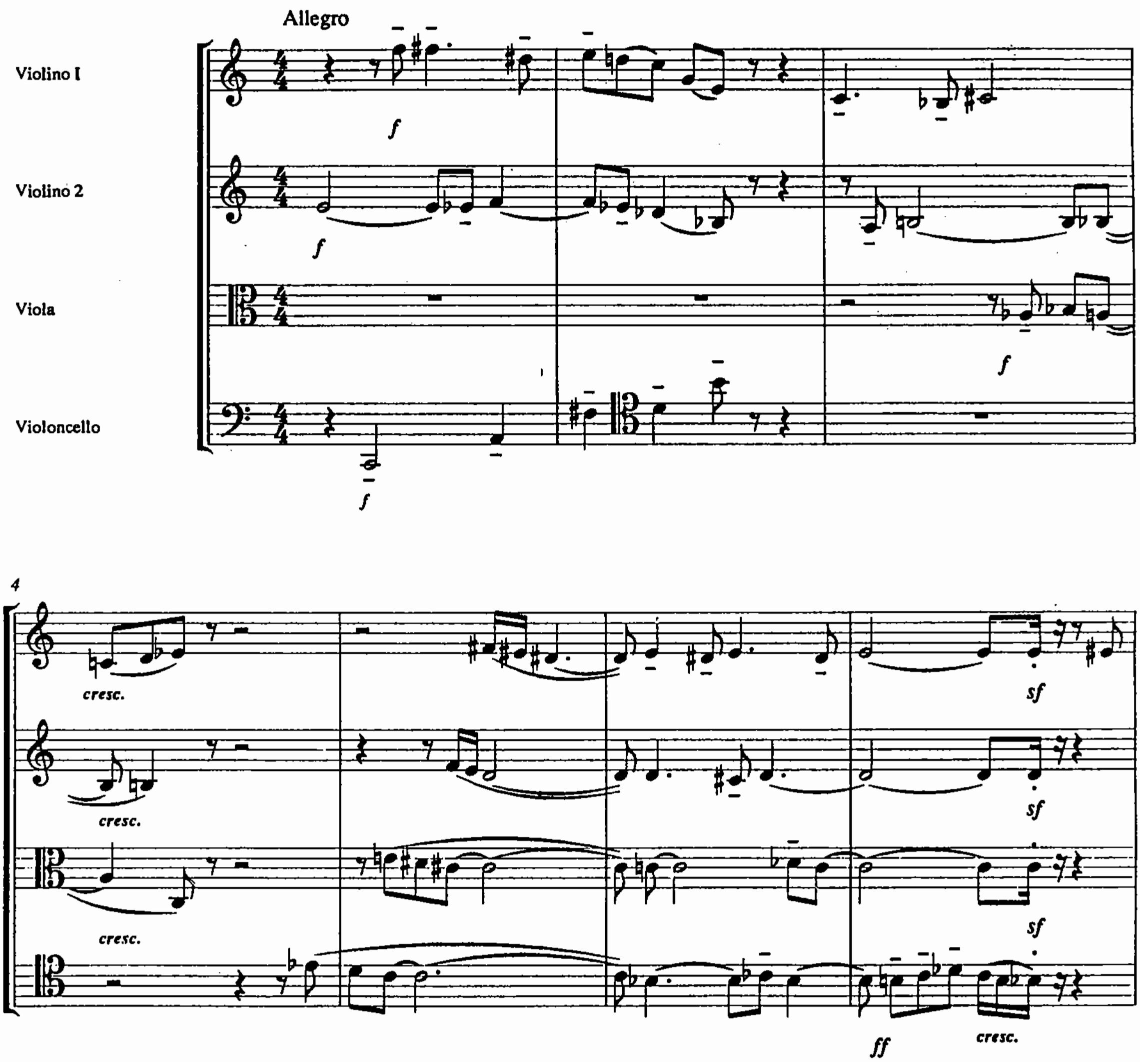



Illustration 43

Software for Printing Music -- 14
Oxford Music Processor (Richard Vendome)

Computer: IBM PC or compatible
Output device: Gould Colorwriter 6320

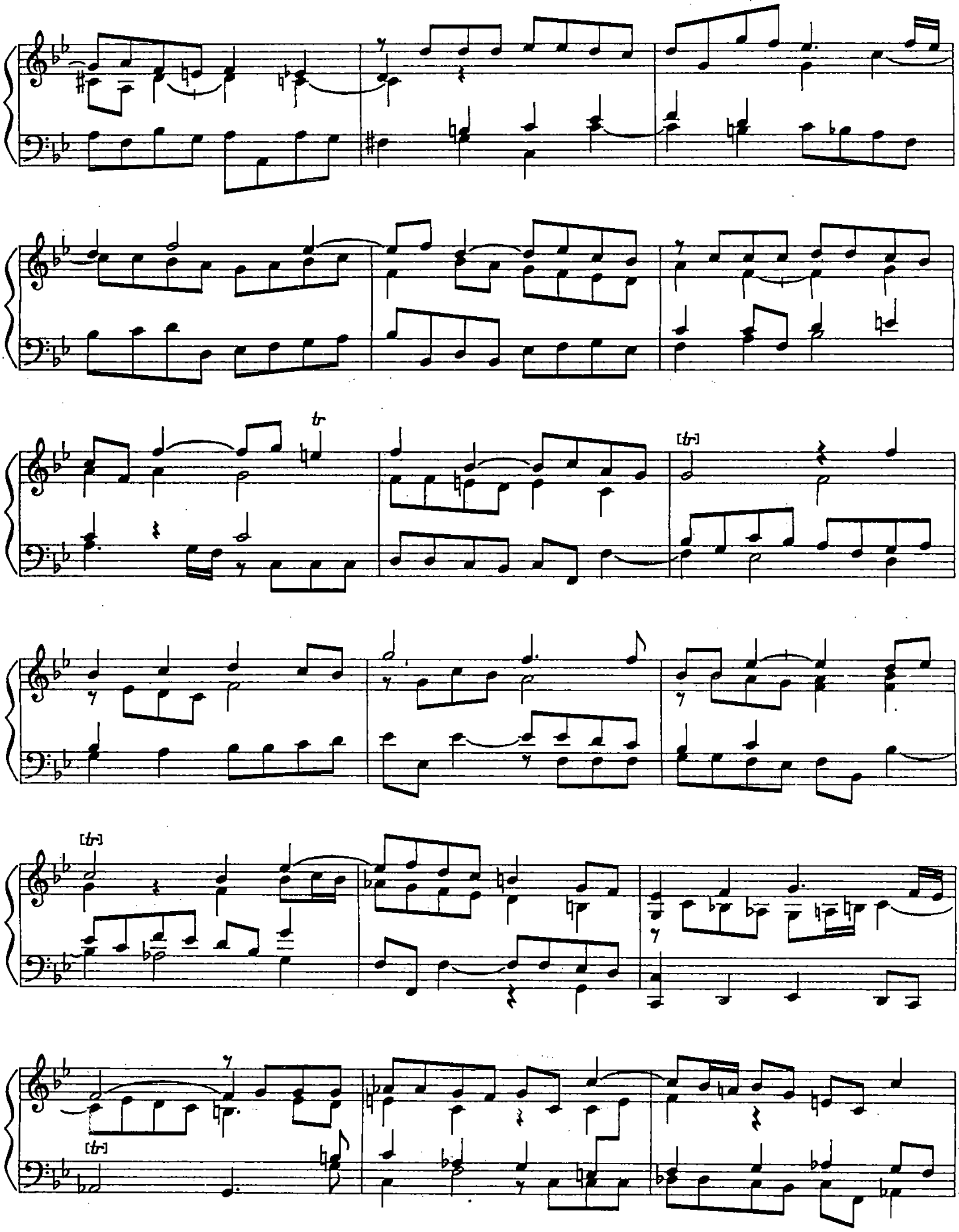
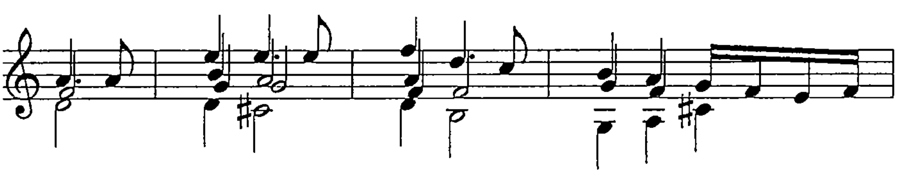
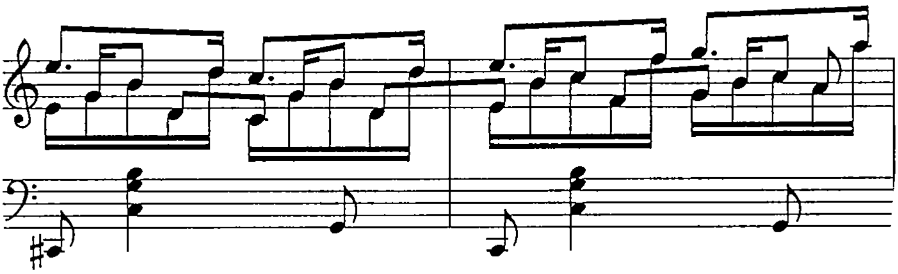



Illustration 44

Software for Printing Music -- 15
ETH (Giovanni Müller)

Hardware: LILITH workstation
Software: interactive editor in Modula--2 under development



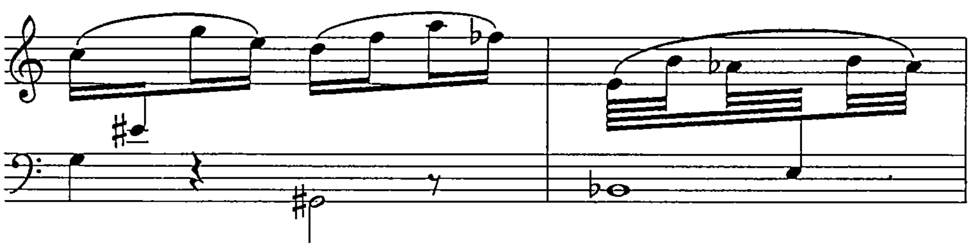


Illustration 45

Software for Printing Music -- 16
ALPHA/TIMES (Christoph Schnell)

Computer: Macintosh
Printing device: Apple ImageWriter II

Unreduced

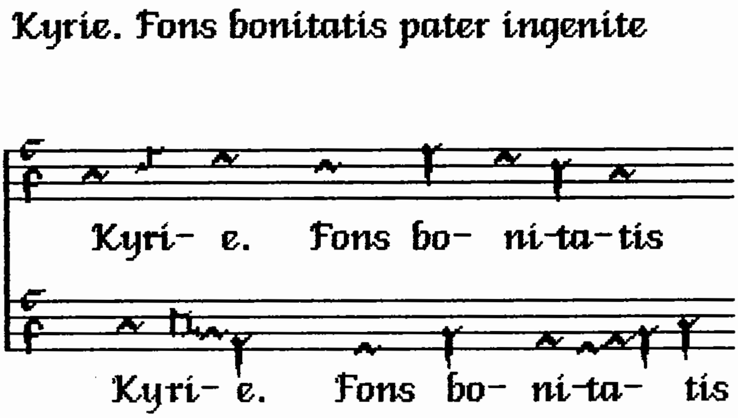
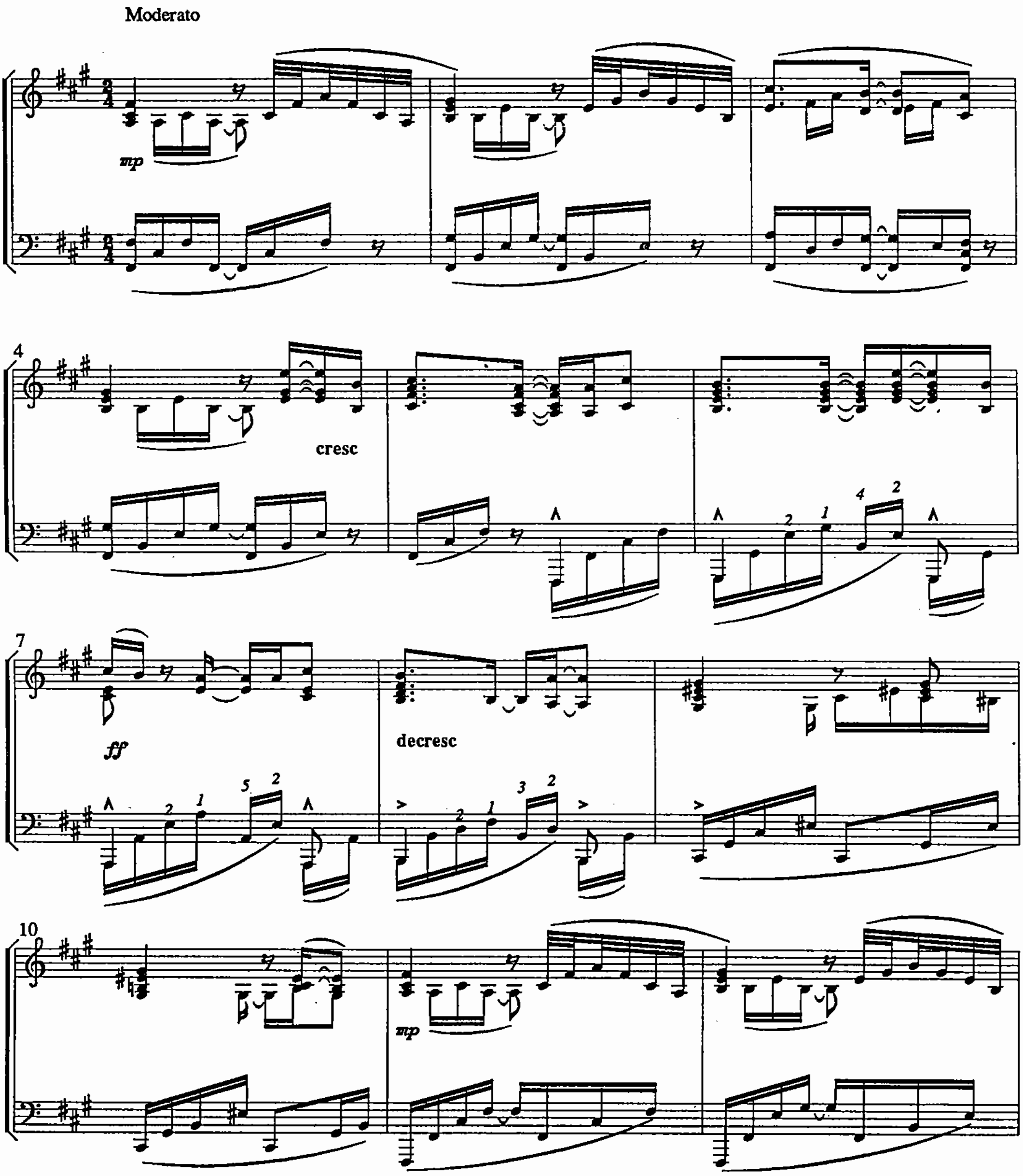


Illustration 46

Software for Printing Music -- 17
Interactive Music System (Lippold Haken, Kurt Hebel)

Computer: PLATO System
Printing device: Apple LaserWriter

Prélude

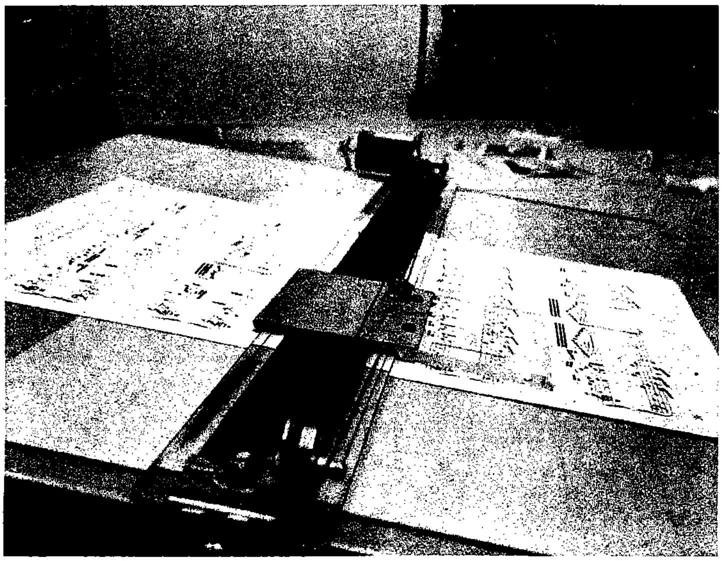
Tom Cortese

An Early System for Printing Music:
Jef Raskin's Lingua Musica pro Machinationibus IV
(1966-67)

The recurrence of certain concepts in efforts to represent and print music is well illustrated by work done by Jef Raskin in the 1960's. Raskin had been involved as a high school student in the earliest phase of DARMS development. As a graduate student in computer science at Pennsylvania State University in 1966-67, he developed a Lingua Musica pro Machinationibus to support music printing. It was designed to represent music of arbitrary complexity and to reproduce it at any size. The printing program used vector graphics, with output from a Calcomp plotter.

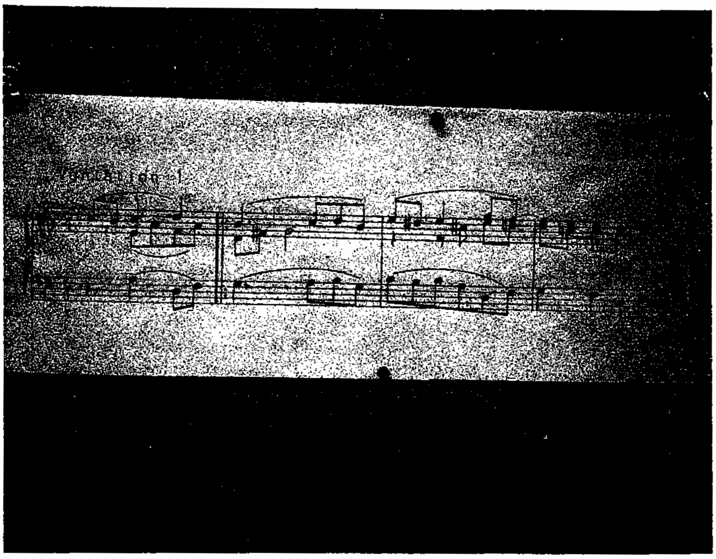
Problems of positioning were resolved by specifying X and Y axis locations. A drafting system coordinated with a keypunch machine facilitated data entry. A screen display was also supported. The screen could display notation that looked the same as the printed output (the only photograph made of screen display is the one shown here).

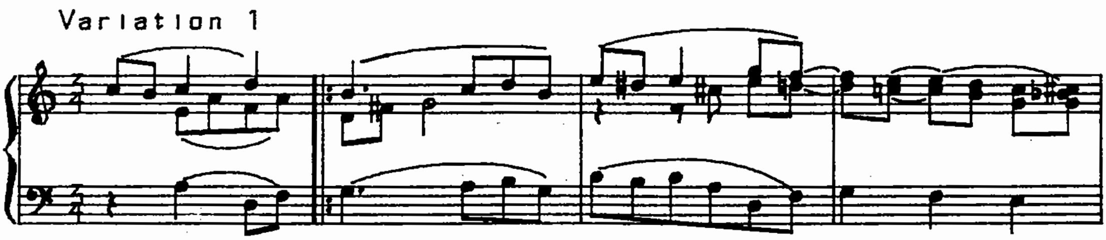
Raskin, a musician and conductor, subsequently gained recognition as a computer graphics artist, a reporter for *Byte Magazine*, and a designer of the Apple Macintosh. An important motivation in designing the Macintosh was, according to him, to make computer printing of music available inexpensively. Raskin· is the founder and president of Information Appliance, Inc. The Center extends special thanks to Mr. Raskin for making available the following illustrations and other documents.

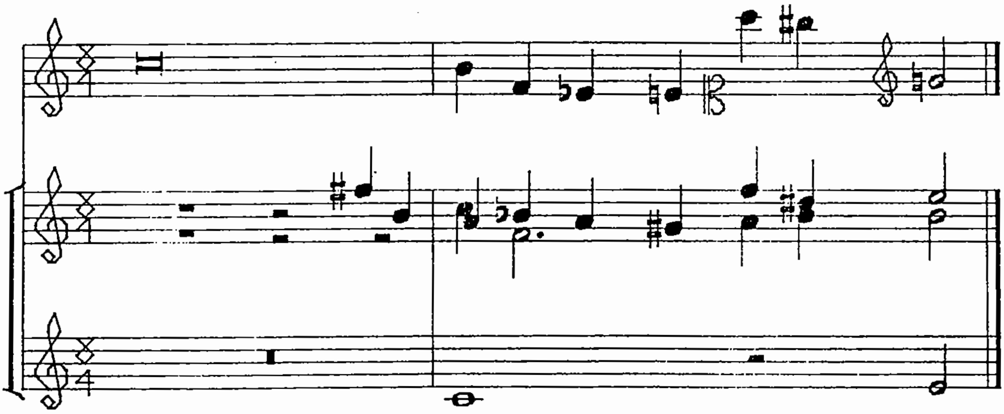
Karen Kalinsky entering the music of Bach onto punch cards using a combination of a keypunch machine and an X - Y graphics digitizer (shown in the following illustration).



Determination of X and Y coordinates.

Screen display (monitor for IBM mainframe).

Photograph of the first musical output.



Recent reproduction of the same material.

Another example from the same system.

News

Standards for Musical Information

ANSI

The American National Standards Institute subcommittee charged with developing a capability for machine interchange of musical information (colloquial name, MIPS, for Musical Interchange Processing Standards; official name, ANSI X3V1.8M) held week-long meetings in Washington D.C. in November 1986, in San Jose in February 1987, and in Minneapolis in June. Charles Goldfarb (IBM) serves as chairman; Steven Newcomb (Center for Music Research, FSU) is vice chairman. Alan Talbot (New England Digital), the secretary, is compiling a "Journal of Technical Developments." Anyone interested in interacting with MIPS should contact the MIPS Secretariat c/o Steven R. Newcomb (Center for Music Research, Florida State University, Tallahassee, FL 32306-2098).

MIPS takes the view that its charge is to develop a "language" that can express any music that can be written in standard notation. The standard is intended "as a storage and interchange format for musical ideas." Provisionally, the subcommittee has decided to differentiate these kinds of musical data: "the underlying musical form ['core']; a set of performances ['gestural']; a set of scores ['visual']; and a set of theoretical analyses ['analytical']. This hierarchical structure will be codified in terms of elements; each element has a related information set consisting of attributes." The coding is compatible with Standard Generalized Markup Language, a tool developed by Goldfarb for designing structured languages.

IFF

The Interchange File Format (IFF) for music is a group of protocols to facilitate exchange of music, text, and video files in diverse formats. Originally developed by Electronic Arts for the Amiga microcomputer, IFF has been extended to other synthesizer-related environments. File segments are labelled to enable the user to determine whether he wants detailed information from them. One protocol (ILBM) supports raster graphics, another (8XVS) supports sound sampling, and a third (SMUS) supports sequencing information. Further information can be obtained from Jerry Morrison at Electronic Arts.

MIDI

A proposal to standardize MIDI (Musical Instrument Digital Interface) file formats has been made by Dave Oppenheim of Opcode Systems. At press time, a draft was being circulated to the MIDI Manufacturers Association and formal consideration was to be given at the meeting of the National Association of Music Manufacturers in Chicago (June 27 - 30, 1987). The standard would serve microcomputers with a MIDI interface.

Recent Events

MILAN

Luigi Finarelli and Goffredo Haus gave a presentation on "A Musical Database on CD-ROM" for a CD-ROM workshop sponsored jointly by the Italian Informatics Association (AICA) and the Department of Information Science of the University of Milan on **May** 20, 1986. Some examples of work previously done with the CNUCE system in Pisa were demonstrated.

OXFORD

A two-day conference on "Computers and Music Research" was held at the Computing Laboratory, Oxford University, on **July** 9 and 10, 1986. Representation systems, data structures, and methods of printing music were among the topics discussed. One practical result of the meeting was the establishment of the electronic "Music-Research Digest" initiated by Stephen Page, one of the organizers of the meeting. The 29 predominantly British participants represented diverse aspects of musical activity.

ESSEN

Dr. Helmut Schaffrath, chairman of the Study Group on Computer Retrieval of the International Council for Traditional Music, convened a three-day symposium (**October** 1 - 3, 1986) at the University of Essen, BRD, to discuss databases, automatic musical notation and analysis, and networks. A previous meeting in Helsinki had been held. The participants, who were from Denmark, France, Great Britain, Holland, Italy, and Germany, explored the Essen database of 4000 German folksongs and saw a demonstration of visual and sound materials stored on CD-ROMs and addressed by the German postal network (btx). [A substantial corpus of encoded folksongs has been deposited with the Oxford Text Archive.] A technical manual in German describing the encoding and format of the data is available at Essen University; an English translation is in progress. Dr. Schaffrath also moderates a continuing electronic discussion of computer projects in ethnomusicology. The electronic address is JMP100@DE0HRZ1A.EARNNET.

CHICAGO

Several areas of computer involvement were discussed at the conference on music bibliography organized by Kären Nagy and hosted by Northwestern University in Evanston, Illinois, on **October** 9 - 12, 1986. Among the papers given were those of John Howard (Harvard University) on "RISM Series A/II: Music Manuscript Bibliography and Electronic Data Processing," Michael Fling and Kathryn Talalay (Indiana University) on "Music Bibliographic Instruction on Microcomputers," Nicholas Temperley (University of Illinois) on "The Problem of Definitive Identification in the Indexing of Hymn Tunes," Michael Keller (Yale University) on "New Bibliographic, Literary, and Musical Tools: The Italian Music and Lyric Poetry of the Renaissance Project," and Arthur Wenk (Québec) on "Varieties of Musical Analysis: Building an Analytical Sieve." The conference was supported in part by the National Endowment for the Humanities.

ZURICH

A two-day workshop on "Music Notation by Computer" was held at the Institut für Informatik of the Eidgenössische Technische Hochschule in Zurich on **October** 17 and 18, 1986. Bruno Spörri of the Schweizerisches Zentrum für Computermusik organized the meeting with the help of several colleagues. There were five speakers (Donald Byrd, Armando Dal Molin, John Maxwell, Giovanni Müller, and Bernhard Päuler) and four systems demonstrations (by Etienne Darbellay, Christoph Schnell, Karl Steinmann, and Christopher Yavelow).

COLLEGE PARK, MARYLAND

George Houle, Professor of Music at Stanford University, gave as a keynote address at the Handel Symposium at the University of Maryland in late **October** a discourse on "Editing Handel: Performance, Scholarship, and Technology." His paper commented on ways in which techniques of printing music in the past encouraged the notion that a "definitive monument of each work" could be created from multiple sources and suggested that eighteenth-century music might be well served in the future by the flexibility offered by emerging technology.

LONDON

A "Review of Data Bases for Eighteenth-Century Sources" was one component of a research students' study day sponsored by the Royal Musical Association in London on **November** 28, 1986. The event, held at the Institute for Historical Research, Senate House (University of London), was organized by Michael Burden, Irena Cholij, and Simon Hughes. Its overall focus was on eighteenth-century English music.

The second annual conference of the Association for History and Computing was held at Westfield College, University of London, from **March** 20 to 22, 1987. Papers on database methods, academic word processing, and typesetting were included.

COLUMBIA, SOUTH CAROLINA

Papers on music projects were read by Michael Keller (Yale), Roger Dannenberg (Carnegie Mellon University), and Linda Sorisio (IBM, Los Angeles) at the Eighth International Conference on Computers and the Humanities, held at the University of South Carolina (Columbia, SC) on **April** 9 - 11, 1987.

LISBON

Barry Brook spoke about the uses of computers at a conference on major trends in musicology. The conference, sponsored by the Gulbenkian Foundation, was held in Lisbon in **April**.

NEW YORK

A seminar on "Music Publishing and New Technology" was given at the annual meeting of the Music Publishers Association in New York on **June** 3, 1987. One music printing program for the IBM PC, *The Note Processor*, was demonstrated.

Forthcoming Events

SOUTHAMPTON

A session on "Computers in Early Music Research" was scheduled to be given during the fifteenth annual conference on Medieval and Renaissance Music held at Southampton University (U.K.) from **July** 24 to 27, 1987.

BOLOGNA

"Databases and the Practice of Musicology" is the title of a study session organized by CCARH for the meeting of the International Musicological Society in Bologna, Italy, scheduled for **August** 27 - **September** 1, 1987. The session is designed to offer detailed descriptions of two large database projects currently underway as a basis for a broad consideration of ways in which the methods and products of scholarship are being extended. Eleven participants from five countries represent the viewpoints of research scholars, editors, publishers, and software designers. A one-day meeting on "Computer-Based Approaches to Musical Data and Analysis: an Exchange of Technical Information" and an open discussion of the aims of the RENARC project (see **Databases of Text**) will also occur during the IMS meeting.

NEW ORLEANS

Maureen Buja of Garland Press has organized a session called "Computers, Musicology, and Music Instruction: Current Projects" for the joint national meeting of the College Music Society and the American Musicological Society in New Orleans in **October** 1987. Participants include Ann Woodward (videodiscs), Julian Elloway (the Oxford Music Processor), Michael Keller (madrigal/lyric poetry project), and Giulio Ongaro (a database for archival research).

Online Communications

HUMANET

ScholarNet, based at North Carolina State University in Raleigh, North Carolina, offers a variety of telecommunications services in exchange for a one-time membership fee. Its humanities branch, HumaNet, will concentrate initially on materials for English, history, philosophy, and religion. Access to DIALOG databases and an online encyclopedia (not specifically identified) is provided by the service. Subscription requests should be addressed to General Videotex Corp., 3 Blackstone Street, Cambridge, MA 02139.

HUMANIST

HUMANIST is an electronic mail network for information concerning computing in the humanities. It is seeking affiliation with the Association for Computers and the Humanities and with the Association for Literary and Linguistic Computing. Enquiries should be addressed to George Brett (*ECSGHB@TICC.BITNET*). Those wishing to subscribe should contact Willard McCarty (*McCARTY@UTOREPAS.BITNET*).

MUSIC-RESEARCH DIGEST

Stephen Page initiated an electronic mail Music-Research Digest in **July** 1986. Installments appear approximately biweekly and cover a host of topics, ranging from casual enquiries to detailed questions of methodology. Administrative requests should be sent to "*Music-Research-Request@uk.ac.oxford.prg*"; contributions may be sent to "*Music--Research@uk.ac.oxford.prg.*" Please note that the second part of the address must be reversed from most countries outside the United Kingdom (*e.g.*, "*prg.oxford.ac.uk*"). Distribution in the United States is being provided by Brad Rubenstein ("*brad@ingres.berkeley.edu*" [Arpa] and "*...!ucbvax!ingres!bradr*" [UUCP]).

MUSICOMP

An ongoing "electronic conference" on music and computers (called *CRT:MUSICOMP*) was started at the University of Michigan in the autumn of 1986. Outside users are welcome to participate but must first establish an account to use the UM system. Enquiries may be addressed to Ms. Julie Amo, Business Office, Computing Center, 1075 Beale Avenue, Ann Arbor, MI 48109 (313-764-8001).

TELETAU

A library of roughly 800 encoded works together with software of various kinds is available from the TELETAU (formerly TAUMUS) system, which is operated from Pisa and Florence. The electronic addresses for TELETAU are *MUSIC3@ICNUCEVM .BITNET* and *CHERU@IFIIDG.BITNET.*

Current Technical Research

Optical Scanning

A significant amount of interest in optical scanning of music, a possibility rigorously explored around 1970, has arisen in the past year. Some of it appears to have been promoted by the marked increase in availability of inexpensive digitizing equipment. Image capture is only the first stage in a long series of processes required for intelligent recognition and data manipulation, which must be carefully distinguished from "dumb" replication of the digitization. In multi-user environments, interest in optical character recognition may occur in conjunction with research related to image processing, signal processing, or automatic transcription.

Nicholas Carter, a postgraduate at the University of Surrey (Guildford, UK), where image processing techniques have been highly developed for some time, is writing programs in 'C' to run on a Gould microcomputer in a UNIX environment. A Canon A3 laser scanner is used for image capture. Carter reports some success with pitch recognition. An article on "Acquisition, Representation, and Reconstruction of Printed Music by Computer: A Review" by Carter and his supervisors, R. A. Bacon and T. Messenger, is forthcoming in *Computers and the Humanities*.

Bernard Mont-Reynaud, who has devoted many years of research to automatic transcription of taped music, has been exploring optical scanning techniques on the Xerox system at the Center for Research in Music and Acoustics (CCRMA) at Stanford University. In its preliminary stages, his work focuses on screen manipulation of visual elements of musical notation. This requires differential manipulation (rotation, enhancement, diminution) of horizontal and vertical planes (see Illustration #47).

The Waseda University (Tokyo) team led by Prof. Samadu Ohteru has been developing competence in automatic recognition of printed music, and in its translation to and from Braille, for several years. [See Illustration #48 for a representative sample of the level of complexity with which this system can currently deal.] Score reading is one component of a series of tasks implemented in the course of robotics research and development. [See also **Facilities.**]

Henry Baird, a specialist in image matching software at AT&T Bell Laboratories in Murray Hill, NJ, has recently begun to work on optical recognition of music. Others reporting some involvement in optical scanning research include Brad Rubenstein (Sun Microsystems and UC Berkeley); Peter Preston-Thomas (IBM PC; University of Ottawa); Neil Martin (IBM PC; undergraduate project in computer science, Thames Polytechnic, London); and Alastair Clarke (IBM PC; University of Cardiff).

Automatic Transcription

A group headed by Professor Seiji Inokuchi in the Department of Control Engineering at Osaka University has been involved for several years with diverse projects involving automatic transcription. Their current focus is on computer performances that provide the variable qualities that distinguish human performance. The analysis of performed music and the use of modelling techniques are steps toward this goal. The work is carried out using an Apollo Domain DN570AX2 computer with a tablet scanning system. Professor Inokuchi is a coauthor of numerous publications concerning this research. Writings on automatic transcription of Japanese folksong have appeared in conference proceedings of engineering symposia held in Montréal (Seventh ICPR, 1984) and Tokyo (ICASSP, 1986). [On other Japanese work related to automatic transcription, see **Facilities: Tokyo.**]

An extensive effort to transcribe Indian music is being made by an ISTAR (International Society for Traditional Arts Research) team with members in Holland, France, India, and elsewhere. A "melodic movement analyser" designed by Bernard Bel generates a graphic notation that Indian collaborators have praised. The graphs, or melograms, are converted into sequential lists of symbols. A number of different ways of representing the data have been developed. Melodic and rhythmic analyses are performed on the captured data. The ISTAR team includes Wim van der Meer of the Netherlands, B. Bel (France), J. Kippen (England), Joep Bor (The Netherlands), and P. Müller (Germany). An Apple // is the main piece of hardware involved. ISTAR publishes its own newsletter, in which extensive commentary can be found. For copies, write to Arcee Press, 5 Desh Bandhu Gupta Road, New Delhi 110055, India. For further information, write to Bernard Bel or Wim van der Meer.

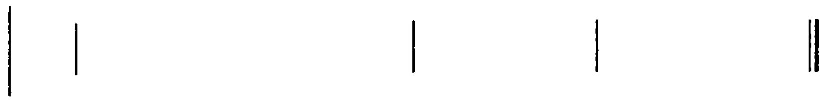
Illustration 47

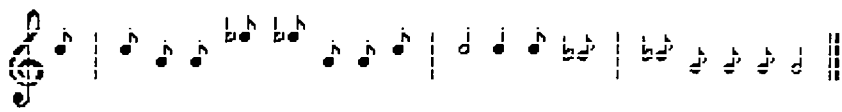
Optical Scanning: Fundamental Concepts

Bernard Mont-Reynaud: Screen manipulation of graphic elements.

(1) Original example.

(2) Simple vertical extraction.



(3) Residue from simple horizontal extraction.

(4) Object (eight-note) extraction.

(5) Rotation of vertical axis.

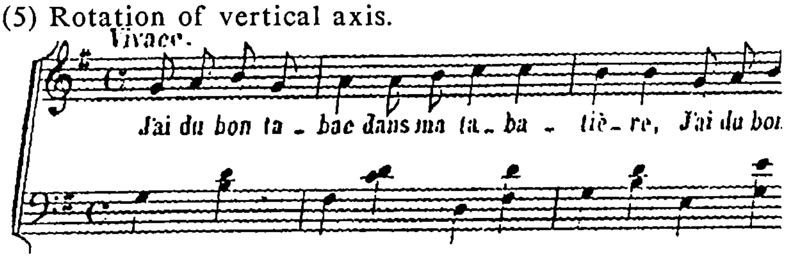


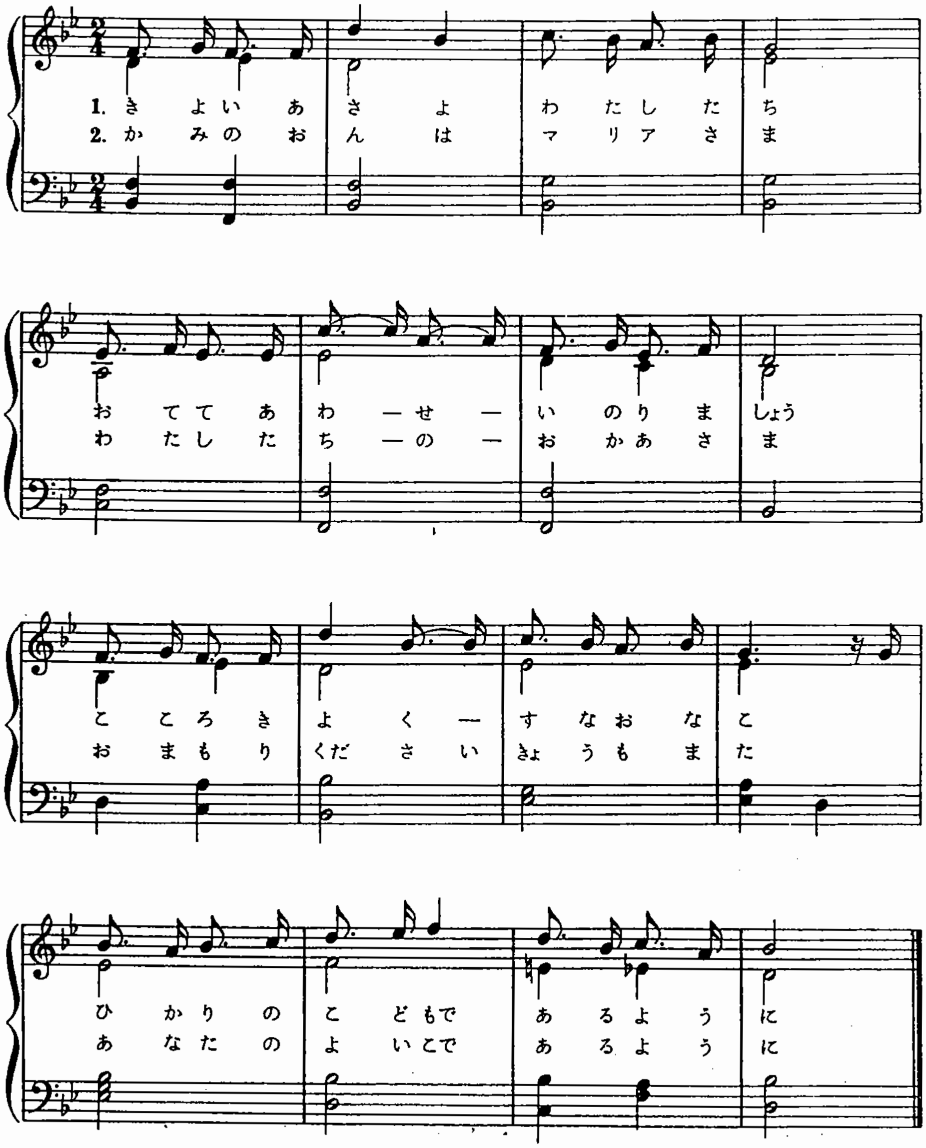
Illustration 48

Optical Scanning: Sample of Recognizable Music

Waseda University (Prof. Ohteru *et al*):

"Ochi no inori," the devotional song shown below, represents the level of notational complexity that can currently be accommodated by the group's Automated Score Recognition System.

2. あさのいのり



Other Areas

Computer studies of musical performance are being carried out in several places. Johan Sundberg and others in Stockholm have been attempting to map musically essential characteristics of musical performance using a Macintosh and MIDI synthesizers. Nicholas Cook, working at the University of Hong Kong, has been investigating performance nuance as a function of formal structure. His work is carried out with a Hewlett Packard Integral PC with custom-built devices and software.

THE MUSES (THEory of MUSic Expert Systems) project, an undertaking of the IBM Scientific Center in Los Angeles, is designed to develop tutorials in music theory appropriate for elementary harmony courses. Headed by Linda B. Sorisio, the project involves simultaneous use of sound and graphics in an "expert system" environment. Currently, it is based on a mainframe computer. Ms. Sorisio is planning to distribute a newsletter on the use of computers in music teaching at the university level.

Music is being examined as a model for a new system for representing events in time in exploratory research being carried out in Los Angeles area schools. Apple Computer is funding the project, which is headed by Apple Fellow Alan Kay. Kay is assisted by John Steinmetz, Ann Marion, and a number of musicians. The project is called Apple Vivarium.

Theses and Dissertations in Progress

* Clive Broadbent (Department of Music, Durham University) is attempting to develop a self-contained system for analytical tasks. Music encoding and printing are practical concerns of his work.

* Christine Buyle (Belgium) is writing a thesis on a computer implementation of a generative grammar for tonal music.

* Nicholas Carter (University of Guildford, Surrey) is seeking a general solution to the problem of automatic pattern recognition of printed music. His research is being conducted in a UNIX-based image processing context. [See **Current Technical Research.**]

* Alastair Clarke, a research student in the Department of Computing and Mathematics at the University of Cardiff, is working on computer typesetting of music and optical scanning.

* Walter Colombo (Mathematics, University of Milan) is developing a series of programs to facilitate harmonic analysis based on Schoenberg's theory of tonal regions.

* Shane Dunne was to write an undergraduate thesis in computer science at the University of Western Ontario (Canada) concerned with the development of a software tool to produce small amounts of musical material at very high resolution on a laser printer. An historical review of efforts to print music by computer is included.

* Luigi Finarelli (Computer Science, University of Milan) is developing a series of UNIX-based programs for elementary analysis procedures. His programs use TAUMUS encoding.

* Timothy Koozin (Music, University of Cincinnati) is doing a pitch-class set analysis of the works of Toru Takemitsu.

* Samuel McKinney completed a thesis on computer-assisted music analysis at the University of Brussels in 1986 and is now working towards a Ph.D. in music theory at the University of California at Santa Barbara. His completed study surveys the major studies of the past three decades, distinguishing statistical, linguistic, and artificial intelligence approaches.

* Bruce McLean (Engineering, SUNY Binghamton) intends to complete his thesis on a DARMS canonizer by August 1987. His canonizer was demonstrated in New York in May.

* N. G. Martin, in a B.Sc. Honors project in computer science (Thames Polytechnic), is investigating methods of identifying a subset of musical symbols in a digitized image of printed music. He is using an IBM PC with Turbo Pascal.

* Rosa Michaelson's M.Sc. thesis (Edinburgh, *c.*1984) considers diverse methods of music input and transcription. Related matters are also considered in the M.Sc. thesis of A. S. Keane (Artificial Intelligence, Edinburgh).

* Stephen Page (Computer Science and Music, Oxford University) is developing a "Query System for Music Information Retrieval." His approach favors description-oriented queries over special-purpose programs and operates on DARMS-encoded data.

* Alastair Pearce (Music, King's College, London) is developing an information retrieval package for use with DARMS-encoded music in connection with a thesis on "Computer Applications in Music."

* Brad Rubenstein (Computer Science, UC Berkeley) expects to complete his thesis on data management of musical information by the summer of 1987.

* Christoph Schnell's thesis (Computer Science, Zurich) was published in German in 1985 (see Bibliography). Parts of it are scheduled for publication in English.

Comprehensive Publications (Recent)

Musikometrika is the title of an intended series of publications "specially oriented towards cooperation between musicology and linguistics," according to a recent announcement. It will form a subseries of *Quantitative Linguistics*. These are some of the topics for inclusion: (1) structural units of musical language, including rule systems and principles of segmentation; (2) statistical and information-theoretical characteristics of specific repertories; (3) relationships between music and speech generally, between music and text in specific works, between vocal and instrumental music, and between composed and folk music; (4) structural and quantitative characteristics of mode, rhythm, and pitch; and (5) frequency vocabularies of musical texts. Enquiries and contributions may be sent to Dr. Moisei G. Boroda, State Conservatory, Griboedova 8, 380004 Tbilisi, USSR, or to the editors of *Quantitative Linguistics*.

Lelio Camilleri's article on "The Current State of Computer Assisted Research in Musicology in Italy" recently appeared in *Acta musicologica*, LXVIII/2. A revised and expanded version with the title "Computational Musicology in Italy: An Overview of Basic Concepts and Applications" is in preparation.

Sebastian Rahtz is the editor of *Information Technology in the Humanities*, newly published by Ellis Horwood [UK; distributed in North America by Halsted Press (John Wiley), ISBN 0-470-20852-X]. A chapter on music applications has been contributed by Alastair Pearce.

Alexander Brinkman has recently completed a book on *Pascal Programming for Music Research*. It covers standard topics in programming and also provides special consideration of such topics as "prime form/normal order algorithms," "spelling pitch structures," and "score processing." Its sample applications are drawn from musicological experience, so that "interpreting DARMS pitch code" provides an example of the use of an array and "interpreting DARMS duration codes" an example of a procedure for rational arithmetic. DARMS, MUSTRAN, and SCORE codes are summarized and a DARMS translator is given in an appendix.

Coda is an inexpensive catalogue of music software published by the Wenger Corp. (Owatonna, MN). Oriented mainly toward sound and instructional programs, it lists roughly 500 items. These are variously for Apple, IBM, Commodore, and Atari microcomputers.

A *MIDI Buyer's Guide* is published annually by *Keyboards, Computers, and Software Magazine*. Although the magazine is directed toward the popular music market, its list of software publishers (with addresses) and products (with prices) is quite comprehensive. It covers products sold in the U.S. for the Apple, Atari, Commodore, and IBM (compatible) microcomputers.

Resource List for Humanities Computing Information

Advances in Computing and the Humanities is an interdisciplinary series edited by Ephraim Nissan (Ben Gurion University) and published by JAI Press in Greenwich, CT. "Musical text processing" is one of its areas of interest.

An Association for History and Computing was formed in England over the months following a well attended conference at Westfield College, London, in March 1986. For details about the Association, please contact Dr. Peter Denley; for information about its newsletter, Bill Speck; and to propose a workshop, Nicholas Davidson. Manchester University Press (Oxford Road, Manchester M13 9PL, UK) has recently published in paperback *History and Computing*, a compendium of several dozen short articles giving an overview of the current range of computer uses in historical scholarship. It represents the proceedings of the inaugural meeting.

Oryx Press (Phoenix, AZ) is currently assembling an *Electronic Scholar's Resource Guide* under the general editorship of Joseph Raben. The guide, which will be available both electronically and in print, aims to cover all humanities disciplines. For further information, contact the editor at Paradigm Press.

Bits and Bytes Review is a new publication that presents extensive reviews of computer products and resources for the humanities. It is published nine times a year. The editor is John J. Hughes. The first issue, which appeared in October 1986, featured detailed, illustrated reviews of the IBYCUS Scholarly Computer, developed by the classicist David Woodley Packard for teaching and research involving ancient languages (Latin, Greek, Hebrew, Coptic), and Nota Bene software for academic word processing involving modern languages.

Humanities Research Tools in Machine-Readable Form

Oxford Text Archive

The Oxford Text Archive, which is maintained by the Oxford University Computing Service, holds machine readable copies of several hundred works and maintains a running list of information about texts in machine-readable form held at other sites around the world. Many texts (rated 'U') can be made available at a modest charge; some ('A') require permission from the depositor; some ('X') are restricted. A large number of the texts are of sources in ancient or non-Western languages. U-rated texts include thirteen plays (first quarto) and the sonnets of Shakespeare, three epic poems by Milton, and Chaucer's *Canterbury Tales*. A revised catalogue of holdings was issued in April 1987 and is available from Lou Burnard. Charges are approximately $7.50 per text plus $22 (UK) or $37 (elsewhere) per tape.

Oxford English Dictionary

Oxford University Press is preparing an electronic edition of the venerable *Oxford English Dictionary*. The new edition will be issued on two CD-ROMs that will be searchable with appropriate software. It will also form the basis of an ongoing databank.

English Drama

English drama is the focus of two large machine-encoded projects. *Records of Early English Drama* is, in the first instance, a computer-typeset series of archival studies intended to "locate, transcribe, and edit all surviving documentary evidence of drama, minstrelsy, and ceremonial in England until the official closing of the theaters in 1642." REED is an international collaboration based in Toronto. Efforts to make the completed series available in machine-readable form are being explored. Meanwhile, a plan to publish in computer-readable form the complete corpus of extant early English dramas themselves is receiving serious consideration at Oxford University. Each text would be available on a floppy disc with its own built-in dictionary.

Greek

The Thesaurus Linguae Graecae, a databank of 60 million words representing 8,400 works from Homer to A.D. 600, provides several services that could be of value to scholars who have occasion to search classical Greek texts. Specific texts may be ordered on tape (a minimum order is $100, but many single works are less than $5). Searches can be run in-house for $10 each, with a surcharge of $.10 a page for printing and documentation. The entire corpus of encoded material can be obtained under license on a CD-ROM; a five-year license is $300 for individuals and $500 for institutions, and additional fees may pertain in some situations. The TLG, on which development work continues, is housed at the University of California at Irvine and issues a periodic newsletter.

Latin

The newly formed Packard Humanities Institute in Los Altos, California, is preparing a database of classical Latin writings. These will be issued on a CD-ROM that can be searched by microcomputers having appropriate hardware and software capabilities. The first installment of data is expected to be available by December 1987.

Log of Current Activities and Applications

This listing of current and recent activities is intended to indicate the state and direction(s) of current research, to identify substantial bodies of data in machine-readable form, and to facilitate communications between users who may be engaged in projects that share a common focus or a common technical approach. For some readers it may make available in preliminary form information that would not be circulated in print without significant delay, while for others it may emphasize the need for interdisciplinary awareness and communication. For an exhaustive bibliography of published work in the field, one should consult Deta Davis's *Computer Applications in Music* (Los Altos, CA, 1987), which will contain more than 3,000 listings.

Our listing is organized under four main headings: (I) bibliogaphies, databases, and editions; (II) musical analysis and analytical methods; (III) general applications in musical analysis and musical information processing; and (IV) musical information processing facilities and programs of study. Placement under the first heading (I) is determined by whether the data is primarily textual or musical and whether the aim is primarily bibliographical or analytical. The second heading (II) includes those projects in musical analysis or in the study of analytical methods which focus on a specific repertory or musical objective. Harmonic, rhythmic, melodic and other kinds of analysis come under this rubric. Under the third heading (III) are grouped those activities whose main objective is to create an overall approach to the processing of musical information (data structures, representation systems, and computer procedures) or to explore defined musical relationships exhaustively (computational music theory). The final section (IV) lists integrated systems for musical information processing and programs of study oriented towards computer applications in musicology.

Occasionally the information received on a project is insufficient to insure its proper classification. Projects that involve the computer only for the purpose of text processing have not been included in the listing. For computer-based discographies and studies primarily concerned with sound synthesis, acoustics, perception, artificial intelligence, and classroom instruction, we suggest consultation of such journals as the *Computer Music Journal*, *Music Perception*, and *The Journal of Computer-Based Instruction* as well as bibliographical databases.

I. Bibliographies, Databases, and Editions

A. Bibliographies and Indices of Text

Barrell/Clavichord
Title: *Eighteenth-Century Literature for the Clavichord*
Investigator: Stephen Barrell
Place: Amsterdam
Scope: Inventory of text about and music for clavichord, with republication of the music in facsimile format
Computer (OS): Zenith 181-92 (MS DOS 3.2)

Bent/Nineteenth-Century Music Theory
Title: *Bibliography of Nineteenth-Century Music Theory*
Scope: printed sources of music theory, 1750-1910
Investigator: Ian Bent
Place: Cripps Computer Centre, Nottingham University
Time: 1982--
Computer: ICL 2988
Software: FAMULUS and FAMULUS 77
Associated Literature: "The 'Compositional Process' in Music Theory, 1713-1850," *Music Analysis* **III** (1984), 29-55

Crawford/Renaissance Liturgy
Title: *Renaissance Liturgical Imprints: A Census*
Scope: creation of a database for books printed between 1450 and 1565 [2500 records to date; 7500 records anticipated]
Investigator: David Crawford
Associate: James Borders
Place: University of Michigan
Time: *c.*1983--
Computer: IBM 3090
Database software: SPIRES

Duggan/Incunabula
Title: *Italian Music Incunabula: Printers and Types* [Berkeley: UC Press, 1988]
Scope: descriptive bibliography of books printed before 1501 with music or space for music
Investigator: Mary Kay Duggan
Place: UC Berkeley
Computer (OS): VAX (Unix)
Associated Literature: "A System for Describing Fifteenth-Century Music Type," *Gutenberg-Jahrbuch* (1984), 67.

Malm/Stearns Collection
Title: *The Stearns Collection of Musical Instruments: A Catalogue* [Vol. I in press]
Scope: lists 2,000 musical instruments
Head of project: William Malm
Associate: James Borders
Place: University of Michigan
Database software: SPIRES

Mercer/Grove
Title: Index to the *New Grove Dictionary of Music and Musicians*
Scope: a traditional comprehensive index of the complete work; output conforms to the British Standard for Indexes
Head of project: David Mercer
Associate: Stephen Lansdown
Place: Tasmania
Time: completion anticipated late in 1988
Computer (OS): NEC APC III (MS DOS)
Software: custom

B. Bibliographies and Indices of Music

Baron/French Airs
Title: *Inventory of French Air Collections*
Scope: listing and identification of duplicate melodies
Investigator: John Baron
Place: Tulane University

Bernskiöld/Swedish Unison Song
Title: *Unison song in the labour, temperance and revivalist movements in Sweden, 1850-1920*
Purpose: a stylistic analysis of the music with particular emphasis on the creative interaction between different socio-cultural forms of expression; 4500 melodic incipits and 9000 texts are involved
Investigator: Hans Bernskiöld (started by Inger Selander)
Computer: IBM PC AT (PC-DOS)
Software: custom

Bernstein/Scotto
Title: *A Catalogue of the Music Published by Girolamo Scotto*
Scope: 1,000 pages of information
Head of project: Jane Bernstein
Place: Tufts University
Computer: DEC VAX
Associated Literature: "The Burning Salamander: Assigning a Printer to Some Sixteenth-Century Music Prints," *Notes* 42/3 (1986), 483-501

Christenson/Shaker Tune Index
Title: *Music of the Shakers from Union Village, Ohio: A Repertory Study and Tune Index of the Manuscripts (1840-50)*
Purpose: to create an alphabetical tune index of the contents of eleven manuscripts
Investigator: Donald E. Christenson
Advisor: Keith Mixter
Place: Ohio State University
Time: 1986-8
Computer: Apple Macintosh
Encoding: Plaine and Easie code

ClinkscaleE/16th-Century Incipits
Title: *Sixteenth-Century Répertoire*
Scope: database of pitch incipits of all sixteenth-century printed music
Investigator: Edward Clinkscale
Place: University of California, Riverside
Computer: IBM PC AT
Encoding: numerical
Database software: Rbase 5000

Davis/Concertos
Title: *A Thematic Identifier Catalogue of Eighteenth-Century Concertos*
Scope: comprehensive index of the standard repertory
Investigator: Elizabeth Davis
Place: New York University
Computer: Cyber 170
Encoding: MUSTRAN

Floyd/CBMR Database
Title: *CBMR Database: A Union Catalog of Black Music Holdings in Chicago-Area Libraries*
Purpose: to provide an integrated reference system for books, recordings, sheet music, manuscripts, and photographs relating to black music
Head of project: Samuel A. Floyd, Jr.
Associates: Marsha J. Reisser, Edward Mannye, Virginia McLaurin, Diane Raptosh
Place: Center for Black Music Research, Columbia College, Chicago
Time: 1985--
Computer (OS): Texas Instr. Business Pro (MS DOS)
Software: custom

HillG/Historical Editions

Title: *A Guide to Music in Collected Editions, Historical Sets, and Monuments*
Aim: to provide an index to the contents and a complete bibliography of the editions previously covered in Heyer's book; musical incipits are encoded if titles are ambiguous [see Illustration]
Head of project: George R. Hill
Associate director: Barbara Renton
Collaborators: Garrett Bowles, Robert Falck, Irving Godt, Richard Jones, Sterling Murray, Gordon Rowley, Norris Stephens, Eric Western (software)
Place: City University of New York (with support from NEH)
Time: 1986-8
Computer: various microcomputers
Musical encoding: custom (Garrett Bowles); see Illustration #49

Kennedy/Burgundian Chanson Index

Title: *Six Chansonniers: A Study of the Central Repertory of the Burgundian Chanson*
Purpose: to make available an index (pitch only) of the chansons found in six extant Franco-Burgundian chansonniers
Investigator: Duff Kennedy
Place: UC Santa Barbara (Ph.D. thesis in progress)
Computer: Tandy 1000; IBM PC
Software: modified version of Hughes' chant code with dBase III

LaRue/Symphonies

Title: *A Catalogue of Eighteenth-Century Symphonies*: Vol I. *IDENTIFIER* [in press, Indiana University Press]
Scope: identification and source files for all known symphonies from *c.* 1720 to *c.* 1810
Head of project: Jan LaRue
Assistants: Kathryn Shanks, David Cannata
Place: New York University
Time: 1982--
Computer(OS): Cyber 180 (NOS)
Encoding: MUSTRAN

Lewis/Gardano

Title: *Antonio Gardano, Venetian Music Printer, 1538-69: A Descriptive Bibliography*, 4 vols., NY: Garland, 1987
Scope: comprehensive study of 442 editions
Head of project: Mary Lewis
Place: Brown University
Time: 1983--87
Computer: Apple Macintosh, LaserWriter
Software: Professional Composer
Associated Literature: "Zarlino's Theories of Text Underlay as Illustrated in his Motet Book of 1549," *Notes* **42**/2 (1985), 239-267

Lincoln/Madrigal

Title: *The Italian Madrigal and Related Repertories: Indexes to Printed Collections, 1500-1600* [Yale University Press, 1988]
Scope: 34,000 melodic incipits representing a repertory of 6000 works (madrigals, frottole, laude, and related genres); incipits of all voices are given)
Head of project: Harry B. Lincoln
Place: SUNY Binghamton
Hardware: IBM 3090 (data); Nicolet Zeta plotter (music printing)
Encoding: DARMS
Software: custom, in PL/1 and PASCAL
Associated Literature: "A Description of the Database in Italian Secular Polyphony held at SUNY Binghamton, N.Y. ," *Fontes Artis Musicae* **XXXI**/3 (1984); sample of music printing in 1986 *Directory*

Lospinoso/Shape-Notes

Title: *American Shape-Note Tunes*
Scope: indexing of repertory, 1800-1865
Heads of Project: Margaret Lospinoso and Martin Dillon
Place: University of North Carolina
Encoding: DARMS
Associated Literature: "American Shape-Note Tunes," *Perspectives in Computing* **1**/3 (1981), 40-48

McCrickard/Stradella
Title: *Alessandro Stradella: A Thematic Catalogue of His Works* [Pendragon Press, forthcoming]
Scope: listing of textual and musical incipits of 300 works, based on a survey of 1000 sources
Heads of project: Eleanor McCrickard and Carolyn Gianturco
Place: UNC at Greensboro
Computer: Apple II
Software: Quick File (data entry), Apple Writer (editing)

Morehen/Anglican Church Music
Title: *A Thematic Index of Anonymous English Church Music*
Scope: all English church music from the Reformation to the Civil War (1550-1640)
Head of project: John Morehen
Place: Cripps Computing Centre, Nottingham University
Time: 1981--
Hardware: ICL 2988; Benson plotter
Software: DARMS encoding with FORTRAN77 and GHOST
Associated Literature: "Thematic Indexing by Plotter from DARMS Input," *Proceedings of the Second International Symposium on Computers and Musicology, Orsay, 1981* (Paris, CNRS, 1983), 31-42; "Thematic Cataloguing by Computer," *Fontes Artis Musicae* **XXXI**/1 (1984), 32-38

Morosan/Russian Choral Music
Title: *Russian Sacred Choral Music: An Encyclopedic Thematic Catalog*
Aim: to compile and cross-reference a published thematic catalog of some 2100 liturgical musical works from the Russian choral repertory of the 18th, 19th, and 20th centuries
Head of project: Vladimir Morosan
Place: Hamden, CT
Music printing: subcontracted to A-R Editions, Inc.

Murray/Anthologies
Title: *A Guide to Standard Anthologies of Musical Examples*
Scope: 35,000 records of information about 48 anthologies of musical examples, with index and genre codes
Head of project: Sterling Murray
Associate: Benjamin Trumbore
Place: West Chester University
Time: 1984--
Computer: Honeywell Sigma 9
Software: custom

Murray/Rosetti
Title: *Thematic Index to the Music of Antonio Rosetti (1750-92)*
Investigator: Sterling Murray

National Tune Index/Overview
Title: *National Tune Index*
Purpose: to create a series of indices of secular music repertories from the 16th to the 20th centuries; completed projects published in microfiche [see following listings]; includes indices of text, scale degrees (numerical representation), interval sequence, stressed notes, and sources
Originator: Kate Van Winkle Keller
Associated Literature: Gustave and Carolyn Rabson, "The National Tune Index: A Systems Overview," *Computers and the Humanities* **15**(1981), 129-137; same authors, "Hum a Few Bars," *Perspectives in Computing* [an IBM publication] **5**/1 (Spring 1985)

National Tune Index/Eighteenth-Century Secular Music
Title: *National Tune Index: Eighteenth-Century Secular Music*
Scope: listings and concordances of 38,000 secular tunes, songs, and dances of the eighteenth century in American, Canadian, and British sources
Heads of project: Kate Van Winkle Keller and Carolyn Rabson
Sponsor: compiled under the auspices of the Sonneck Society with support from the National Endowment for the Humanities; data stored at Clarkson University (Potsdam, N Y)
Time: 1976-80
Software: modified DARMS [musical material in numerical format] with SPITBOL
Associated Literature: the complete index is published in microfiche (New York: University Music Editions, 1980) with a *User's Guide* by the co-directors

National Tune Index/American MSS
Title: *National Tune Index: Eighteenth-Century Popular Secular Music in America in Manuscript*
Scope: based on sources already indexed in the above compilation
Head of project: Kate Van Winkle Keller
Place: Radnor, PA
Time: in progress

National Tune Index/American Songsters
Title: *National Tune Index: American Songsters to 1820*
Scope: index of titles, first lines, burden and chorus lines, and melodic incipits based on Irving Lowen's bibliography
Heads of project: Arthur F. Schrader and Kate Van Winkle Keller
Place: Radnor, PA
Time: in progress

National Tune Index/English Folk Song
Title: *National Tune Index: English Language Traditional Folk Song*
Scope: similar to that of above projects
Head of project: Anthony Barrand
Place: Boston University
Time: in progress

National Tune Index/Wind Band Music
Title: *National Tune Index: Early American Wind and Ceremonial Music, 1636-1836*
Scope: a listing and concordance of eighteenth-century wind music in American, Canadian, British, French, and British libraries
Head of project: Raoul Camus
Place: CUNY--Queensborough (with support from NEH)
Time: 1987
Publication: microfiche binder with printed contents guide (University Music Editions, 1987)

PowersD/Troubadour Songs
Title: *Troubadour Songs*
Purposes: to create a numerical index, modelled on the Gregorian chant index of Bryden and Hughes, and to create a database of poetic and melodic analyses of songs
Investigator: Doris B. Powers
Place: Carrboro, NC

Rees/Grancino Collection
Title: *Catalogue of the Grancino Collection*
Scope: detailed listing of 8,000 works for cello (1630-1850) collected in photographic copies by Nona Pyron
Head of project: Fred Joseph Rees
Associate: Nona Pyron
Place: New York University
Time: 1984-8
Computer: DEC-10; VAX (VMS)

Selfridge-Field/Marcello
Title: *Benedetto Marcello (1686-1739): A Thematic Catalogue* [to be published by Oxford University Press]
Scope: listing of textual and musical incipits of 700 works, based on a survey of 3,000 sources, with multiple indices and source filiation
Investigator: Eleanor Selfridge-Field
Place: CCARH, Menlo Park, CA
Time: 1984-87
Hardware(OS): HP-1000 (IBYCUS); HP LaserJet II
Software: custom designed by Walter B. Hewlett

Stinson and Griffiths/Fourteenth-Century Music
Title: *Fourteenth-Century Répertoire*
Scope: comprehensive catalogue of all known repertoire of the fourteenth century (5500 items to date) including musical incipits
Heads of project: John Stinson and John Griffiths
Associate: Giovanni Carsaniga
Place: La Trobe University and Univ. of Melbourne (Australia)
Time: 1984-88
Hardware: Vax mainframes, Ericsson PC, Epson SQ-2000 (music), Houston plotter
Software: SCRIBE
Associated Recording Project: fourteenth-century music--digital recording of 200 works not previously available

Temperley/Hymn Index
Title: *Hymn Tune Index*
Scope: listing of 115,000 hymn and Psalm tunes associated with English texts (1536-1820)
Heads of project: Nicholas Temperley and Charles G. Manns
Place: University of Illinois (with support from NEH)
Time: 1982--
Hardware: IBM terminal and Cyber computer
Software: FORTRAN (numerical pitch representation)
Literature: *Fuging Tunes in the Eighteenth Century* (Detroit, 1983)

Wall/Broadway
Title: *The Music of Broadway, 1866 to Date: A Fact Book and Finding Guide*
Head of project: Richard C. Wall
Place: Queens College (with support from NEH)
Time: 1984--

C. Databases of Text

Baroni/Bolognese Libretti
Title: *Libretti of Works Performed in Bologna, 1600-1800* [Modena: Mucchi, 1987]
Scope: multiple index of authorship and performing details of published libretti for operas, oratorios, and other musical performances (4000 works) in Bologna and Emilia generally
Head of project: Mario Baroni
Associates: Gabriele Bersani Berselli, Laura Callegari, Maria Gabriella Sartini
Place: Istituto di Studi Musicali e Teatrali, Univ. of Bologna
Time: 1980-85
Hardware: Apple II (data entry); Sun 1 (printing)

Boston Dainas Project
Title: *Boston Danais Project*
Purpose: to create a database of the texts of Latvian dainas
Head of Project: Kristine Konrad

CCARH/Handel Edition Concordance
Title: *A Concordance of Complete Editions of Handel's Music*
Purpose: to facilitate location of particular editions [*Hallische Händel-Ausgabe*, *Händelgesellschaft*/original, *Händelgesellschaft*/Belwin Mills] of Handel's works by HWV, opus, RISM number, key
Place: Menlo Park, CA
Compiler: Frances Bennion
Date: Phase 1 - Instrumental music, 1987

ClinkscaleM/Early Pianos
Title: *Early Pianos, 1750-1850*
Scope: comprehensive database with fields for maker, place, date, owners, etc.
Investigator: Martha Novak Clinkscale
Place: UC Riverside
Database software: R:Base V

Degrada/Neapolitan Comic Opera
Title: *Neapolitan Comic Opera Libretti, 1700-1750*
Scope: multiple indexing of performance details and text incipits of all comic operas produced in Naples from 1700 to 1750
Head of project: Francesco Degrada
Place: University of Milan
Time: 1986--
Computer: Olivetti

Griffin/Gazzetta di Napoli
Title: *Gazzetta di Napoli*
Purpose: to create an indexed database of extracts from the *Gazzetta di Napoli* (1681-1725) containing information about music (composers, performances, works) in this Napolitan weekly
Investigator: Thomas Griffin
Place: Hollister, CA
Access: CP/M discs; available by modem
Database Software: dBase II

McGuinness/Musical References in London Newspapers
Title: *A Computer Register of Musical Data in London Newspapers, 1600-1800*
Aim: to record data in its entirety and to index it in such a way as to make it useful for interdisciplinary study
Head of project: Rosamund McGuinness
Associates: Simon McVeigh, Ian Bent, Ian Spink and others

Place: Royal Holloway and Bedford New College (Univ. of London)
Time: 1987-89

Monson/Eighteenth-Century Opera Data
Title: *Database for Eighteenth-Century Italian Opera*
Scope: data concerning performance (date, theater), libretti, personnel (librettist, composer, performers), and surviving music for 15,000 opera productions cited in the Sartori libretto index and other catalogues
Head of project: Dale Monson
Place: University of Michigan (Michigan Terminal Service)
Time: initiated 1984 [discontinued, 1987]
Computer: Amdahl 5860
Database software: TAXIR

Monson/Singer Index
Title: *Index of Singers in Eighteenth-Century Italian Opera*
Scope: a subset of data derived from the project listed above
Investigator: Dale Monson
Computer: Zenith 158
Database software: dBASE III

Illustration 49

Databases of Text -- 1

George Hill *et al.* List of fields available in record.

[The purposes of this large collaborative project is to create an upgraded version of the Heyer catalogue of music in collected sets and monumental editions.]

1. Start-of-record marker
2. Serial number
3. Name of composer
4. Uniform title
5. Additional titles
6. Opus and thematic catalogue numbers
7. Authority thematic catalogue number
8. Format
9. Non-standard clefs
10. Figured bass
11. Duration
12. Editor
13. Language of text
14. Librettist
15. Genre
16. Text incipit
17. Musical incipit
18. Instrumentation
19. Practical editions
20. Notes
21. Source
22. Date and initials of encoder
23. Date and initials of senior editor
24. Date and initials of project directors
25. End-of-record marker

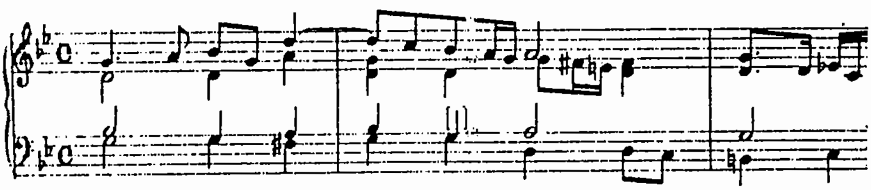
Field 17 accepts encoded music. Garrett Bowles' code for the top voice of the Piper's Pavan by John Dowland is shown with the music in the following example.

>MI G2/2F/TC/4.G4/8A/B/G/4D5+8/C/B4/16A/G/2A/8.G/16D/EF/C/

Illustration 50

Databases of Text -- 2

Charles Mould. List of fields available in record.

[The purpose of this project is to provide an ongoing database of information concerning 1500 surviving harpischords and clavichords. The information was originally assembled to facilitate revisions to the second edition of the Boalch catalogue.]

1. Name of collection
2. Catalogue or accession number
3. Last name of maker
4. First name of maker
5. Middle name of maker
6. Date of manufacture
7. Place of manufacture
8. Type of instrument
9. Remarks on fields 1--8
10. Number of manuals
11. Types of stops
12. Special features of manuals, stops
13. Compass
14. Short or broken octave information
15. Key covering
16. Case finish
17. Number of roses
18. Style of rose
19. Initials in rose
20. Case construction
21. Remarks on fields 10--20
22. Scale length (mm)
23. Case length
24. Case width
25. Case depth
26. Inscriptions
27. Former owners
28. Location of illustrations
29. Security restrictions
30. Number in Boalch, 2nd edition
31. Number in Boalch, 3rd editions
32. Remarks on fields 22--31

Illustration 51

Databases of Text -- 3

Berkeley/Ferrara Madrigal Project. List of fields.

[This very large database project seeks to meet several objectives including cataloguing, analysis of both text and music, and reconstruction of lost items. The following list of fields is in use in the pilot phase of the project. Fields marked here with a colon are repeatable. Therefore, the exact number of fields for any given record is variable. These fields are used in a SPIRES database.]

1. System-supplied record number
2. Title of work as given in original source
3. Uniform title of work
4. RLIN catalogue record identification (MARC compatible)
5. Composer(s):
   a. Name
   b. Profession
   c. City of activity
   d. Institution
6. Author(s):
   a. Name
   b. Profession
   c. City of activity
   d. Institution
7. Editor(s):
   a. Name
   b. Location
8. Printer(s):
   a. Printer, name
   b. Printer, location
   c. Publisher, name
   d. Publisher, location
   e. Bookseller, name
   f. Bookseller, location
9. Year of publication
10. Names of partbooks
11. Page format
12. Pagination

13. Dedicatee(s)
    a. Name(s)
    b. Title(s)
    c. Text Quotations
    d. Signature of dedication
    e. Names in text of dedication
    f. Date of dedication
    g. Place of dedication
14. Cross-reference to Library of Congress name authority file
15. Preface:
    a. Date
    b. Signature
16. Modern edition(s):
    a. Title
    b. Place
    c. Name of publisher
    d. Date
17. Indexes in volume (may be by name of poet, kind of poem, title)
18. Colophon information
19. RISM number
20. Vogel catalogue number
21. Errata listed in original source
22. Record of SPIRES operations already carried out
23. Location of copies:
    a. Library name
    b. Place
    c. Call number
    d. Edition
24. Notes:
    a. Date
    b. Text
    c. Author
25. Entry data
    a. Name of inputter
    b. Date
26. Maintenance data:
    a. Nature of alteration to any field
    b. Date of change

Illustration 52

Databases of Text -- 4

RENARC. Sample of retrievable information.

RENARC is a databank of information about Renaissance musicians. It is maintained at Columbia University. The first three windows in the illustrations show display of (1) the archival source, (2) details of the circumstances surrounding the document and a summary of its contents, and (3) a list of names mentioned in the document. The remaining windows are used for commands.

```
                    RENARC DOCUMENT NO. 2
SOURCE:  (1548) LILLE: ARCH NAT 4G 6798 (1548-49), 8
--------------------------------------------------------------------------------
CITY:     CAMBRAI                RULER:                    INSTITUTION:   CATH
YEAR:     1548                   ARCHIVE: LAN              SUBMITTED BY:  CWW
SUMMARY:  PRO GRATIA FACTA PER DOMINOS CAPITULARES CIRCA FESTUM SANCTORUM
          OMNIUM (1548) VIGINTI TRIBUS VICARIUS VIDELICET DOMINO (SEE LIST)
          ET MISGTRO PUERORUM CUILIBET XXX S. SUNT SIMUL XXXIIIJ LB. XS.
--------------------------------------------------------------------------------
  1) JO DE PUTEO                2) JO REIGNERJ             3) JO PREPOSITI
  4) FRANCISCO BOULIC           5) MICHAELI LIBERT         6) RO BELHOST
  7) JO DE DERY                 8) CRUSTA JUVENIS          9) JO SELLIER
 10) ANTHO. BOUCHIER           11) MARRO MERCHANT         12) ROBERTO OGIER
 13) PHILIPPE DE MONTE         14) OLIVIERO WYON          15) (MORE...)
================================================================================
 D  Document                   +  Show More               O  Off
 N  Name                       R  Re-Display              E  Edit
 L  List Names                 Q  Query                   ?  Help
--------------------------------------------------------------------------------
COMMAND?.
```

```
                    RENARC DOCUMENT NO. 2
SOURCE:  (1548) LILLE: ARCH NAT 4G 6798 (1548-49), 8
--------------------------------------------------------------------------------
CITY:     CAMBRAI                RULER:                    INSTITUTION:   CATH
YEAR:     1548                   ARCHIVE: LAN              SUBMITTED BY:  CWW
SUMMARY:  PRO GRATIA FACTA PER DOMINOS CAPITULARES CIRCA FESTUM SANCTORUM
          OMNIUM (1548) VIGINTI TRIBUS VICARIUS VIDELICET DOMINO (SEE LIST)
          ET MISGTRO PUERORUM CUILIBET XXX S. SUNT SIMUL XXXIIIJ LB. XS.
--------------------------------------------------------------------------------
 13) PHILIPPE DE MONTE         14) OLIVIERO WYON          15) JO ROUSSEL
 16) PIETRO BERTO              17) NICO. QUILLIART        18) JACOBUS DE KERLE
 19) JO SLAPPEN                20) BENEDICTO DARRAS       21) NICO. LENGLEZ
 22) ADRIANO POOTRE
================================================================================
 D  Document                   +  Show More               O  Off
 N  Name                       R  Re-Display              E  Edit
 L  List Names                 Q  Query                   ?  Help
--------------------------------------------------------------------------------
COMMAND?.+
```

Mould/Harpsichord

Title: *Makers of the Harpsichord and Clavichord, 1440-1840* [3rd edn. of the 1956 study by D. H. Boalch; forthcoming from Oxford University Press]

Scope: revised version of original work to be supplemented by an online database concerning the instruments themselves; a hardcopy version of the latter information is also anticipated; this survey includes roughly 1500 harpsichords and clavichords; 32 searchable fields include details of compass, manuals, materials, decorations, and dimensions; offers many points of access to information about unsigned instruments [see Illustration #50]

Investigator: Charles Mould

Place: Bodleian Library, Oxford University

Date of Completion: Summer 1989

Computer: IBM PC compatibles

Database software: dBase III

Perry-Camp/Mozart

Title: *Non-musical Markings in Mozart Autograph MSS*

Scope: a complete compilation of data (330 MSS to date) and correlations with musical, biographical, and textual events to ascertain the sources and functions of the markings

Investigator: Jane Perry-Camp

Place: Florida State University

Computer: Cyber 730

Software: custom designed (music) with Sir II (database)

Literature: "Divers Marks in Mozart's Autograph Manuscripts: Census and Significance," *Mozart-Jahrbuch 1984/85*

Perkins/RENARC [=Renaissance Archive]

Title: *Repository of Archival References... concerning Music and Musicians in the Renaissance*

Scope: a multiple index of personnel information (names, dates, occupations) also citing the location and provenance of the document and the person contributing the information (six fields in all); see Illustration #52

Head of project: Leeman Perkins

Associates: Brian Stierup (software); Lewis Lockwood, Jeremy Noble, Richard Sherr, Craig Wright *et al.*

Place: Columbia University, Center for Computing Activities

Computer: IBM 3083B

Software: custom, in PL/1

Access: under review

UCB *et al.*/Italian Lyric Poetry

Title: *Italian Music and Lyric Poetry of the Renaissance*

Scope: full-text transcriptions of Italian lyric poetry and associated music from *c.* 1450 to 1650, and a bibliographical record of the sources; view toward exploration of *topoi* in the texts and thematic families in the instrumental music [see Illustration #51]

Associates: Michael Keller (Yale), Anthony Newcomb (UCB); Thomas Walker (U. of Ferrara); five Italian literature specialists including Louise Clubb (UCB and Villa I Tatti)

Locations: UC Berkeley, Pisa, Ferrara, Rome and elsewhere

Time: 1985-95

Computers: IBM PC ATs (all points) electronically linked

Database software (text): SPIRES [see illustration]

Encoding: custom

Access: RLIN (bibliographical data)

Vassalli et al./Madrigal Poetry

Title: *Indagine sulla poesia per musica (1530-1630)*

Purpose: to identify authors of poems set to music [related to the preceding listing]

Investigators: Antonio Vassalli, Lorenzo Bianconi, Angelo Pompilio

Place: Istituto di Studi Rinascimentali, Ferrara

D. Databases and Editions of Music

CCARH/Bach
Title: *The Complete Works of J. S. Bach*
Aim: creation of a database designed to permit extensive, rapid music retrieval and analysis; most works for harpsichord and for orchestra, as well as some works for organ, two passions and the B-Minor Mass are currently stored
Place: Menlo Park, CA
Computer(OS): HP-1000 (IBYCUS)
Software: custom designed by Walter Hewlett
Associated Literature: Walter B. Hewlett, "A System for Numeric Representation of Musical Pitch" [forthcoming; see below]

CCARH/Corelli
Title: *The Complete Works of Arcangelo Corelli*
Aim: creation of a database designed to permit extensive, rapid musical analysis; multiple versions from encoding of early editions
Place: Menlo Park, CA
Computer(OS): HP-1000 (IBYCUS)
Software: custom designed by Walter Hewlett

Charnassé/German Lute Tablature
Title: *Transcription automatique de tablatures de luth allemandes*
Purpose: systematic transcription of sixteenth-century lute manuscripts in diverse tablatures, with extensive consideration of specific musical traits and a printing capability for both the music and its analysis
Investigators: Hélène Charnassé, Bernard Stépien
Place: CNRS, Paris
Computer: IBM PC
Encoding: TABINT (Interactive Tablature Encoding)
Internal representation: numerical
Software (printing): LUTH
Associated literature: "Automatic Transcription of Sixteenth Century Musical Notations," *Computers and the Humanities* 20 (1986), 179; "Transcription of XVIth Century Lute Tablatures," *Advances in Computing and the Humanities*, forthcoming

CNUCE Library
Title: *A Library of Encoded Music*
Scope: currently, about 800 works by such composers as Frescobaldi, Bach, Handel, Mozart, Beethoven, Paganini, Brahms, Verdi, Wagner, Joplin, and Boulez; the encoded data is available for playback, analysis, and processing
Head of project: Pietro Grossi
Places: Pisa (CNUCE) and Florence (Conservatory)
Encoding and software: TELETAU
Email access: *cheru@ifiidg.bitnet*

Houghton/Chigi Codex
Title: *Critical Edition of the Chigi Codex*
Scope: transcription and commentary on the polyphonic repertory in Bibl. Vaticana C.VIII.23X (c.1470-1515)
Head of project: Edward F. Houghton (UC Santa Cruz)
Associate: Herbert Kellman (Univ. of Illinois)
Computer and software: diverse

Duffin/Dufay
Title: *Forty-Five Dufay Chansons from Canonici 213*
Scope: a performing edition in white mensural notation
Investigator: Ross Duffin
Place: Stanford University
Time: completed in 1977 (D.M.A. thesis)
Computer: DEC PDP-10, Versatec plotter
Software: SCORE [illustration in the 1986 *Directory*]

Hughes/Rhymed Offices

Title: *Late Medieval Rhymed Offices*
Scope: thousands of manuscripts and ten printed volumes of text relating to repertory from the tenth through the sixteenth centuries; the objective is to analyze this collection of chants
Investigator: Andrew Hughes
Place: University of Toronto
Time: 1974--
Computer: various S100 Z-80 machines
Software: custom designed encoding system to handle square and Gothic plainchant notation (numerals for pitch; letters for notation)

Hughson et al./Folk Song Analysis

Title: *The Computerization of Folk Song Analysis*
Objective: to specify a system capable of analysis and classification of folk music using the methods of the Kodaly Institute of Canada, including the ability (1) to reduce the time required for these activities, (2) to classify music consistently and accurately, and (3) to provide a more efficient means of storing and transmitting this information
Head of project: M. E. Jernigan
Reporting for project: Mary Hughson
Other researchers: Anita Gatti, Bill Van Hout, Mary Hughson
Place: University of Waterloo [Canada] Dept. of Engineering
Computer: IBM PC (compatible)
Software (data entry): Personal Composer
Software (storage and analysis): under development
Associated Literature: *Final Report: Computerization of Folk Song Analysis; SD 262* (December 1, 1986); available through the Dept. of Systems Design Engineering, University of Waterloo (Ontario)

Hultberg/Spanish Tablature

Aims: to implement the tablature-to-standard-notation transcription process developed earlier for larger systems on a Macintosh; conversion capabilities can deal with Spanish, Italian, English, French, and German styles of tablature; thematic indices of Spanish sources are in preparation
Head of project: Warren Hultberg
Associate: Mary Lou Hultberg
Place: SUNY Potsdam
Computer: Macintosh 512
Software: BASIC, PASCAL
Encoding: modified DARMS
Music printing: Professional Composer
Literature: "Data Bases for the Study of Relationships among Spanish Music Sources of the 16th-17th Centuries," *Fontes Artis Musicae* XXXI/3 (1984); edition of Diego Pisador's *Libro de musica de vihuela [Salamanca, 1552]* in the report of the *Congresso Internacional "Espana en la Musica de Occidente"* (Salamanca, 1985)

Morosan/Russian Sacred Music

Title: *Monuments of Russian Sacred Music*
Aim: preparation of a 40-volume edition to commemorate the millenium of Christianity in Russia (1988); choral repertory by major Russian composers with full annotation, transliteration, etc.
Head of project: Vladimir Morosan
Associatets: Nicolas Schidlovsky, Olga Dolskaya-Ackerly, Peter Jermihov, Alexander Ruggieri, Gerald Seaman
Place: Hamden, CT
Computer (entry): Apple Macintosh
Computer (printing): Linotronics 100 typesetter (with 'Sonata' font)
Software: Deluxe Music Construction Set; Laser Cyrillic

NewcombA/Italian Instrumental Music
Title: *Italian Instrumental Music in the Renaissance*
Purpose: related to the Italian Lyric Poetry project described under Databases of Text, the aim of this project is to identify thematically related families of works
Head of project: Anthony Newcomb
Place: UC Berkeley

O'Maidin/Irish Music
Title: *Database for Retrieval and Analysis of Irish Music*
Scope: development of software for input, editing, analysis
Head of project: Donncha O'Maidin
Place: Waterford Regional Technical College (Eire)
Time: 1986--
Hardware: DEC VAX-11/780, BBC micro, Epson FX-100, C.ITOH Cl-600Q
Software: ALMA (encoding), custom (analysis), SMUT (printing)
Associated Literature: "A Computer System for Music Analyses," *Proceedings of the Conference on Music and the Computer 1984* (forthcoming, Paris, Eratto)

Perkins/Busnois
Title: *The Complete Secular Works of Antoine Busnois*
Scope: a facsimile score is produced by computer, which then makes a detailed comparison of the sources for each work and lists the variants according to type; this data appears in the critical report
Head of project: Leeman Perkins
Place: Columbia University
Hardware: IBM 3083BX; Gould plotter
Encoding: FASTCODE (adapted by Frank Esposito)
Software: SPITBOL
Associated Literature: *Newsletter* of the Columbia University Center of Computing Activities, XIII/13 (Sept. 23, 1981)

PowersH/Lassus
Title: *The Motets of Lassus and Susato*
Scope: storage, analysis, and editing of 278 motets by Lassus and 250 by Susato
Head of project: Harold Powers (Princeton)
Associate: Lawrence Earp (Wisconsin)
Computer: IBM 3033
Encoding: FASTCODE
Software: MIR (retrieval) with SPITBOL
Literature: "Tonal Types and Modal Categories in Renaissance Polyphony," *Journal of the American Musicological Association* **XXXIV** (1981)

SmithDA/Weiss
Title: *Silvius Leopold Weiss: Complete Works for Lute*
Scope: preparation of 10 volumes of music both in a computer-generated "facsimile" of the original tablature and in modern edition for publication in *Das Erbe deutscher Musik*; more than 80 works (roughly 700 movements) are involved
Head of project: Douglas Alton Smith
Associate: David Fitzpatrick
Place: CCRMA, Stanford University
Time: 1983--
Computer (data entry): Commodore-64
Computer (editing and page makeup): PDP-10
Printing device: Versatec plotter
Encoding: SCORE/MS
Software: SCORE/MS; custom facsimile font [illustrated in the 1986 *Directory*]

Wade *et al*/C. P. E. Bach
Title: *The Carl Philipp Emanuel Bach Edition*
Aim: the publication of the complete works of the composer in a critical edition [supported by NEH]
Head of project: Rachel Wade
Associates: Eugene Helm (with roughly 20 editors)
Place: University of Maryland

Time: 1983-2008
Computer (data entry): IBM PC
Printing devices: Epson FX-80 (draft); Gould plotter 6320 (final)
Software: Oxford Music Processor
Associated Literature: Gary A. Greene, "Report from the University of Maryland at College Park," *Current Musicology*, **37/38** (1984), 280

E. Textual Analysis

Boroda/Text Repetition
Title: "Principles of the Organization of Repetitions on the Micro-level of the Musical Text," doctoral dissertation [in Russian], Tbilisi, 1979
Investigator: Moisei Boroda
Place: Tbilisi

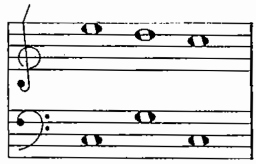
Christie/Greek Poetry
Title: *Conversion of the Ancient Greek Poetic Meter from Euripides's* **The Bacchae** *into Digitially Produced Sound*
Investigator: George Christie
Places: Uranus Studio (Wilmington) and Northern Illinois Univ.
Hardware: PDP 11/04 (RT-11); IBM PC; Epson LQ-800; Buchla synthesizer

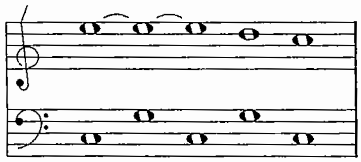
Grijp/Contrafacta
Title: "Footbank: A Method of Finding Melodies by Text Association" [in Dutch], *Tijdschrift van de...Ned. Muziek-deschiedenis* XXXIV/1 (1984), 26-48
Scope: using the poetry of P.C. Hooft (1613), a search for contrafacta in 16th-18th century Dutch song was conducted
Investigator: Louis Peter Grijp

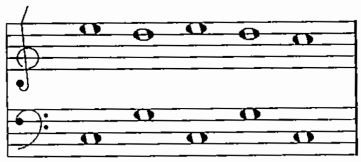
HillJ/Contrafacta
Title: *Italian Contrafacta*
Aim: identification of text parodies in musical settings, 1500-1700; program counts the number of syllables in each line (accent is not analyzed); Stage 1 (arias by Vivaldi) completed in April 1986; Stage 2 (other composers) in progress
Investigator: John Hill
Place: University of Illinois
Time: 1985--
Computer: IBM PC AT
Software: Savvy - PC (analysis)

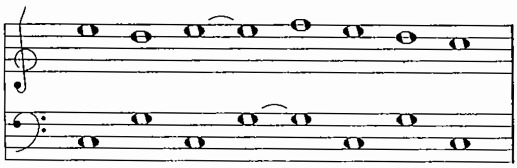
Illustration 53

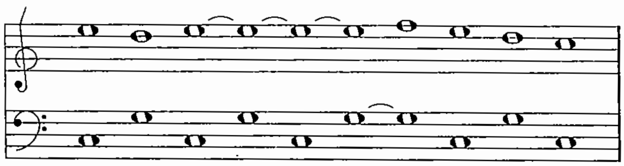
Musical Analysis -- 1

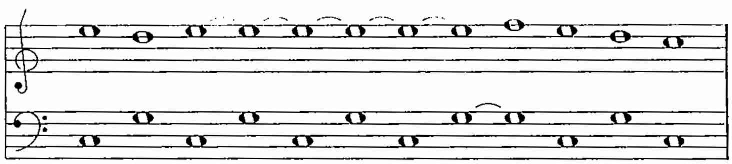
Michael Kassler: Beginning of a derivation in the explication of Schenker's middleground.

3-to-1 axiom

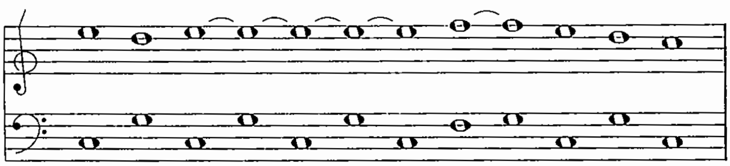


inferred from last by rule of bass arpeggiation

inferred from last by rule of articulation



inferred from last by rule of neighbour-note prolongation

inferred from last by rule of bass arpeggiation



inferred from last by rule of bass arpeggiation

inferred from last by rule of bass ascent

Musical examples printed by Michael Kassler on a Canon LBP 8A2

II. Musical Analysis and Analytical Methods

Barbieri & Del Duca/Microtonal Performance
Title: *Renaissance and Baroque Microtonal Music Research*
Purpose: to demonstrate the microtonal tuning systems used by Vicentino (1595), Colonna (1618), Sabatini (1650), and Buliowski (1699)
Investigators: Patrizio Barbieri, Lindoro Del Duca
Hardware: IBM PC, synthesizer
Associated Literature: abstract in *ICMC Proceedings 1986*, 51

Barnes/Elgar
Title: *Computer Analysis of Romantic Orchestral Music*
Purposes: Stage 1 -- to develop an encoding system and analytical techniques suitable for this kind of music; Stage 2 -- to apply these methods to style analysis, especially of Elgar symphonies
Investigator: Roger Barnes
Place: Leicester (U.K.) Polytechnic
Time: Stage 1, complete; Stage 2, by 1990
Computer: ICL 2900
Software: SPITBOL (version 4)

Baroni/Chanson 2
Title: *Antiche canzoni francesi: uno studio di metrica generativa*
Scope: analysis of 70 French songs published in *c.* 1760; undertaken to examine the interplay of patterns of meter and accent (1) between text and music within the repertory and (2) in this repertory as contrasted with the same features in a repertory of Lutheran chorales
Head of project: Mario Baroni
Associates: Laura Callegari, Carlo Jacoboni, Rossella Brunetti
Place: University of Bologna
Time: 1981-86
Computer: Apple //
Software: custom
Associated Literature: "Antiche canzoni francesi: Uno studio di metrica generativa," *Quaderni di Informatica Musicale* 5 (1984); "A Grammar for Melody: Relationships between Melody and Harmony" in *Musical Grammars and Computer Analysis: Proceedings of the Conference [Modena...1982]* (Florence, 1984)

Baroni/Chorale Melodies
Title: *Bach Chorales*
Purpose: to deduce grammatical rules for the construction of the chorale melodies used by Bach; the newly generated melodies test the veracity of the rules so deduced
Heads of project: Mario Baroni, Carlo Jacoboni
Place: University of Bologna
Associated Literature: *Proposal for a Grammar of Melody: The Bach Chorales* (Montréal, 1978); "Computer Generation of Melodies: Further Proposals," *Computers and the Humanities* **XVII** (1983); "The Concept of Musical Grammar," *Music Analysis* **II**/2 (1983), 175-208

Baroni/Legrenzi
Title: *Legrenzi cantatas*
Purpose: investigation of the melodic features found in Legrenzi's *Cantate*, 1676
Head of project: Mario Baroni
Place: University of Bologna

Baroni/European Melody
Title: *The Study of Melody in European Music*
Purpose: to explore diverse repertories with a view toward defining concepts and working principles of melody in European culture; the three preceding projects are components
Associated Literature: "A Project of a Grammar of Melody" in *Informatique et musique: Actes du second Symposium International, Orsay 1981* (Orsay, 1983)

Bevil/Folktune Presevation

Title: *A Paradigm of Folktune Preservation and Change Within the Oral Tradition of a Southern Appalachian Community, 1916-86*

Purpose: to investigate developments within a small geographical area since Cecil Sharp's visit in 1916

Investigator: J. Marshall Bevil

Computer: Apple //c

Encoding: custom numerical encoding with stress coefficient

Associated Literature: "Scale in Southern Appalachian Folksong: A Reexamination," *College Music Symposium* **26** (1986), 77-91

Blombach/Bach Chorales

Title: *The Bach Chorales*

Scope: 150 Bach chorales queried for note and interval counts, ranges, pattern analysis, and relationships between vertical and horizontal features such as scalar contradictions and harmonic implications

Head of project: Ann K. Blombach

Place: Ohio State University

Software: Musicode A [now being redesigned for the Macintosh]

Associated Literature: "An Introductory Course in Computer-Assisted Analysis; the Computer and the Bach Chorales," *Journal of Computer-Based Instruction* 7/3 (1981), 70-77; "Harmony vs. Counterpoint in the Bach Chorales," *Computing in the Humanities*, ed. Richard W. Bailey (1982), 79-88; "An Implementation of Hewlett's Second Order [Pitch Representation] Solution on a Micro" [*JCBI*, forthcoming]

Brinkman/Melodic Process in Bach

Title: "The Melodic Process in Johann Sebastian Bach's *Orgelbüchlein*," *Music Theory Spectrum* II (1980), 46-77

Purpose: to study motivic derivation from the cantus firmus

Head of project: Alexander Brinkman

Place: Eastman School of Music (Rochester, NY)

Computer: IBM mainframe

Software: in SNOBOL 4 and PL/1

Associated Literature: "The Melodic Process in Johann Sebastian Bach's *Orgelbüchlein*: A Computer-Assisted Study of the Melodic Influence of the Cantus Firmus on the Contrapuntal Voices" (Ph.D. thesis, 1978)

Camilleri/Schubert

Title: "A Grammar of the Melodies of Schubert's Lieder" in *Musical Grammars and Computer Analysis* (Florence, 1984), 229-237

Scope: establishment of rules governing the first four notes of melodies from *Die schöne Müllerin, Die Winterreise*, and the *Schwanengesang*

Head of project: Lelio Camilleri

Place: CNUCE (Florence), Musicology Division

Software: TAUMUS

Cantor/Landini

Title: *Landini Ballate*

Scope: examination of vertical sonorities and voice crossings

Head of project: Don Cantor

Place: Boston University

Time: 1985

Cook/Contextual Performance Analysis

Title: *Contextual Analysis of Musical Performance*

Objective: to investigate performance nuance as a function of formal structure; Stage 1 restricted to rhythmic analysis; Stage 2 will be extended to intonation analysis

Investigator: Nicholas J. Cook

Place: Hong Kong

Computer: Hewlett Packard Integral PC

Other devices: custom built

Encoding: custom
Associated Literature: 'Structure and Performance Timing in Bach's C Major Prelude (WTC 1): An Empirical Study' (given at the 1986 Music Analysis Conference at Cambridge University; forthcoming in *Music Analysis*)

Crerar/Authorship Analysis (Valentini)
Title: "Elements of a Statistical Approach to the Question of Authorship," *Computers and the Humanities* **19** (1985), 175-182
Scope: reevaluates the statistical techniques advanced in W. J. Paisley's 1964 article on minor encoding habits [*Journal of Communcation* XIV/4, 219-37] with particular reference to a thematic index by the author of the music of Giuseppe Valentini (*c*.1680--after 1759) and its stylistic relationship to the music of Corelli and Vivaldi (105 incipits each)
Head of project: Alison Crerar
Place: Heriot-Watt University
Encoding: Plaine and Easie code
Associated Literature: "Giuseppe Valentini: A Computerized Instrumental Catalogue," M.Sc. dissertation (Computer Science), Heriot-Watt University (Edinburgh), 1983

Eastwood/French Baroque Air
Title: *The French Baroque Air in the Eighteenth Century*
Objective: to investigate the history of the style of all printed secular songs published in Paris, 1695-1740
Head of project: Anthony C. Eastwood
Associate: Christina A. Eastwood
Place: University of Western Australia
Time: 1984-90
Computer: Microbee
Encoding: Plaine and Easie code
Software: custom program (INFIND) for matching incipits
Associated Literature: "The French Air in the Eighteenth Century: A Neglected Area," *Studies in Music* **18** (1984), 84-98; "The Philosophical Implications of the Study of Numerically Large Repertories," *Studies in Music* **19** (1985)

Ebcioglu/Bach Chorale Harmonization
Title: "An Expert System for Schenkerian Synthesis of Chorales in the Style of J. S. Bach" in *Proceedings of the International Music Conference 1984*, 135-141
Aim: to define the Bach chorale style by testing 200 rules (in first-order predicate calculus) for harmonization, taking into account chordal skeletons, individual melodic lines, and hierarchical relationships
Head of project: Kemal Ebcioglu
Place: SUNY Buffalo
Time: 1984--
Software: BSL (Backtracking Specification Language) with 'C'

Ellis/Bach
Title: *Linear Aspects of the Fugues of J. S. Bach's Well-Tempered Clavier: A Quantitative Approach*
Scope: data entered in numerical code for counts of patterns, note recurrences, and pitch/interval or rhythmic groupings
Head of project: Mark Ellis
Place: University of Nottingham (Ph.D. thesis, 1980)
Hardware: ICL 2900 with Benson plotter
Software: FORTRAN
Associated Literature: "Are Traditional Statistical Methods Appropriate to Musical Analysis?" in *Proceedings of the Second International Symposium on Computers and Musicology, Orsay, 1981* (Paris, CNRS, 1983)

Gross/Harmonic Analysis
Title: "A Project in Computer-Assisted Harmonic Analysis" in *Computing in the Humanities* (Lexington, MA, 1981)
Head of project: Dorothy Gross
Place: University of Minnesota
Computer: CDC mainframes
Software: MUSTRAN with SNOBOL4
Associated Literature: "A Computer Project in Music Analysis," *Proceedings of the International Computer Music Conference*, ed. Hubert S. Howe (San Francisco, 1980)

Gross/Rhythmic Analysis
Title: *A Study of Rhythmic Complexity in Selected Twentieth- Century Works* in *Musical Grammars and Computer Analysis* (Florence, 1984), 337-344
Head of project: Dorothy Gross
Place: University of Minnesota
Computer: CDC mainframes
Software: MUSTRAN with SNOBOL4

Hofstetter/Nationalism
Title: "The Nationalistic Fingerprint in Nineteenth-Century Romantic Chamber Music," *Computers and the Humanities* 13 (1979), 105-119
Scope: differentiation of Czech, French, German, and Russian styles on the basis of melodic intervals in 130 melodies from 16 string quartets
Head of project: Fred T. Hofstetter
Place: Ohio State University

Houle/Articulation
Title: *Eighteenth-Century French Articulation as Described by Engramelle and Dom Bedos de Celles*
Scope: investigation of articulation as described in Engramelle's *La Tonotechnie* (1775)
Head of project: George Houle
Place: Stanford University
Computers: IBM PC and Macintosh
Software: custom ("Tonotechnie") by Roland Hutchinson

Jensen/Lute Ricercar
Title: *A Computerized Approach to the Early Italian Lute Ricercar*
Head of project: Richard Jensen
Place: UCLA
Time: 1985-87
Hardware: Macintosh; ImageWriter
Process: alphanumeric description of musical traits with associated iconographical files
Associated Literature: "A Computerized Approach to the Early Italian Lute Ricercar," *Journal of the Lute Society of America*, forthcoming

Kassler/Tonal Theory
Title: *Explications of the Theories of Tonality of A.F.C. Kollmann and Heinrich Schenker*
Purpose: exploration of rule systems by two highly original harmonic theorists [see Illustration #53]
Investigator: Michael Kassler
Computer(OS): Canon A-200 (MS-DOS)
Printing device: Canon LBP-8A2
Software: APL*Plus (music encoding and analysis)

Kimberlin/Ethiopian Church Music
Title: *Pattern Recognition in Ethiopian Church Music*
Purpose: to define qenet system, which forms the tonal basis of the music
Head of project: Cynthia Tse Kimberlin
Assistants: J. Kimberlin, Fu Su
Place: Hercules, CA
Computer: IBM PC compatible
Software: proprietary

Koozin/Takemitsu
Title: *Linearity and Pitch-Class Set Recurrence in Selected Works by Toru Takemitsu*
Scope: computation of normal order, integer equivalent, transposition type and prime form for any set of pitch-classes
Head of project: Timothy Koozin (Univ. of Cincinnati)

Associate: Mok Tokko (Univ. of North Dakota)
Computer: IBM PC
Software: custom (MUSET), based on numeric input

Kwiatkowska/Graphic Dictionary
Title: *Graphic Music Dictionary*
Aim: to create simple graphic symbols for use in music analysis
Developer: Barbara Kwiatkowska
Place: Los Angeles
Time: 1985-86
Computer: Macintosh

Li/Bartok
Title: *A Study of Harmonic Organization in Bartok's String Quartets*
Scope: investigation of the harmonic features found in Bartok's string quartets with a view towards developing a system suitable for harmonic analysis of string and wind ensemble music
Investigator: Betty Li
Place: Hong Kong Baptist College
Time: 1987-88
Computer: VAX mini 11/750
Encoding: custom, alphanumeric
Software: custom, in SPITBOL

Ligabue & Giomi/Jazz
Title: *A software tool for generation and study of jazz*
Aim: definition of a system of rules capable of providing a model of jazz improvisation to facilitate automatic generation
Investigators: Marco Ligabue, Francesco Giomi
Place: Florence Conservatory
Time: 1985-87
Hardware: Gould 32/27, Yamaha CX-5
Software: TELETAU
Associated Literature: "Un sistema di regole per l'improvvisazzione jazzistica" in *Atti del VI colloquio di informatica musicale* ([Ligabue], Naples, 1986); "A System of Rules for Computer Improvisation," *ICMC Proceedings 1986*

Longyear/Macroanalysis
Aim: development of macroanalytical procedures for study of eighteenth and nineteenth century repertory
Head of project: Rey Longyear, with Kate Covington
Place: University of Kentucky

Moseley/Notre Dame notation
Title: *Source and Notation Studies, 1150-1200*
Aim: development of software for matching ligature patterns in Notre-Dame notation and other medieval polyphonic music
Head of project: Jane Moseley
Place: Nottingham University
Time: 1986-87
Computer: ICL 2984
Software: custom (DARMS-related)

Nettheim/Schubert
Title: *Analysis of the Works of Schubert*
Scope: oriented towards stylistic comparison with other ocmposers
Investigator: Nigel Nettheim
Place: Sydney Conservatorium
Hardware: IBM PC; Toshiba P1340
Software: custom

NewcombS/Sixteenth-Century Counterpoint
Title: "LASSO: An Intelligent Computer-Based Tutorial in Sixteenth-Century Counterpoint," *Computer Music Journal* 9/4 (1985), 49-61
Scope: describes an interactive learning environment for species counterpoint
Author: Steven Newcomb
Place: Florida State University

O'Maidin/Irish and Scottish Jigs
Title: "Computer Analysis of Irish and Scottish Jigs," *Musical Grammars and Computer Analysis* (Florence, 1984), 327-336
Scope: advances mathematical formulae for computation of the degree of relationship between tunes, taking into account measurements of intervallic distance and stress
Head of project: Donncha O'Maidin
Place: Waterford Regional Technical College (Eire)
Software: custom, with ALMA encoding

Pearce/Troubadours
Title: "Troubadours and Transposition: A Computer-Aided Study," *Computers and the Humanities* 16/1 (1982)
Head of project: Alastair Pearce
Place: King's College, London
Software: custom

Pelinski/Eskimo Song
Title: "A Generative Grammar of Eskimo Songs" in *Musical Grammars and Computer Analysis* (Florence, 1984), 273-286
Scope: development of an algorithm that takes into account syntactic structures, structural elements, melodic modes, and rhythmic patterns and creates a melodic lexicon
Head of project: Ramón Pelinski
Place: University of Montréal

Plenkers/Cantigas
Title: *The Cantigas de Santa Maria*
Aim: pattern recognition
Head of project: Leo J. Plenkers
Place: University of Amsterdam
Time: 1984-88
Hardware: Data General / Eclipse
Software: custom
Associated Literature: "A Pattern Recognition System in the Study of the Cantigas de Santa Maria" in *Musical Grammars and Computer Analysis* (Florence, 1984), 59-70

Pont/Rhythm and Accent in Handel's Music
Title: *Rhythm and Accent in Handel's Music*
Aim: to analyze variations of rhythm, articulation, and ornamentation in the vocal and instrumental incipits of the arias from Handel's operas and oratorios, and to explore the encoded data systematically in order to gain a fuller understanding of Handel's style (genres, figures, rhetorical associations) and its relation to that of other composers (Rameau, Mozart)
Head of project: Graham Pont
Associates: Nigel Nettheim, Jennifer Nevile
Place: University of New South Wales
Time: 1983-88
Computers(OS): Osiris One (UNIX), Olivetti M24 (MS/DOS)
Software: Plaine and Easie code
Associated Literature: "A Revolution in the Science and Practice of Music," *Musicology* V (1979), 1-66; "Handel and Regularization: a Third Alternative," *Early Music* XIII (1985), 500-505

Rahn/Ars Antiqua Motets
Title: "Theories of Some Motets of the *Ars Antiqua*" in *Perspectives of New Music* (in English, forthcoming) and in *Musical Grammars and Computer Analysis* (Florence, 1984), 39-58 (in Italian)
Scope: applies twentieth-century analytical techniques to motets from the Montpellier Codex
Head of project: John Rahn
Place: University of Washington

Schaffrath/Folk Tune Analysis
Title: *Computer Assisted Analysis of Folk Tune Melodies*
Scope: input, storage, and analysis of folk tune melodies; studies of similarities and variants by means of a database system
Head of project: Helmut Schaffrath
Associate: Barbara Jesser
Place: Essen University

Computers: IBM mainframe; Olivetti PC M24
Encoding: ESAC (Essen Associative Code)
Associated Literature: ESAC manual [May 1987; available from author]

Schulenberg/C.P.E.Bach Variants
Title: *C.P.E. Bach: Critical Edition*
Scope: collation of variants in sources of keyboard concertos
Head of project: David Schulenberg
Computer: Kaypro 4
Software: Perfect Filer with letter code [available from author]

ShapiroA/Tune Families
Title: *Handbook of British-American Tune Families*
Scope: 3,000 tunes from the most frequently used collections of British-American folksong, with data about stressed tones, cadence tones, etc.
Head of project: Ann Dhu Shapiro
Place: Harvard University
Time: 1983-7
Hardware: DEC VAX (text); Macintosh with Yamaha DX-7 (music)
Software: custom designed (by David Epstein and Kate Fissell) in 'C'

Silbiger/Modality - Tonality
Title: *The Emergence of the Major-Minor Key System in Seventeenth-Century German Keyboard Music*
Scope: an application and extension of statistical techniques applied previously to Italian repertories (Gabrieli, Monteverdi, Frescobaldi, Corelli)
Head of project: Alexander Silbiger
Associate: J. Michael Allsen
Place: University of Wisconsin; Duke University
Time: 1983-7
Computer: Apple // and //e
Software: numerical representation in BASIC
Associated Literature: report of the conference "From Scheidt to Buxtehude" (Wellesley College, June 1987)

Silbiger/Tonal Types
Title: *Tonal Types in the Keyboard Music of Frescobaldi* in the *Proceedings of the Ferrara Frescobaldi Conference*, 1983)
Reseacher: Alexander Silbiger
Place: University of Wisconsin
Time: 1982-3
Computer: Apple // and //e
Software: numerical representation in BASIC
Associated Literature: "Tipi tonali nella musica di Frescobaldi," *Gerolamo Frescobaldi nel IV Centenario della nascita* (Florence, 1986), 301-14

Simonson/West African Music
Title: *A Tool for User-Defined Notation and Analysis of West African* Jaliva
Purpose: to develop a software tool for musical and textual display and analysis of Jaliva, especially of Mandinka *kora* music (a heptatonic tonal multi-modal West African art music)
Investigator: Linda Simonson
Associate: William LeJeune Brown
Place: Laurel, MD
Time: 1987-9
Computer: Amiga

Stech/Microanalysis
Title: "A Computer-Assisted Approach to Micro-Analysis of Melodic Lines" in *CHum* XV/4 (1981)
Scope: 3000 records
Head of project: David Stech
Place: University of Alaska (Ph.D. thesis, U. of Michigan, 1976)
Computer: IBM mainframe

Steel/Troubadours
Tite: *Evolution of a Musical Style: Early, Middle, and Late Troubadours*
Scope: compares repertory of twelfth and thirteenth-century Provencal troubadours in diverse neumatic notations with selected chant and other monophonic secular repertories
Head of project: Matthew Steel
Place: University of Michigan
Time: in progress
Computers: Amdahl mainframe; IBM PC XT
Encoding: custom
Database software: MTS, SPIRES

Suchoff/Bartók
Title: *A Bartók Source Database*
Head of project: Benjamin Suchoff
Associate: Elliott Antokoletz
Time: 1985-86
Hardware: Macintosh, Imagewriter
Software: abbreviated DARMS

Sward/Babbitt and Xenakis
Title: *An Examination of the Mathematical Systems Used in Selected Compositions of Milton Babbitt and Iannis Xenakis*
Head of project: Rosalie Sward
Place: Northwestern University (Ph.D., 1981)

Terricciano/Jazz
Title: *Contour Analysis in Monophonic Jazz Solos*
Purpose: to test a method of analyzing melodic structure of jazz solos on three levels -- the phrase, the chorus, and the solo as a whole
Investigator: Alan Terricciano
Place: Eastman School of Music
Time: 1986
Computer(OS): Digital Professional 350 (VENIX)
Encoding: integer representation of pitch

Trowbridge/Chanson
Title: "Style Change in the Fifteenth-Century Chanson," *Journal of Musicology* IV/2 (1985-6), 146-170
Scope: attempts to provide attributions for *c.*90 anonymous works associated variously with Binchois, Dufay, Ockeghem, and Busnois, whose individual traits are closely examined
Head of project: Lynn M. Trowbridge
Place: University of Illinois (Ph.D. thesis, 1982)
Software: LMIL with COBOL

Wenk/Debussy Harmony
Title: *A Grammar of Debussy's Harmonic Practice*
Aims: to write a formal grammar, based on the Baroni/Jacoboni model, to describe the harmonic content of a corpus of 92 initial phrases of instrumental works and to test this grammar by means of computer simulations
Head of project: Arthur Wenk
Place: Québec
Time: 1987-88
Computer: Texas Instruments Professional
Encoding: custom
Software: Music Processor (in 'C')

Wenk/Debussy Melody
Title: *A Grammar of Debussy's Melodic Practice*
Aims: to write a formal grammar, based on the Baroni/Jacoboni model, for a corpus of 92 initial phrases of instrumental works and to test this grammar by means of computer simulations
Head of project: Arthur Wenk
Place: Québec
Time: 1980-87
Computer: Texas Instruments Professional
Encoding: custom
Associated Literature: "Parsing Debussy: Proposal for a Grammar of His Melodic Practice" (forthcoming)
Associated Literature: "Varieties of Musical Analysis: Through the Analytical Sieve and Beyond," *Proceedings of the Conference on Music Bibliography, Northwestern University, 1986;* "Parsing Debussy: Proposal for a Grammar of His Melodic Practice," *In Theory Only* **9**/8 (1987) and *Musikometrika* **1** (1987); "Debussy's 'Little Chemistry': Melody at the Molecular Level" [forthcoming]

III. General Applications in Musical Analysis and Musical Information Processing

A. Data Structures, Representation Systems, and Computer Procedures for Musical Analysis

Balaban/Tonal Theory
Title: *A Computer Basis for Research on Western Tonal Music Theories*
Purpose: to develop a formal basis for the study of music
Head of project: Mira Balaban
Place: SUNY Albany
Computer(OS): VAX 750 (UNIX)
Software: C-Prolog
Associated Literature: "Foundations for AI Research of Western Tonal Music," *Proceedings of the International Computer Music Conference 1985*, p. 375; "CSM--A Formal Basis for Research in Theories of Western Tonal Music - an AI Approach," [*Computer Music Journal*, forthcoming]

Berardinis/Structural Analysis of Atonal Music
Title: "The Microcomputer in the Structural Analysis of Atonal Music" [in Italian] in the *Quaderno informatica musicale* (1984)
Scope: provides sample programs to generate tables of "normal order" and "prime forms"
Investigator: Piero de Berardinis
Place: Studio di Sonologia Computazionale, Pescara
Computer: Apple //
Encoding: numerical (programs in BASIC)

Bevil/Folktune Analysis
Title: *Textfile Functions and Array Manipulation in the Application of the Microcomputer to Folktune Analysis and Comparison*
Aim: determination of tune kinships based on concordances of pitch, duration, and stress
Head of project: J. Marshall Bevil
Place: Houston
Computer: Apple //+
Software: custom designed (in BASIC)
Associated Literature: "Centonization and Concordance in the American Southern Uplands Folksong Melody" (Ph.D. thesis, North Texas State University, 1984)

Boroda/Elementary Metrorhythmical Units
Title: "On the Concept of the Elementary Metrorhythmical Unit in Music" [in Russian], *Bulletin of the Academy of Sciences of the Georgian SSR* **71/3** (1973)
Investigator: Moisei Boroda
Place: Tbilisi Conservatory

Boroda/Informational Melodic Units
Title: "On the Definition of a Phrase-Type Informational Melodic Unit" [in Russian], *Bulletin of the Academy of Sciences of the Georgian SSR* **89/1** (1978)
Purpose: to formulate general principles of melody segmentation and to isolate, on their basis, a hierarchical system of unambiguously defined melodic units giving natural segmentation within the broad group of musical styles
Investigator: Moisei Boroda
Place: Tbilisi Conservatory
Associated Literature: German translation in *Sprache, Text, Kunst: Quantitative Analysen* (*Quantitative Linguistics* **15**, Bochum, 1982)

Boroda/Structural Units

Title: *The Segmentation Problem in Music: Structural Units of Musical Language* [in Russian], monograph No. 1203 of the Lenin Library, Moscow, 1986

Purposes: to isolate strongly determined basic units of musical language; general quantitative principles and regularities of the organization of the musical composition; and interrelationships between music and natural language

Investigator: Moisei Boroda

Place: Tbilisi Conservatory

Brinkman/Score Analysis

Title: "A Data Structure for Computer Analysis of Musical Scores" in the *Proceedings of the International Computer Music Conference 1984*, 233-242

Scope: describes a doubly-linked ring structure to facilitate rapid access to specific points in a score, specifically in variable textures; Bartók's Fourth String Quartet is used as an example

Head of project: Alexander Brinkman

Place: Eastman School of Music

Software: DARMS encoding

Associated Literature: "Representing Musical Scores for Computer Analysis," *Journal of Music Theory* 30/2 (1986), 225-75

Brinkman & Harris/Contemporary Music Analysis Package (CMAP)

Title: *Contemporary Music Analaysis Package*

Scope: a set of 20 programs for analysis, modelling, and composition of atonal and serial music; includes a compiled database of pitch-class set information and a library of subroutines for bitwise manipulation of pitch-class sets

Developers: Alexander Brinkman and Craig Harris

Places: Rochester, NY and Ann Arbor, MI

Time: 1986--

Computer: IBM PC initially; Macintosh version under development

Operating system: UNIX family initially; MS/DOS version under development

Software: in 'C'

Encoding: hexadecimal notation (0..b) or set names

Associated Literature: "A Unified Set of Software Tools for Computer-Assisted Set-Theoretic and Serial Analysis of Contemporary Music," *Proceedings of the 1986 International Computer Music Conference* [Harris and Brinkman]; "Computer Programs for Set-Theoretic and Serial Analysis of Contemporary Music" (Ph.D. dissertation by Harris, Eastman School of Music, 1986)

Broadbent/Thematic Analysis

Title: *Computer Assisted Thematic Analysis*

Purpose: to develop a self-contained computer system to analyze the construction of compositions

Investigator: Clive Broadbent

Place: University of Durham (UK)

Time: 1986-88

Computer(OS): Amdahl (MTS)

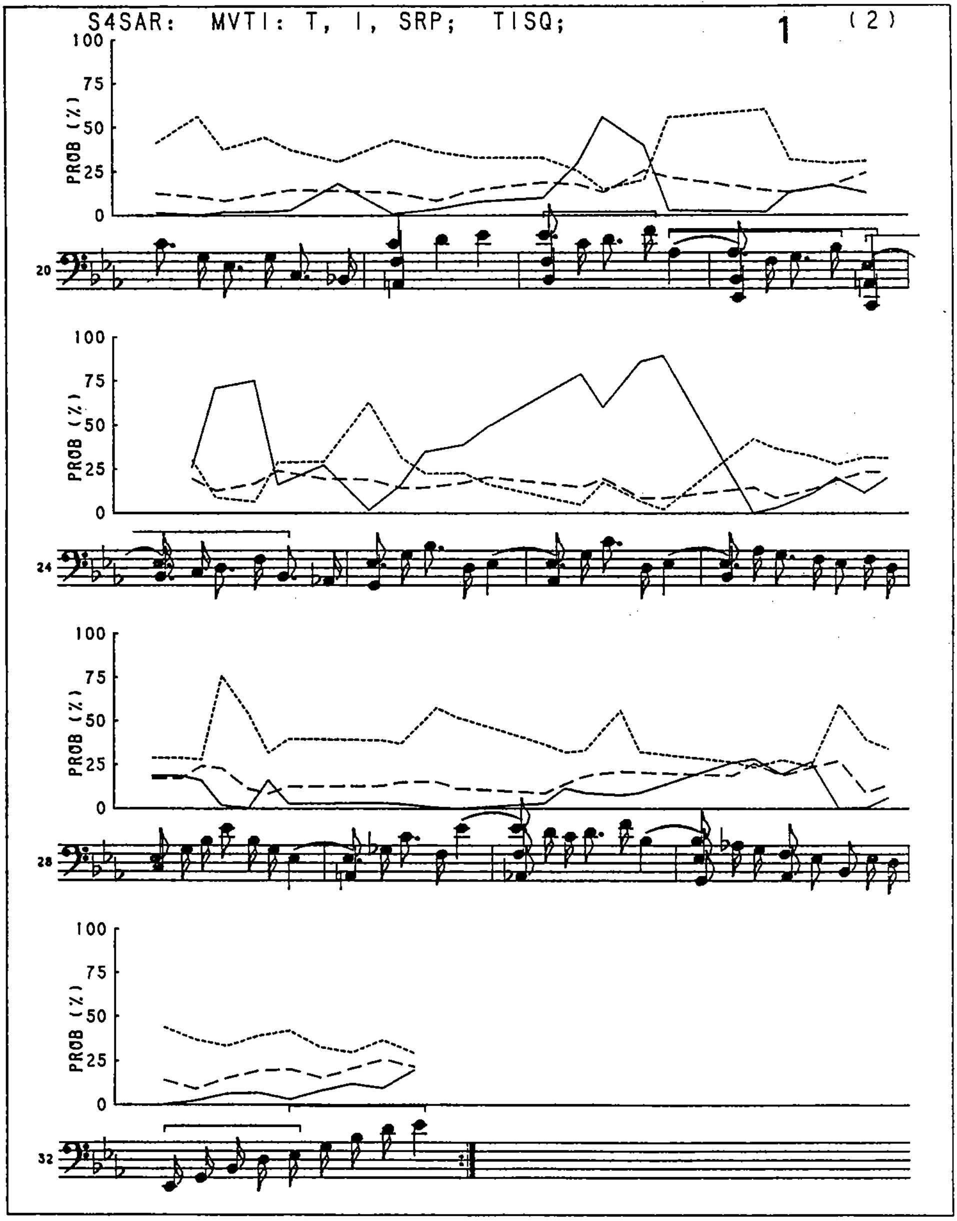
Encoding: custom

Printing devices: QMS 1200 laser printer; unspecified plotter

Papers in progress: "Toward a Programming Language for Musical Analysis," "A Non-intelligent Music Typesetter," "The Computer Implementation of Analytical Method," "Toward a Processable Representation of Analytical Intuition"

Illustration 54
Musical Analysis -- 2

David Coombs: Probability theory applied to Bach cello suites.



Camilleri/Grouping and Harmonic Segmentation

Title: *Grouping and Harmonic Segmentation*

Purpose: to develop software for grouping and harmonic segmentation based on Lerdahl and Jackendoff's theory and other rule systems

Investigator: Lelio Camilleri

Places: Pisa (CNUCE) and Florence (Conservatory)

Time: 1987--

Computer: IBM 3081

Software and encoding: TELETAU

Associated Literature: "A Computational Theory of Music: Five Definitions" [paper presented at the International Colloquium on *Basic Concepts in Studies of Musical Signification*, July 21-3, Imatra, Finland [forthcoming in *Semiotic Webb*; Indiana University Press]

Camilleri/Music Analysis

Title: "A Software Tool for Music Analysis," *Interface* **XVII**/1-2 (1987)

Scope: creation of an analytical environment comprising programs using statistical and quantitative techniques and analytical strategies derived from diverse musical theories

Head of project: Lelio Camilleri

Place: CNUCE (Florence), Musicology Division

Time: 1983-7

Hardware: IBM 3081, Gould 32/27

Software: TELETAU

Camilleri/Tonal Harmonic Analysis

Title: *An Expert System for Tonal Harmonic Analysis*

Scope: establishment of an expert system based mainly on the hierarchical approach to harmonic structure of Lerdahl and Jackendoff

Head of project: Lelio Camilleri

Associate: Francesco Carreras

Place: CNUCE (Florence), Musicology Division

Time: 1985-8

Computers: IBM 3081, IBM PC

Software: TELETAU

Carr & Porter/Perle's Tonality

Title: *ttt: An Aid for Composers and Theorists using George Perle's Twelve-Tone Tonality System*

Purpose: to create a software aid that replaces manual methods for use of Perle's system

Investigators: James Carr and Charles Porter

Place: New York

Time: 1987

Computer: Macintosh

Software: in 'C'

Printing devices: Apple ImageWriter and LaserWriter

Carter/Lute Tablature

Title: *Lute Tablature Transcription*

Purpose: to translate French and Italian lute tablature into conventional notation

Investigator: Marie Carter

Place: Eastman School of Music

Time: 1986

Computer(OS): DEC Professional 350

Colombo/Harmonic Regularity

Title: *Mathematical Models for Harmonic and Regularity Analysis of Musical Texts*

Aim: development of a series of programs for tonal harmonic analysis based on Schoenberg's theory of regions

Head of project: Walter Colombo

Supervisor: Goffredo Haus

Place: University of Milan

Computer: Sinclair QL

Coombs/Information Theory

Title: *Information Theory Applied to J. S. Bach's unaccompanied cello suites*

Purpose: to apply information theory to a specific repertory; the program pro-

duces graphs showing the probability of various parameters [see Illustration #54]
Investigator: David Coombs
Place: Eastman School of Music
Time: 1984
Hardware: Calcomp plotter
Associated Literature: "An Analysis of Expectation in Music: A Computer-Aided Study" (M.A. thesis, 1984)

DallaLibera/Retrieval Techniques
Title: *Music Retrieval by Incipit Information*
Purpose: to experiment with text processing techniques in music processing
Head of Project: Francesco DallaLibera
Associates: Susi Dulli, Franco Crivellari
Place: Statistics Faculty, University of Padua
Time: 1987-9
Computer: IBM PC compatible

Fink/Data Indexing
Title: *DataMuse*
Purpose: to develop a musical database program with the capacity to index and search musical scores; permits user specification of field names and structure; music stored in linked list representation of scores [see Brinkman: Score Analysis]
Investigator: Robert Fink
Place: Eastman School of Music
Time: 1986
Computer(OS): DEC Professional 350 (VENIX)
Encoding: DARMS

Forte/Pitch-Class Sets
Title: *Pitch-Class Sets and Relations*
Head of project: Allen Forte
Place: Yale University
Computer: IBM PC AT
Software: custom (SNOBOL4+)

Gibson/Pitch-Class Set Identity
Toward an Understanding of Pitch-Class Set Identity as a Measure of Aural Similarity in Nontraditional Chords
Purpose: to determine the significance of octave equivalence as a measure of aural similarity
Investigator: Don Gibson
Place: Baylor University
Time: 1986
Computer: Apple //e

Hewlett/Pitch Representation
Title: "A System for Numeric Representation of Musical Pitch Notation" [forthcoming]
Scope: proposes a base-40 system for discrete description of musical pitches, recognizing absolute pitch, letter (and octave) name, and written accidentals; discusses this system in the context of other number line representation systems and offers a general theory of interval invariant representations of pitch
Head of project: Walter Hewlett
Place: Menlo Park, CA
Time: 1984-7
Hardware/Software: Device independent

Jackson/Horizontal and Vertical Analysis
Title: *Horizontal and Vertical Analysis Data Extraction Using a Computer Program*
Aim: retrieval of selected musical data (roots, pitch classes, intervallic relationships) from twentieth-century repertory
Head of project: David L. Jackson
Place: University of Cincinnati (Ph.D. thesis, 1981)
Computer: Amdahl 4700
Software: custom designed encoding system with FORTRAN

Kolosick/Pitch Relationships
Title: "A Computer Representation of Pitch Relationships: Toward a Music Expert System," paper given at the annual meeting of the Society for Music Theory, Vancouver, November 1985
Scope: numeric representation of intervals derived from the Circle of Fifths
Head of project: Timothy Kolosick
Place: University of Arizona

Laprade/Contour-Class
Title: *A Program for the Calculation of Similarity Measurements for Contour and Pitch-Class Sets*
Purpose: to establish a means for the expeditious processing of pitch-class and contour-class sets through a series of similarity measures
Investigator: Paul Laprade
Place: Eastman School of Music
Time: 1987
Computer(OS): Digital Professional 350 (VENIX)

McVity/Algorithmic Composition
Title: *A History of Algorithm Composition*
Purpose: to unify expert systems for generating tonal music
Investigator: Jonathan McVity
Place: Arlington, VA
Hardware: Macintosh, MIDI instruments
Encoding: 32-bit representation

Morehen/Validity
Title: "Computer-Assisted Musical Analysis: a Question of Validity," *ICMC Proceedings 1986*
Aim: to examine the extent to which computer-assisted stylistic analysis is a valid exercise, especially in relation to polyphonic music before 1600; raises questions about defining phrase length, accounting for the direction of melodic intervals, ignoring the distinction between duple- and triple-meter contexts in analyzing durations, and so forth
Investigator: John Morehen
Place: Nottingham University

Morse/Graphic Analysis
Title: *Use of Microcomputer Graphics to Aid in the Analysis of Music*
Scope: developing of a music encoding language and software for tabulation, time-domain graphic presentation, and performance of standard notation
Head of project; Raymond Morse
Associate: Lauren Dunn (encoding system)
Place: University of Oregon (D.M.A., 1985)
Hardware: Apple //, Epson MX-80

Roeder/Declarative Analysis
Title: *Declarative Analysis of Atonal Music*
Purpose: to develop predicate-calculus expression of analytical understanding of atonal works by Schönberg, Berg, and others
Investigator: John Roeder
Place: University of British Columbia
Time: 1988--
Computer(OS): VAX (UNIX)
Software: custom, in CProlog

Russell/Pitch-Class Sets
Title: *A Set of Microcomputer Programs to Aid in the Analysis of Atonal Music* [paper given in the ICCH meeting in Provo, Utah, June 1985]
Scope: a series of programs to explore pitch-class sets, following the theoretical concepts advanced by Forte (1973), Rahn (1980) and Wittlich (1975)
Head of project: Roberta Russell
Place: University of Oregon (D.M.A. thesis, 1983)
Computer: Apple //

Solomon/Pitch-Class Sets
Title: *Music Set Analysis* (software)
Developer: Larry Solomon
Place: University of Arizona
Computer: Apple //

Spiegel/Modality - Tonality
Title: *Generative Algorithms for Tonal and Modal Music*
Head of Project: Laurie Spiegel
Place: New York City
Software: custom

Stépien/Melodic Fragment Classification

Title: Classification of Variable Length Melodic Fragments
Scope: designed for applications in ethnomusicology
Head of project: Bernard Stépien
Associate: Luigi Logrippo
Computers: Amdahl / IBM PC
Analysis software: MUSICANA (custom)
Encoding: alphanumeric

Stépien and Logrippo/Cluster Analysis

Title: "Cluster Analysis for the Computer-Assisted Statistical Analysis of Melodies," *Computers and the Humanities* **20** (1986)
Aims: to compare several kinds of analysis packages in the study of a database of monophonic songs and to explore the uses of cluster analysis in the classification of melodies by pattern types [cluster analysis is a method of classifying a set of entities (melodies, in this case) according to a predefined set of indicators (here notes)]
Place: University of Ottawa (Dept. of Computer Science)
Time: 1980-86

B. Computational Music Theory

Alegant/Even-Partition Mozaics

Title: *Even-Partition Mozaics*
Purpose: to generate all equal partitions of the aggregate (dyads, trichords, tetrachords, hexachords) and to tabulate the possible set-class combinations
Head of project: Brian Alegant
Place: Eastman School of Music
Date of completion: February 1987
Computer: DEC 350 (VENIX)
Software: custom in 'C'

Jungleib/Modes

Title: *Music Possible* (Los Altos, CA., 1985)
Scope: a digital analysis of tonality listing all conceivable 2-, 3-, and 4-note modes together with 266 of the 462 possible 7-note modes and a representative sample of modes based on other numbers of notes
Head of project: Stanley Jungleib
Place: Los Altos, CA
Time: 1983-85
Hardware: Xerox 860, Commodore-64 with MIDI interface

Schottstaedt/Species Counterpoint

Title: *Automatic Species Counterpoint*
Purpose: to generate second-species counterpoints to a given cantus firmus following Fux's rules
Investigator: Bill Schottstaedt
Place: Stanford University
Time: 1984

Wright/Species Counterpoint

Title: *Species Counterpoint*
Purpose: to develop a recursive algorithm that generates all "correct" counterpoints in first and second species to a given cantus firmus in the major mode, according to a given set of principles
Investigator: Rhonda Wright
Place: Eastman School of Music
Time: 1987
Computer: IBM PC
Software: custom, in "C"
Associated Literature: David Lewin, "An Interesting Global Rule for Species Counterpoint," *In Theory Only* **6/8**, 19-44

IV. Musical Information Processing

Facilities and Integrated Systems

ALBANY

Mira Balaban and others at the State University of New York at Albany are developing a "hierarchy-based music workstation" to provide a uniform basis for analysis, instruction, composition, and typesetting of music. The system is UNIX-based and involves an Imagen laser printer.

DELAWARE

Fred Hofstetter and Michael Arenson head the GUIDO music learning system at the University of Delaware. The system, which utilizes Macintosh and IBM microcomputers as well as PLATO terminals, has recently come to include video discs. Literature on the system includes "Computer-Based Aural Training: the GUIDO System," *Journal of Computer-Based Instruction* 7 (1981), 84-92 [Hofstetter] and "Computer-Based Instruction in Musicianship Training: Some Issues and Answers," *Computers and the Humanities* 18/3 (1984), 157-164 [Arenson].

The Videodisc Music Series initiated in 1981 has recently been released. Designed for teaching, the four discs provide simultanenous sound and graphics. Fourteen institutions collaborated on the project, which was supported by the National Endowment for the Humanities. Hofstetter was the principal investigator.

HAIFA

MUSICIAN is the name of a system for music processing and synthesis under development at the Laboratory for Computer Music Engineering at the Technion-Israel Institute of Technology in Haifa, Israel. The system is based on mainframe computers (PDP11 and VAX11) running programs in FORTRAN77 and uses both digital and analog synthesizers. Currently oriented toward synthesis and acoustical applications, MUSICIAN's designers are also interested in questions of music representation and in devising a notational system for electroacoustic music.

LOS ANGELES: UCLA

Roger Kendall and Irene Levenson continue to develop a system at UCLA for teaching harmony and other aspects of music theory. In its current phase their work uses an IBM PC with a mouse. Personal Composer is used with an Apple LaserWriter for music printing. Custom software for analysis is used.

MILAN

At the Laboratorio di Informatica Musicale in Milan, a personal music workstation is under development by Goffredo Haus and his colleagues. It is oriented largely toward acoustical manipulation (analysis, transformation, synthesis) and music printing. It uses both Apple Macintosh and IBM computers and printers and accommodates both MIDI keyboards and a DARMS-like code.

The LIM system can generate a number of musical ornaments of the seventeenth and eighteenth centuries (trill, mordent, appoggiatura, etc.) in numerous permutations. Capabilities for automatic transcription of taped electronic music and for score analysis following the Lerdahl/Jackendoff and Bertoni/Haus/Mauri/Torelli models also exist. Score printing is supported; following the establishment of a minimum set of musical symbols, a digital music font has been implemented with METAFONT.

MOSCOW

Within the Department of Pattern Recognition of the Computer Centre of the USSR Academy of Science in Moscow, an active research program is currently being developed under the auspices of the Composer's Union Commission on Popular Creativity. Particular areas of interest are automatic transcription of performance, synthesis of "human-like" performance, analysis of folk music, description of performance rules, semantics of performance, and simulation of performance expression and improvisation. The hardware is primarily of Soviet manufacture. Andranick Tanguiane is one of three co-chairs of a working group on "Mathematical Methods in Musicology." His coworkers include Victor Kalyan and Natalia Michailova.

OSLO

The MUSIKUS project at Oslo University is aimed at musical analysis and the development of a graphical representation of musical scores. It involves VAX and micro-VAX hardware and uses its own encoding system, MUSIKODE.

PARIS

A Système d'Informatique Musicale at the Université de Paris--VIII is being developed with MIDI input and a series of IBM computers, both mainframe and personal, to support composition, transcription, analysis, and printing. Horacio Vaggione is the project leader.

SARDINIA

A composer workstation is under development at the Centro Informatica Musicale in Caguari, Sardinia. Nicola Bernardini (Rome) and others are working on this IBM PC compatible system. The project is reported in the *ICMI 1986 Proceedings*.

TOKYO

Professor Samadu Ohteru heads a collaboration of approximately 50 people involved in a multifaceted program in musical robotics. His group, under the wing of the Applied Physics Department of Waseda University, includes engineers, computer scientists, musicologists, and performers. The overall purpose of the group's work is to develop an integrated musical informaton system. Recent work has focused on automatic recognition of printed music and bilateral translation between a printed score and Braille notation. Separate encoding systems are used for these activities, but there is some interest in devising a unified code. Recreation of printed music from an automatically recognized score follows extensive work directed towards performance from an automatically recognized score. The robot WABOT-2 can be seen in a videotape made at the University using all ten "fingers" and both "feet" in performances of the repertory that his "brain" can scan. WABOT-2 also provides automatic accompaniments for singers and is equipped to comment on elements of human performance that deviate from its expectations.

The research program is carried out in a UNIX environment using 'C'. Some of the main hardware components of the system are a NEC PC-9801 with a music generator board and a high resolution CCD camera, PIC-2300. The WABOT vision system is described in the *Proceedings of the International Conference on Advanced Robotics, September 1985*, pp. 477-482, and in Bulletin No. 112 of the Science and Engineering Research Laboratory of the University (1985), pp. 25-52.

WATERFORD

Donncha Sean O'Maidin's system, under development at the Waterford Regional Technical College (Eire), is based on a VAX-11/780 linked to a MIDI keyboard, and various printers and sound output devices. Musical data is scored in a customized version of ALMA and printed using SMUT.

Programs of Study

FLORENCE

A course in computer music at the Florence Conservatory extends to the study of computer applications in musicology. The course utilizes TELETAU resources (including data and software) developed by the Musicological Department of CNUCE [the Institute of the National Research Council] in Pisa. Lelio Camilleri implements the course. Pietro Grossi chairs the CNUCE musicology department.

NOTTINGHAM

The University of Nottingham (UK) offers an M.A. degree in Computer Studies in Musicology. The curriculum includes courses in applied programming, analytical methods, use of databases, and the history of applications in music. Ian Bent and John Morehen have developed the program over several years.

ROCHESTER

Alexander Brinkman offers a two-semester graduate course in Computer Applications in Music Research at the Eastman School of Music in Rochester, NY. The course combines instruction in Pascal and data structures with techniques for music encoding and processing. Computer applications may also be selected as a secondary field of emphasis in the Ph.D. program in Music Theory.

STANFORD

John Chowning and others at the Center for Research on Music and Acoustics at Stanford University offer an M.A. program in "Computational Musicology"; the focus is primarily on matters related to acoustics and sound synthesis.

TALLAHASSEE

The Center for Music Research at Florida State University offers a certificate program in Computers in Music that provides instruction in computer graphics programming, design in instructional materials, and statistical analysis methods. The program is available to both undergraduate and graduate students.

Short Courses

Gary Wittlich regularly teaches courses at Indiana University that involve computer-assisted analysis. David Crawford offers an introduction of computer-assisted music research annually. Allen Forte offers a graduate course at Yale University on "The Use of the Microcomputer for Music Research." An undergraduate course in musical stylometrics is under development at the University of Ulster.

Jon Appleton of Dartmouth College will again offer a summer seminar for musicologists, theorists, and composers on "Music and Technology". The seminar will consider the ways in which composers, performers, and listeners interact with technology and will assess the impact of electronics on the role of music in culture and on concepts of style in Western art music. The dates for this course, which was also given in 1980 and 1984 and is funded in part by the National Endowment for the Humanities, are June 22 to August 14.

COMPUTER TERMINOLOGY

ENGLISH	FRANÇAIS
computer	ordinateur
application	application
hardware	hardware
memory	mémoire
network	réseau
punchcards	cartes perforées
software	logiciel
integrated system	système intégré
storage	mémoire virtuelle
data	données
alphanumeric	alphanumérique
base	banque
design	dessein
character (ASCII)	symbole
entry/input	entrée
exchange	échange de données
field	champ de données
file	fichier
structure	structure (de fichier)
output	sortie
record	article de données
representation	représentation
retrieval	retrait, extraction
method of retrieval	mèthode d'éxtraction
search	recherche
string	chaîne de caractères
graphics	graphiques
bitmap graphics	bitmap graphiques
CRT terminal	écran
display	affichage
editing	éditer
object-oriented graphics	
screen	écran
graphics screen	éçran graphique
screen editing	éditer à l'écran

COMPUTER TERMINOLOGY

DEUTSCH	ITALIANO
Computer	calcolatore, (elaboratore)
Anwendung, Applikation	applicazione
Hardware	hardware
Speicher, Speicherung	memoria
Netzwerk	rete
Lochkarten	schede perforate
Software	software, programmi
interiertes System	sistema integrato
Speicherung	deposito, memoria di massa
Daten	dati
alphanumerisch	alfanumerico
Datenbank	data base, base
Datenbank-Design (-Entwurf)	disegno
Zeichen (ASCII)	caratteri
Dateneingabe, Input	input (ingresso), (entrata)
Datenaustausch	cambio di dati
Datenfeld	campo
Datei	file
Struktur, Aufbau	struttura
Output, Ausgabe	output (uscita)
Datensatz	record
Darstellung	rappresentazione
Abfrage	recupero, retrieval
Methode der Datenabfrage	metodo di recupero
Suche, Datendurchzucken	rercerca (di dati)
Zeichenkette	stringa
Graphik	grafica
bitmap Bildschirm	grafica bitmap, gr. a matrici di bit
Terminal, Datensichtregät	terminale CRT, terminale video
Anzeige	schermo, video (display)
Editerun	elaborazione
objekt-orientierte Graphik	
Bildschirm	schermo
Graphikbildschirm	schermo grafico
bildschirmorientiertes Editieren	elaborazione dei dati sullo schermo

	ENGLISH	FRANÇAIS	
	hardware (computer)	hardware	
	CD	disquette compacte	
	CD-ROM	CD-ROM	
	CRT	écran	
40	device	machine, dispositif	40
	-independent	indépendant de la machine	
	voice recognition d.	d. de reconnaissance de parole	
	digitizer	digitaliseur	
	ultrasonic	à ultrasons	
45	disc	disque	45
	drive	lecteur de disque	
	storage	stockage	
	optical scanner	scanner optique	
	optical character recognition	reconnaissance optique des caractéres	
50	printer	imprimante	50
	dot matrix printer	à points matricielle	
	laser printer	imprimante au laser	
	plotter	plotter	
	robot	robot	
55	tape	bande	55
	tape drive	lecteur de bande	
	terminal	terminal	
	instrument (music)	instrument (musique)	
	keyboard	clavier	
60	synthesizer	synthètiseur	60
	sampler	lecteur de clavier	
	music (acoustic)	son	
	duration	durée	
	dynamics	dynamique	
65	measure	mesûre	65
	pitch	hauteur	
	playback	playback	
	voice ('part')	voix	
	voice-leading	conduite des voix	

DEUTSCH	ITALIANO
Hardware	hardware
CD (Compact Disk)	CD (Compact Disc)
CD-ROM	CD-ROM
Bildschirm(gerät)	CRT, tubo a raggi catodici
Gerät	dispositivo, apparecchiatura
geräte-unabhängig	indipendente dal d.
Spracherkennungsgerät	d. per il riconoscimento della voce
Digitalisierer	digitalizzatore
Ultraschall- Digitizer	a ultrasuono
Platte(n), Disk	disco
Plattenlaufwerk	unità disco
Plattenspeicher	memoria a disco
Lesegerät	analizzatore ottico, lettore ottico
Optische Zeichenerkennung	riconoscimento ottico dei caratteri
Drucker	stampante
(Punkt)matrix Drucker	stampante a (matrice di) punti
Läserdrucker	stampante (a) laser
Plotter	plotter
Roboter	robot
Band	nastro
Bandlaufwerk	piastra che trascina il nastro,
Terminal	terminale
(Musik-) Instrument	strumento musicale
Klaviatur	tastiera
Synthesizer	sintetizzatore
mit Klaviatur Sampler	lettore di tastiera
Ton, Music (akustische)	suono
Tondauer	durata
Dynamik	dinamica
Takt	battuta
Tonhöhe	altezza
Playback	playback
Stimmen, Part	voce (parte)
Stimmführung	condotta (andamento) delle voci

	ENGLISH	FRANÇAIS	
70	musical notes (visual)	notes	70
	accidentals	altérations, accidents	
	articulation signs	signes d'articulation	
	beam	barres de valeur	
	dot	point	
75	figured bass	basse chiffrée	75
	key signature	armure	
	notation	notation	
	notes, misspelled	notes erronées	
	ornaments	ornements	
80	part (for performance)	partie sèparée	80
	rests	silences	
	score	partition	
	slurs	liaison d'articulation	
	staff	portée	
85	stem	haste	85
	systcm	système (de portées)	
	tie	liaison	
	time signature	indication de mesure	
	time value of notes	durée, valeur	
90	tracks	pistes	90
	print(ing)	imprimé(er)	
	typesetting	typographie	
	printed music	musique imprimée	
	publication	publication	
95	copyright	droit d'auteur	95
	edit	éditer	
	edition	édition	
	proofreading	lecture d'épreuves	
	publisher	maison d'édition, éditeur	
100	publishing	publication	100
	reader (of manuscripts)	lecteur	
	text	text	
	text processing	traitement du texte	
	text underlay	disposition du texte	

This list of terms has been compiled from contributions by Mario Baroni, Laura Callegari, Lelio Camilleri, Etienne Darbellay, Christoph Schnell and others for the Fourteenth Congress of the International Musicological Society (Bologna, 27 August - 1 September 1987).

	DEUTSCH	ITALIANO	
70	(Musik)noten (optische)	note (visive)	70
	Versetzungszeichen, Vorzeichen	alterazioni	
	Artikulationszeichen	segni di articolazione	
	Balken	barra	
	Punkt	punto	
75	bezifferung Bass	basso numerato	75
	Vorzeichnung	armatura di (in) chiave	
	Notation, Notenschrift	notazione	
	falschgescrieben N.	note compitate	
	Ornamenten, Verzierung	ornamenti, abbellimenti	
80	Noten, Stimme	parte	80
	Pausen	pause	
	Partitur	partitura	
	Bundebögen, Bindebögen	legature di fraseggio	
	Notensystem	pentagramma, rigo musicale	
85	Notenhals	stanghetta, gamba	85
	Akkolade	sistema (pentagramma)	
	Haltebogen	legatura di valore	
	Taktartangabe	metro	
	Notenwert	durata delle note	
90	Banden, Spur	tracce (piste)	90
	Druck(en)	stampa(re)	
	Drucklegung	composizione della stampa	
	gedruchter Notentext	musica a stampa, musica stampata	
	Verlag	pubblicazione	
95	Copyright	copyright	95
	herausgeben	pubblicare, curare	
	Ausgabe	edizione	
	korrekturlesen	correttura di bozze	
	Verleger	editore	
100	Verlägwesen	stampa, casa editrice	100
	Lektor	lettore	
	Text	testo	
	Textverarbeitung	elaborazione del testo	
	Textunterlegung	disposizione delle sillabe del testo	

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Carter, Nicholas, R. A. Bacon, and T. Messenger. "The Acquisition, Representation, and Reconstruction of Printed Music by Computer: a Review," *Computers and the Humanities* [in press].

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