Directory of

Computer Assisted Research

in Musicology

1986

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Introduction

In the winter of 1985 the Center for Computer Assisted Research in the Humanities distributed a questionnaire for the purpose of determining what had become of efforts initiated in the 1960's and 1970's to use computers in the field of musicology. The response was greater than anticipated, causing us to report the results in the form of a 56-page booklet, the 1985 *Directory of Computer-Assisted Research in Musicology.* Originally, there were a hundred copies, but owing to the response to notices printed in sundry musicological journals, we have reprinted the *Directory* several times and have distributed more than 500 copies.

Assuming, therefore, that this form of communication, which we originally offered in a less than elegant format, must have been serving a need that was otherwise unmet, we distributed a new questionnaire in the winter of 1986. It focussed on current activities in software development and applications. The results, together with a large volume of informative correspondence describing current needs, intentions, and frustrations, form the basis of information in this new *Directory.*

Last year's *Directory* carried a review article on non-commercial methods of entering music into a computer. This year we consider methods of printing music by computer, which ranks high on scholars' lists of priorities and is timely in terms of the current interests and activities of software developers. Other activities of note are reported in the News section.

The applications section subsumes most of the material reported last year and combines it with many newly reported projects. It is sometimes difficult to decide what constitutes a valid application. Some of the important rubrics are whether a new technique (excluding word processing) has been used, whether the process is transferable, whether new questions have been made possible by the introduction of technology, whether sheer bulk of information would have precluded investigation of the subject by any other means, and whether the application is directed toward a well-defined, well-understood scholarly process that can be enlarged or improved by more intensive control of the data involved. It has frequently been difficult to establish how well many of the projects reported meet these criteria, but we would urge our readers to give these matters serious consideration in formulating their own ideas.

The preceding year has made us increasingly aware of a convergence of interest in computer assisted musicology from a host of disciplines that are not generally considered natural allies. The bulk of our contributors are musicologists. However, the information we report here has also been provided by engineers, physicists, mathematicians, computer scientists, psychologists, and philosophers, all in academic settings, and from commercial firms and independent software designers. Likewise, among the projects reported, funding support has come variously from scientific, humanistic, educational, and commercial domains.

Our intended focus is on the traditional areas of interest and the traditional approaches to musicology. While wanting to give some indication of the whole spectrum of computer uses, we have nevertheless had to limit the scope of coverage for certain applications. For more information, we recommend that our readers look also to the regular channels of news about electronic music, computer assisted instruction, artificial intelligence, perception, cognition, and acoustics, to which references are given as needed, and to the trade press for information about software generally.

Quite obviously, we would be unable to provide the kind of information that appears here without the bountiful and well considered communication that arrives at our office in a steady stream. The well articulated thoughts of many correspondents are woven into the fabric of this *Directory*, as are the very helpful national reports that were offered by Alastair Pearce (for the United Kingdom) and Lelio Camilleri (for Italy), to both of whom we extend special thanks. Similarly, we are indebted to David Crawford and to Graham Pont for their help in identifying and locating important contributors to the field in the United States and Australia respectively.

The focus of this *Directory* carried us into the commercial sphere of endeavor. We should like to acknowledge the illustrations and information provided by all of the following: Donald Byrd, Creative Solutions, ConcertWare, Etienne Darbellay, Stephen Dydo, Electronic Arts, Great Wave Software, Keith Hamel, Thomas Hall, Hybrid Arts, Anton Khourty, John Laffan, Harry Lincoln, Kurt Maas, Mark of the Unicorn, Oxford University Press, Passport Designs, Personal Composer, Carla Scaletti, Christoph Schnell, Leland Smith, Southworth Music Systems, Temporal Acuity Products, Richard Vendome, and Christopher Yavelow. We are specially grateful to Cleo Huggins and Geoff Brown for hastily assembling preview materials representing products that will not otherwise be available until roughly three months after this *Directory* appears.

Our staff members - Frances Bennion, Edmund Correia, and Michel Flexer - have also made valuable contributions to this effort, which we acknowledge with particular gratitude.

Printing Music by Computer

Efforts to print music by computer began in the early 1960's. Buoyed by an initial optimism, researchers expended a substantial amount of time, energy and resources in laying the foundations for comprehensive computer-based music printing systems. It was through these efforts that the multi-tiered aspects of musical notation began to be appreciated. Early projects were frequently motivated by an interest in printing contemporary music at low cost. This intention carried with it the need to accommodate a variety of notational practices that are not encountered in the standard repertory. While important conceptual progress was made in this area, the desired result of a flexible, low-cost system for printing music was initially not possible, mainly because of the high cost of computing and the impracticality of the available output devices. Today, these restrictions have largely disappeared and the development of semi-automated systems for printing music by computer is now in progress.

The effort to develop computer printing of music is actually taking place in three environments, the academic research environment, the commercial publishing environment and the low-end, commercial software environment. The goal of all these efforts is the same: low-cost, easy-to-use, versatile, high-speed, high-quality systems for printing music. One may imagine progress toward this goal as being like the convergence of separate spokes of a wheel toward a single hub. The reason for representing progress on three different lines is that the nature of the development process in these environments is somewhat different. Academic research oriented systems tend to be one-of-a-kind systems, usually focussing on specific problems in music printing and not designed for general use. Commercial music publishers are production-oriented and require very high standards of quality and versatility. They tend not to be interested in the development of music printing systems for general use. Low-end commercial software companies are geared toward meeting the immediate general need for low-cost music printing.

Important contributions are being made in all three areas. The academic environment has traditionally been the source of new ideas and techniques for music printing. The commercial publishers continue to set the standards for quality, flexibility and automation. The commercial software companies have certainly made the greatest progress in terms of producing low-cost, easy-to-use systems. The current status and objectives in each of these development areas are discussed in more detail in the following sections.

1. Research-Oriented Systems

A. Originating Before 1980

The best developed printing capabilities belong to one-of-a-kind systems developed by scholars for university applications. Leland Smith's music printing system at Stanford University, Donald Byrd's at Indiana University, and Richard Vendome's at Oxford University all exemplify such systems. Most of these systems were developed and currently run on mainframe computers. Musical text is typed into the computer using an alphanumeric code. Music which is displayed on a CRT screen may be edited though a series of alphanumeric commands. The final result is put out on a high quality plotter. Photographic reduction may be used to further improve the resolution of the printing. Many of these systems have not been duplicated in their present form because (1) the full complement of hardware is very expensive, (2) the software is regarded by its developer(s) as incomplete, and (3) the quantities of storage and operating time required in sharing a mainframe system can interfere with the needs of non-musician users.

For these and other reasons, many of the people who have been involved in the development of experimental one-of-a-kind systems are now involved in efforts to adapt their programs to run on personal computers linked to desktop printers. Both Smith's and Vendome's programs have been adapted to IBM and compatible personal computers, while Byrd's current work is devoted to the Apple MacIntosh. The strength of these efforts lies in the fact that the designers are serious scholars who appreciate the wide range of needs that musicologists (and their publishers) encounter.

One of the obstacles faced by this group in the past was the limited memory available on personal computers. With more than a half megabyte of RAM memory and twenty megabytes of hard disc storage available on today's personal computers, this is no longer a problem.

B. Originating Since 1980

Most of the research-oriented systems that have originated during the current decade have been designed to accept musical data from an electronic music keyboard. This can greatly reduce the amount of time necessary for data entry. Several newer systems also allow screen editing in a graphics mode using a digitizer or a mouse.

The PLATO Interactive Music System developed by Lippold Haken and others at the University of Illinois originated in the 1970's but, like systems of more recent derivation, it permits data entry from a musical keyboard and screen editing. The IMS is unusually comprehensive in its modes of operation. It is available only to PLATO subscribers. The hardware needed to implement the music programs costs about $10,000. At present the IMS provides draft-quality scores from a dot-matrix printer; a laser printing capability is under development. The developers are chiefly engineers, but their products have been use-tested by musicologists at Illinois for several years.

The Mockingbird system developed around 1980 by Severo Ornstein and John Maxwell at Xerox Research Park in Palo Alto was based on proprietary technology and was never released as a product. The system has been disassembled and its designers have moved on to other projects. While the value of this research to Xerox was primarily technical, the example it provided to other people working on music printing was extremely valuable in terms of the concepts introduced. Large segments of the essential programs have been adapted to other environments such as the Apple Macintosh, and these now represent some of the most fertile areas of development in music printing.

The Center for Computer Assisted Research in the Humanities is also engaged in efforts to facilitate the development of high quality music printing. The Center's experimentation with music typesetting concentrates on specific problems that have been encountered perennially in efforts to print music by computer. Draft-quality printing has been developed for the Epson FX-80 (dot matrix) printer and camera-ready copy can, within certain limits of scope and quality, be produced on a LaserJet printer. It is the intent of the Center to make available the results of this experimental work in due course.

2. Production-Oriented Systems

Early university-based attempts to print music by computer were watched with more than casual interest by the music publishing establishment. Lack of substantial progress after more than a decade of development, however, caused most of the major publishers to dismiss this new technology as too complicated and too expensive. With a few notable exceptions, this situation has persisted into the present, and the major music publishers now find themselves in the awkward position of having little or no capability for computer printing of music. If one assumes that the next three to five years will see an almost complete conversion from manual engraving to computer typesetting of music, music publishers will have a major adjustment to make as part of this process.

Our attempts to evaluate and compare the various production-oriented systems have been hampered somewhat by the proprietary nature of these systems. Publishers and music engravers using the computer are somewhat disinclined to talk about their in-house systems, either because they do not want it generally known that they are using a computer or because they do not want to reveal certain details of how their systems function. An exception is A-R Editions, Inc. in Madison, Wisconson, which has generally been most forthright in answering questions about its music printing system.

The music printing system at A-R Editions originated as an outgrowth of university based research at Princeton. Its computer-based music printing system depends on alphanumeric entry that is hybridized from two early encoding systems--FASTCODE, which was developed by Thomas Hall at Princeton University (for various sixteenth-century projects), and DARMS, which was initially called the Ford-Columbia music representation language but has in recent years been refined chiefly by persons associated with the University of New York at Binghamton. The A-R system, which is used not only for A-R's own music publications but also on a consignment basis by other publishers of musicological material, requires a $50,000 typesetter, and the system is itself continually being improved.

Whereas A-R maintains an in-house system for computer typesetting of music, some other music publishers are turning to outside sources for this expertise. Bärenreiter Verlag is working with a Japanese firm, Toppan, in developing the programs and fonts for printing its large, complete editions by computer. As a first example, Volume 1 of the Mozart *Divertimenti und Serenaden für Blasinstrumente* (Ser. VII, N. 17 of the *Neue Mozart-Ausgabe*), published in 1984, was typeset electronically in Japan. The enabling software was originally developed in Denmark.

Kurt Maas's Amadeus Music Software runs on a system that in its versatility resembles the Illinois IMS but functions purely within the commercial sphere. Its high quality music typesetting has been used both for music marketed by Maas and for editions published by B. Schotts Söhne. The system is available as a commercial product, but an investment of roughly $40,000 is required to cover the costs of hardware, software, and licensing fees.

Many independent music copyists are also attempting to computerize their operations. Some merely use existing off-the-shelf software, but others are designing their own fonts or software or both. The Provencal engraver Dominic Montel, for example, has developed a music printing system on the Apricot computer that is being used to prepare the Debussy collected edition for the Costellat firm in Paris.

3. Low-end Commercial Systems

Commercial efforts to facilitate music printing range from programs that print a single line of music at draft quality with only limited editing capability (some of which were considered to be extremely competent only a few years ago) to *promises* of programs that will, within a few months, make it possible to print large quantities of the standard repertory at a quality almost equal to that of the best engraved editions.

Commercial music software is usually designed by programmers or engineers whose expertise is technical rather than musical. The industry itself is driven by market factors that favor the broadest bases of interest, which come from the domain of popular music. Software houses that become aware of the complexities involved in developing an extensive musical capability may take the view that the expenses inherent in such development cannot be justified by market potential. When problems of relevance to academic needs are solved by commercial software, it is usually in a stowaway capacity. Some commercial software houses targetting the popular music market believe that written music is on the verge of extinction, and this in itself is a decisive clue to the amount of development being devoted in such quarters to those capabilities that scholars require for printing music.

For scholars, this rapidly developing market brings many happy prospects, but with them come areas of confusion and occasional deception. For example, a system consisting of a personal computer, a synthesizer, and a desktop printer may appear to offer the possibility to play in, edit on the screen, and print out a full score. It is essential to remember, however, that the software that relates input to storage is different from the software that relates storage to output. It may not be possible to print everything that goes in. Conversely, it may be necessary to add symbols with a screen editor that cannot be entered as sound (*e.g.*, slurs). There are also systems that do not permit intermediate editing and systems that produce screen notation but do not print music.

Special licensing agreements for software products that are abridged versions of successful mainframe programs may offer the best hope of accommodating academic interests within the commercial sphere. Heretofore, the limited memory of microcomputers has restricted the potential for retaining the full range of features supported on larger systems, but the emerging availability of hard discs is removing this obstacle to completeness.

The following commentary is a composite picture of the information we received from a questionnaire that was distributed to a number of commercial music software developers in March 1986. Our intent is not to duplicate the numerous product reviews that regularly appear in the *Computer Music Journal* and the trade press but simply to give a composite picture of the current competence of commercial products as a group.

A. Host Microcomputers

Most available music printing programs are designed to run on one of three popular microcomputers--the Apple II series, the IBM PC and its compatibles, and the Apple Macintosh. Although it is common for popular word processing programs to be available in both IBM PC and Macintosh versions, this is generally not feasible for music software, and especially for music printing software: music handling on PC's is code-dependent, while for the Macintosh it is generally picture-dependent. Code-intensive representations are valuable for analysis but somewhat cumbersome for graphics; graphics-oriented systems, conversely, are well suited to printing *per se* but somewhat cumbersome (possibly even impenetrable) for analytical tasks.

There is also an important practical difference in the hardware configurations in which the IBM PC and Macintosh computers run: Macintosh users can interface with both a dot matrix printer (the Apple ImageWriter) and a laser printer (the Apple LaserWriter) without special difficulty, and most Macintosh music software can run with either device. IBM does not currently support a laser printer of its own design, so users of IBM music software may be left with the choice of a dot matrix printer (the IBM ProPrinter) or non-IBM devices favored by the software designer, for which special interfaces may be required.

There are some important exceptions to both general observations. The ALPHA system (for the Apple III and Macintosh) gives dual representation of code and graphics. Laffangraff produces an IBM PC program that supports a laser printer (KISS). SCORE is unique in coupling IBM PC input with Apple LaserWriter output, thus uniting the strengths (and circumventing the weaknesses) of both systems.

B. Printing Devices

In academic systems, the dot matrix printers of choice for music have been three Epson models--the FX-80, the MX-80, and the LQ-1500--as well as the Centronics 729, the Star Gemini 10, and the Toshiba P1350. We are not aware of any music software conceptualized in the commercial sphere that drives a plotter, although most music printing programs first devised in university environments were designed for plotters. Miscellaneous users have cited the Gould plotter (to be supported by the Oxford Music Processor) and the Watanabe WX4675. The Hewlett-Packard LaserJet, in use in some experimental settings including our own, has similarly not been reported to be in use with any of the commercial software programs included in our survey, whereas the somewhat more expensive Apple LaserWriter is widely supported.

C. Approaches to the Formation of Musical Symbols for Printing

There are several approaches to defining musical symbols for the purpose of printing music. Most commonly, and especially in the case of dot matrix printers, a design for each musical symbol is specified by selecting specific dots on a grid. Once these dots are selected, the size and shape of the symbol are fixed. This representation is called a *bit-map.* In contrast, plotters require instructions that define symbols as a series of points connected by lines (*vectors*). This feature is of value for such aspects of musical notation as setting beam inclinations. The composite representation of a series of notes beamed together is not frozen, as it would be in a bit-map representation: the size of and distance between constituent parts can be adjusted.

For certain applications, of which noteheads offer a prime example, *splines* (curved lines connecting midpoints and endpoints) may be used in conjunction with vectors. Because the description is of *shapes* only, the *size* of the output and in fact the printer that produces it can be selected at the time of output. This device-independent orientation underlies Adobe Systems' page description language Postscript, which provides a library of pre-defined symbols in such printers as the Apple ImageWriter (dot matrix) and LaserWriter as well as the Mergenthaler Linotronics typesetter. Cleo Huggins is currently designing a music font that will be released by Adobe around September 1. This font, which will include 256 musical symbols, is now being tested by several music software designers for the Macintosh. It should be emphasized that the Postscript music font is not a program for printing music but simply a library of symbols that saves software developers the task of designing the characters. Once the font is installed in a printer (which occurs prior to purchase), further refinement of the symbols or expansion of the set is precluded. The matter of placing the symbols appropriately is the responsibility of the software developers.

A final approach to the formation of musical character sets for printers is to treat symbols as groups of segments, at least some of which are common to multiple figures. The straight line of a stem, for example, is common to half-notes and all smaller rhythmic denominations. Although current applications of this principle, which has been prominent in letter font design, are not currently in use in available music software, Goffredo Haus at the University of Milan is developing a device-independent music printing system based on this approach.

D. An Inventory of Printable Musical Symbols

An inventory of some main facets of musical representation will help to clarify the current status of efforts to print classical music by computers, both large and small. Before assessing these, the prospective user should be aware of some general considerations about the data entry and editing that precede printing. Processing time is dependent upon the computer, its operating system, software design, and the complexity of the task being performed. Alphanumeric entry is slow but comprehensive; play-in from an electronic keyboard is efficient but generates the need for screen editing if text and/or articulation marks need to be added. On-screen assembly of a score often will seriously limit the dimensions of the result. Screen editing of any sort was available on less than half the products on which we received reports.

(1) *Musical pitch.* There are no real obstacles to the storage or printing of musical pitch. Every pitch has a notational equivalent and there is an orderly notational system for representing them. Personal computer software that receives input from a MIDI-based synthesizer may be quite arbitrary in its discrimination between sharps and flats, however. MIDI instruments typically have a four- to five-octave note range. Software can extend these limits, but not all programs do. The maximum range that was reported was 17 octaves; programs that permit a compass of eight or more octaves tend to require alphanumeric encoding.

(2) *Timbre.* There is no visual method for representing timbre; the instrumental designations of orchestral scores are merely suggestive. Scholars and publishers generally have little interest in timbre, but it is a major focus of electronic composers, synthesizer users, and acoustical researchers. Therefore, some experimental systems and many commercial software programs have highly developed capabilities in this area.

(3) *Dynamics indications.* These are easy to handle in printing applications but are of variable difficulty in acoustical applications because of the one-to-many relationship between sign and pertinent notes. Some electronic keyboards are touch sensitive, but this confers no capabilty to "proof-hear" crescendos and diminuendos in a written score.

(4) *Text underlay and verbal cues.* There are no serious theoretical obstacles to providing accurately placed text underlay in music printed by computer. Text underlay requires that considerable thought be given to those circumstances in which one syllable is sung to a series of pitches, or conversely in which many notes are sung to one syllable. In addition, the frequent need in academic applications for texts in languages other than English may impose constraints on the software and hardware choices that are appropriate. The need to incorporate musical examples in a text is one that in most cases can be done only by preparing the music and the commentary separately, although the potential for interleaving the two is theoretically available on systems that are designed to handle multiple functions simultaneously. Picture screens like that of the MacIntosh are not impeded by these obstacles, if the purpose is limited to printing, but the

user must bear in mind that the information on the screen is not necessarily absorbed by the computer.

(5) *Duration.* The rhythmic values of notes are for the most part easily expressed numerically and the underlying theory of relationships between the main denominations (*e.g.*, quarter notes to half notes) are among the easiest aspects of musical notation for the computer to absorb and manipulate at every stage. However, some of the refinements of rhythmic notation, including ties, come at the expense of extensive program volume. Provisions for rhythmic complexity vary greatly in commercial programs. The smallest acceptable note values ranged from standard sixteenth-notes to triplet 128th's in our survey.

(6) *Synchronicity.* Simultaneous relations between parts are among the easiest to deduce from the graphic representations of conventional notation but among the most tedious to reproduce in computer generated music printing. Outside a graphics environment, the computer must do an enormous amount of counting and bookkeeping in order not only to know where to put the notes of a second or subsequent part in relation to the first but also to anticipate, when formatting the first, that smaller note denominations may occur in succeeding parts.

All programs have some limit as to the number of parts they can integrate into a score. For screen display it may be a smaller number than in printing. While some programs can brace as many as 50 parts in print, none can display more than six on the screen (some display only two). Differences in the resolution of computer screen and printer may be such that screen editing cannot take full advantage of the print space available. In the case of music printing, the What You See [on the screen] Is What You Get [in print] (or "WYSIWYG"; pron. "Whizzy Whig") environment may still not be perfectly matched to the printing capabilities at hand.

The problem of alignment is not so complicated for sound output, where one can meter the flow to the "beat" of the smallest denomination within the work. For high quality music printing, this kind of metering does not work: we do not normally allocate the same amount of *space* for a bar consisting of four quarter-notes as we do for a bar of sixteen sixteenth notes, although in *time* all bars that may theoretically consist of sixteen sixteenth notes are equivalent.

(7) *Other spacial relations.* Some features of musical notation confer their meaning contextually. To interpret the meaning of a dot we must first know whether it is on a vertical or horizontal axis relative to the nearest note. Durational dots are easily accommodated in printing programs, but staccato markings and other articulation signs are not universally available.

(8) *Pattern delimiters.* Some aspects of musical perception, such as accentuation, recur regularly but require neither written representation *per se* nor conscious effort to perform. Yet they may be of interest for analytical purposes. They can be inferred from written music, but only at the expense of expanding the program, since in order to interpret correctly the accent of a note, we need a large number of other pieces of information.

(9) *Sets and Their Associated Symbols.* Although the signs that constitute musical notation must be treated individually, they may also in some circumstances need to be treated as members of sets including other musical symbols. One example of a set that is essential for music printing by computer is the group of notes to which a beam, a tie, or a slur may pertain.

Beams depend on two variables: length and inclination. In the case of vocal music, the rules of beaming also require some foreknowledge of text syllabification. Beaming is manageable, but many commercial programs have defects in their ability to handle beams appropriately in all situations.

Ties depend on two variables: length and rotation (underhand or overhand). They too are manageable in computer-based music printing but may not be under complete control in commercial software programs.

Slurs depend on three variables--length, inclination, and rotation--from which a fourth--curvature--may be derived. The number of conceivable results runs into the thousands. To provide an open-ended range of all conceivable slurs would require an immense amount of computer memory. Those programs that provide slurs may produce them according to a few algebraic formulae--that is, the problems of memory and logic are solved by limiting the menu to a finite number of curvatures. For the most part, computer-produced slurs look mechanical, so that even in otherwise camera-ready copy, the slurs may not closely resemble those we find in engraved editions.

(10) *Page Formatting*: most currently available music printing programs offer the user little, if any, control over page spacing and therefore over page turns.

Conclusions

The lapses and delays in the development of engraving-quality music printing can be attributed principally to an insufficiently sustained effort in the sphere of software development. The factors that have contributed to this insufficiency have been a frequent tendency in the industrial realm to underestimate the complexity of the undertaking and a tendency in the academic realm to so enjoy the complexity of the problem that practical results could be deferred until such time as every conceivable element of complexity might be accommodated. The obstacles contributed by hardware considerations, such as limitations of memory and processing time, have been quietly disappearing. There is no doubt that music printing of engraving quality will be widely available from many vendors soon.

The next challenge will be that of devising standards to facilitate the transfer of data between different systems, for although when the question is "Can I print music by computer?", the spokes of the wheel all seem to be directed toward the hub, when the question is changed to "Can I send an electronic music manuscript to a publisher?", the spokes for the moment seem to diverge, and much of the potential for flexibility that the computer otherwise promises is unrealized.

Illustrations

The following illustrations pertain to the preceding article on printing music by computer. Materials that were too wide for our page as received are shown in small fragments at actual size and in reduced versions to indicate the overall configuration on a finished page.

Temporal Acuity Products' Musicprinter for the Apple II+ [*Illustration 1*], and Personal Composer for the IBM PC [*Illustration 2*] both offer examples of output from the Epson MX-80. Keith Hamel's MusPrint example [*Illustration 3*] comes from an Apple Imagewriter, while the Professional Composer example [*Illustration 4*] was produced on an Apple LaserWriter. Of other products for the IBM PC, Laffangraff [*Illustration 5*] uses an IBM Personal Printer and Stephen Dydo [*Illustration 6*] a Toshiba dot matrix device.

Among programs that derive from academic environments, we show in *Illustration 7* output from the dot matrix Star Gemini, driven by Darbellay's Music Processor, and in *Illustration 8* HP LaserJet output from our own Center. Schnell's ALPHA system output [*Illustrations 9, 10*] works in conjunction with Professional Composer on a dot matrix printer. Dot matrix output from the IMS at Illinois University is shown in *Illustration 11.*

Plotter output is shown in *Illustrations 12*, from the Apple-based MEG system with a Watanabe plotter, and *13*, from a Gould plotter with Vendome's IBM PC-driven Oxford Music Processor. Larger plotters and mainframe computers were used to generate the incipits shown in *Illustrations 14* (Morehen, with DARMS encoding), *15* (Lincoln, with DARMS encoding), and *16* (Böker-Heil, with Plaine and Easie encoding). A Versatec plotter produced Illustrations 17, 18, and 19 on the SCORE sytsem at Stanford; a result similar to that shown in *Illustration 17* will be possible on an Apple LaserWriter if used in conjunction with SCORE; special notations such as those involved in the work of Ross Duffin (*Illustration 18*) and Douglas Smith (*Illustration 19*) may eventually be available on the Tandy 2000/IBM PC version of SCORE.

Illustrations 20 and *21* were specially assembled for this *Directory* at Adobe Systems in Palo Alto to give a preview of the music font that will be released on September 1. Viewed together, these examples show small differences (particularly in beams and slurs) between output from the LaserWriter and the Linotronics typesetter. *Illustrations 22* and *23* also use the Adobe music font, but in an upgraded version of the Deluxe Music Construction Set, a program licensed by Geoff Brown to Electronic Arts; this version of the program will not be available until the autumn.

Illustration 24 gives an example of music that the Japanese robot Wabot-2 [see **Current Technical Research**] can both read and perform with complete accuracy.

1. Musicprinter (Apple II+) Epson MX-80

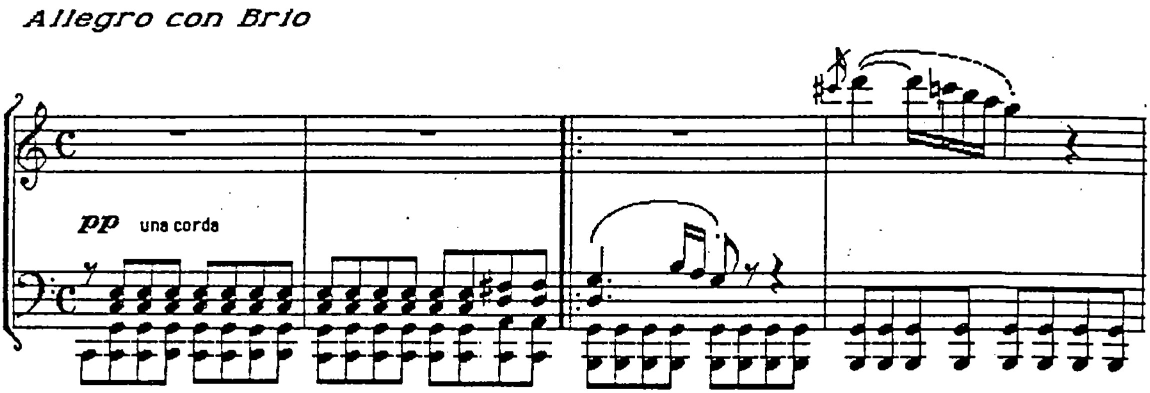
CANTATE DOMINO, *by Hassler*

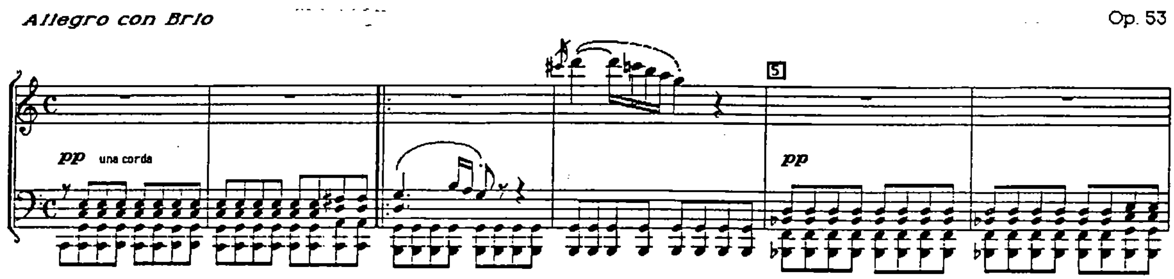
2. Personal Composer (IBM PC) Epson MX-80

VISIONS FUGITIVES Op.22, XI

3. MusPrint (Macintosh)

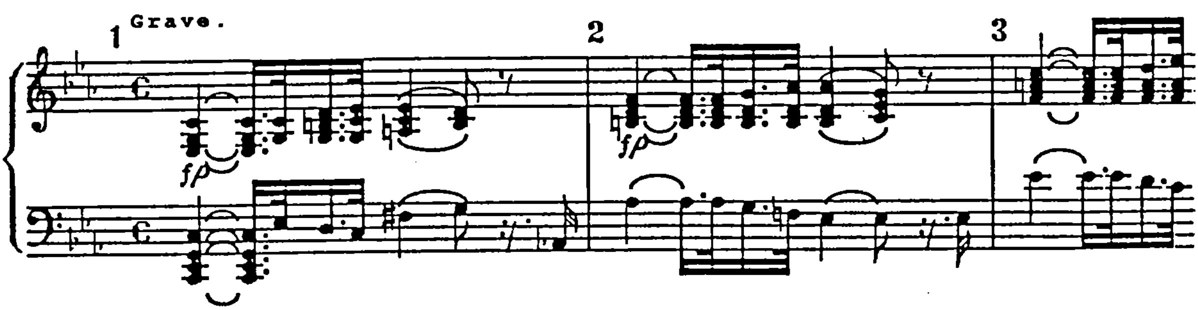
Apple ImageWriter

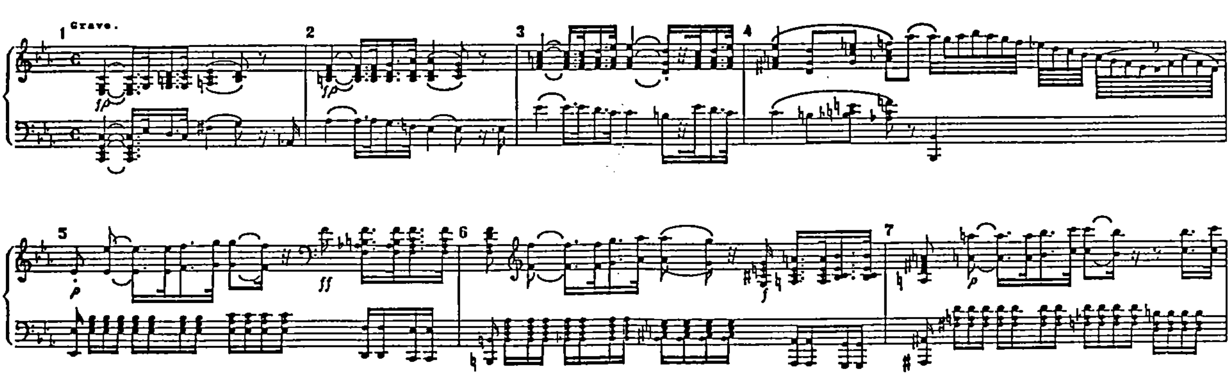




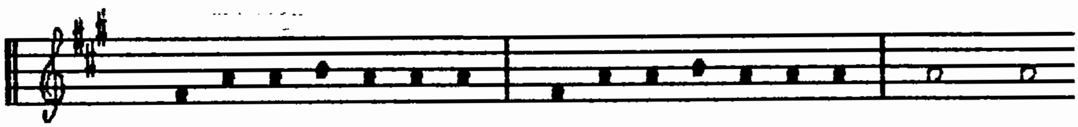
4. Professional Composer (Macintosh)

Apple LaserWriter

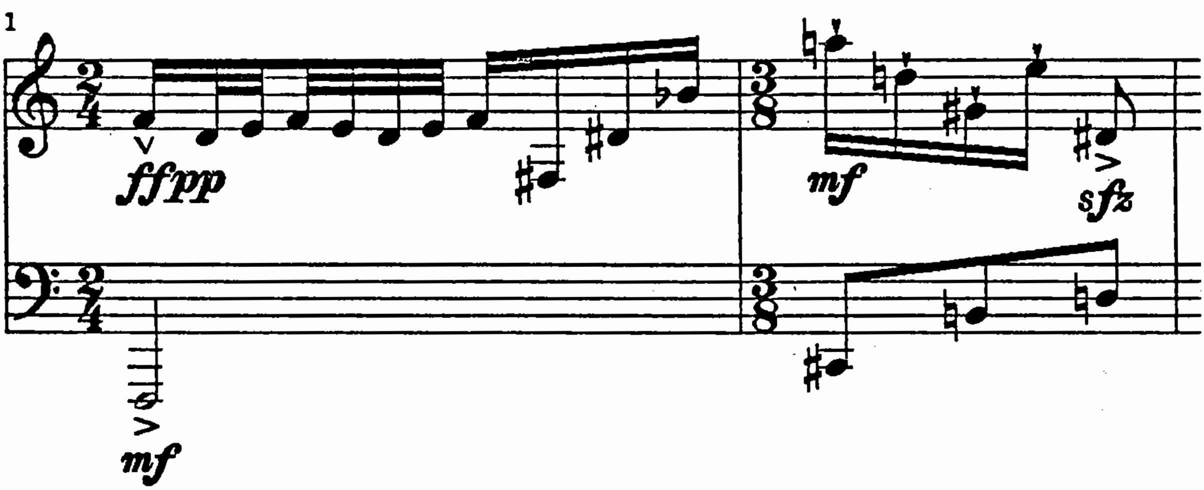


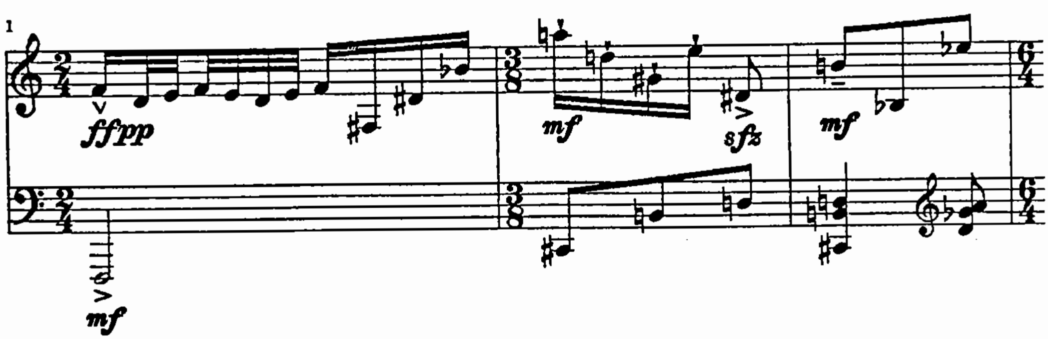


5. Laffangraff (IBM PC) IBM Personal Printer



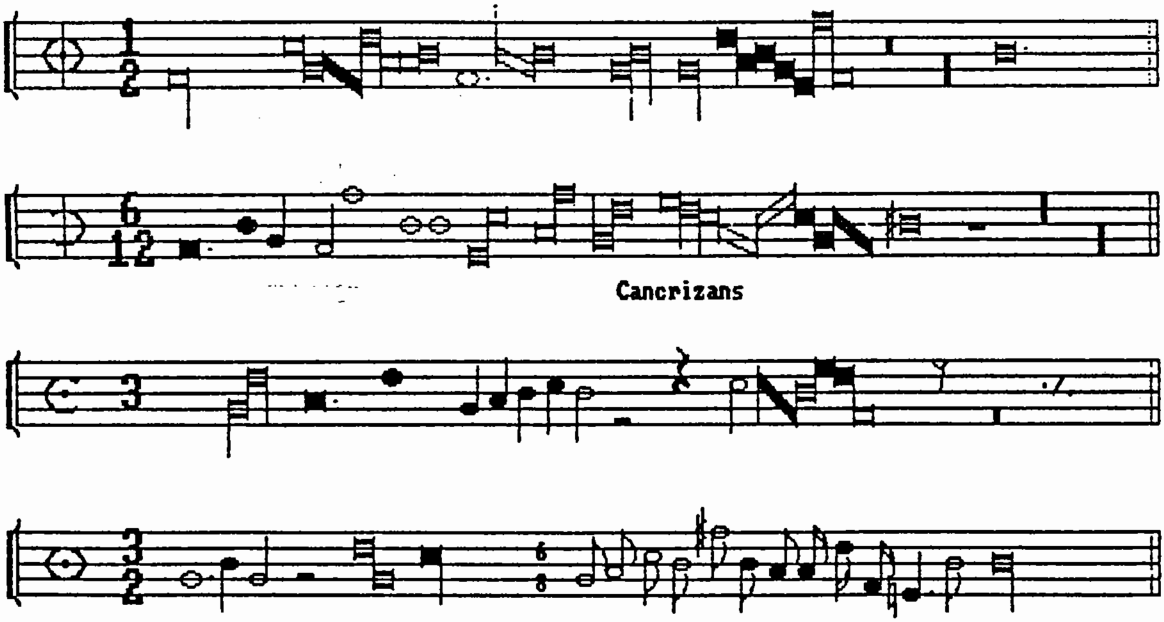
6. The Music Factory (IBM PC) Toshiba dot matrix printer





7. Music Processor (Texas Instruments Professional) — Star Gemini 10

Canones Navaronenses



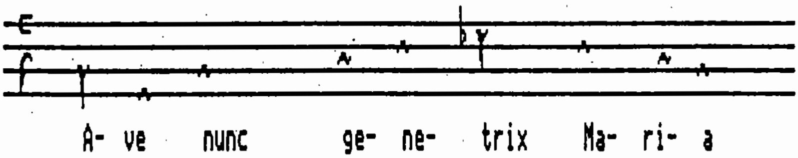
[Extrait de O <u>Muliercules in Horto</u>, Ludi Amoris, Horticulto Anno MVIIIIXV]

8. CCARH (HP 1000/IBYCUS) — Hewlett-Packard LaserJet

9, 10. ALPHA/IRMA (Macintosh) plus Professional Composer Apple ImageWriter

Ave nunc genetrix Maria

Handschrift Engelberg, Stiftsbibliothek, 314 (f 98r)



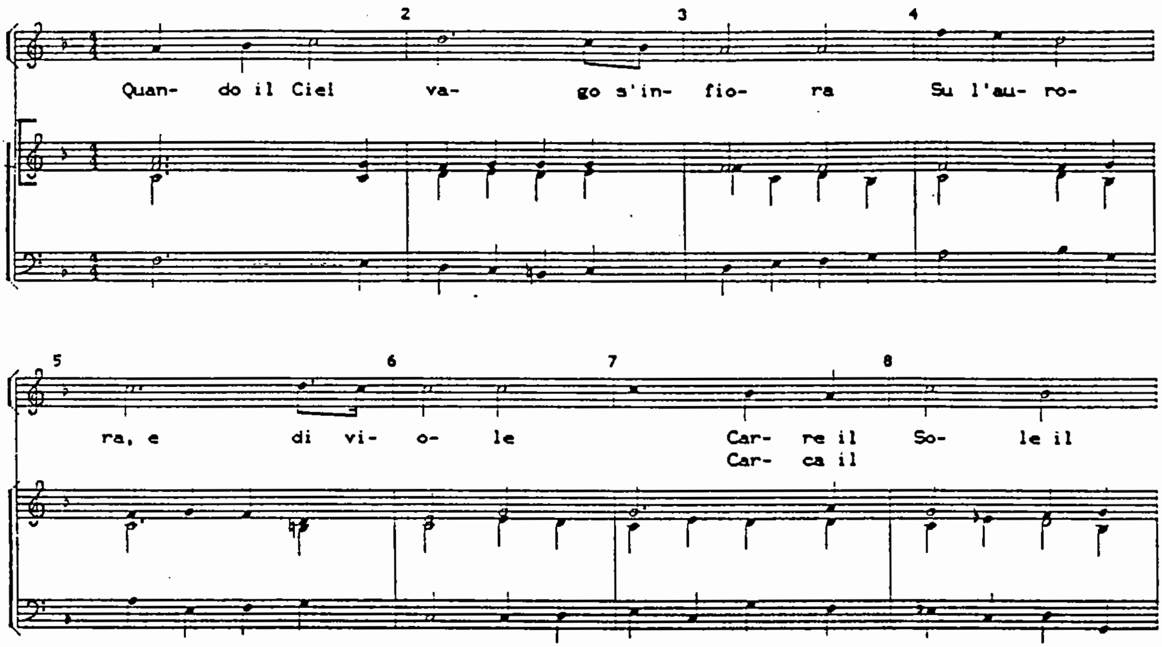
Jean Mouton: Kyrie aus "L'homme arme'"

Handschrift Roma, Cap.Sist. Cod. 160, f 5v

Paul Hindemith. 2.Streichquartett, op.16 (2. Satz, T 11 und 12)

11. Interactive Music System — Reduction — Epson FX-80

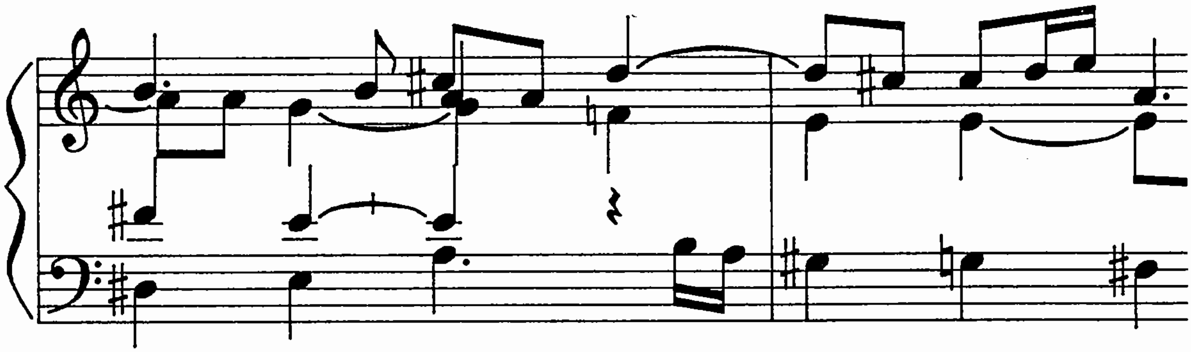
Don Ippolito Macchiavelli, "Quando il ciel vago s'infiora," I:Vc, Inv. no. 2952, fols. 34^v-37^r; words added below the first text show adaptation for the Terzo intermedio to Bradamante gelosa by Alessandro Guarini (Ferrara: Baldini, 1616). Continuo realized by John W. Hill, editor.



12. MEG (Apple II) — Reduction — Watanabe plotter

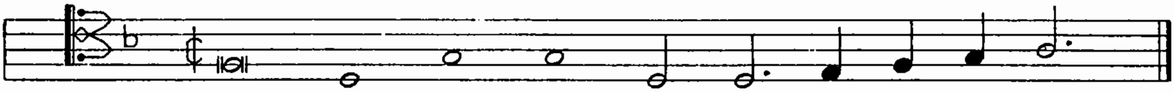
13. Oxford Music Processor (IBM PC)

Gould plotter



14. John Morehen (ICL 2988) **Benson plotter**

GRAVI PEN' IN AMOR SI PROVAN MOL P. 3 1559/20 MADRIG



15. Harry Lincoln (IBM mainframe) **Zeta plotter**

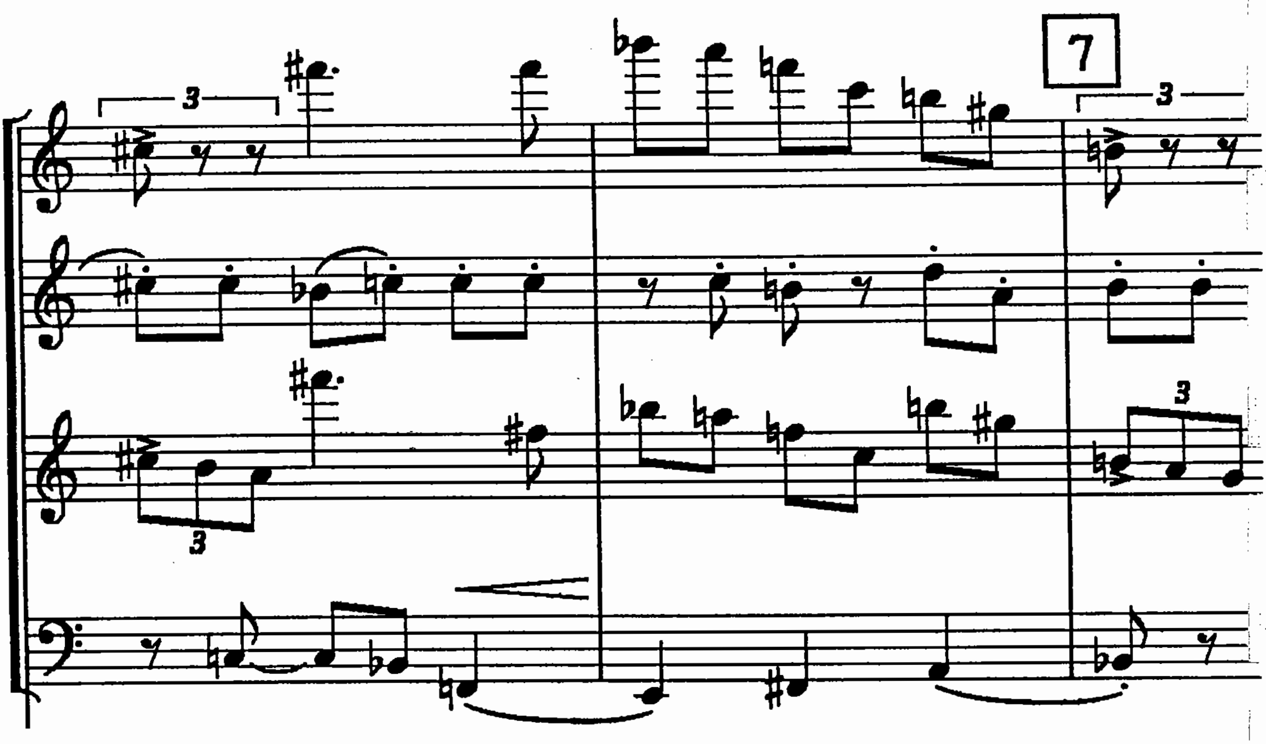
Pratoneri, Spirito Bella e nobil Signora ben dicesti
1587/11, p. 25 Madrigal
ALSIGNOR CAVALIERO SCARUFFI

16. Norbert Böker-Heil (mainframe) **Reduction** **unspecified plotter**

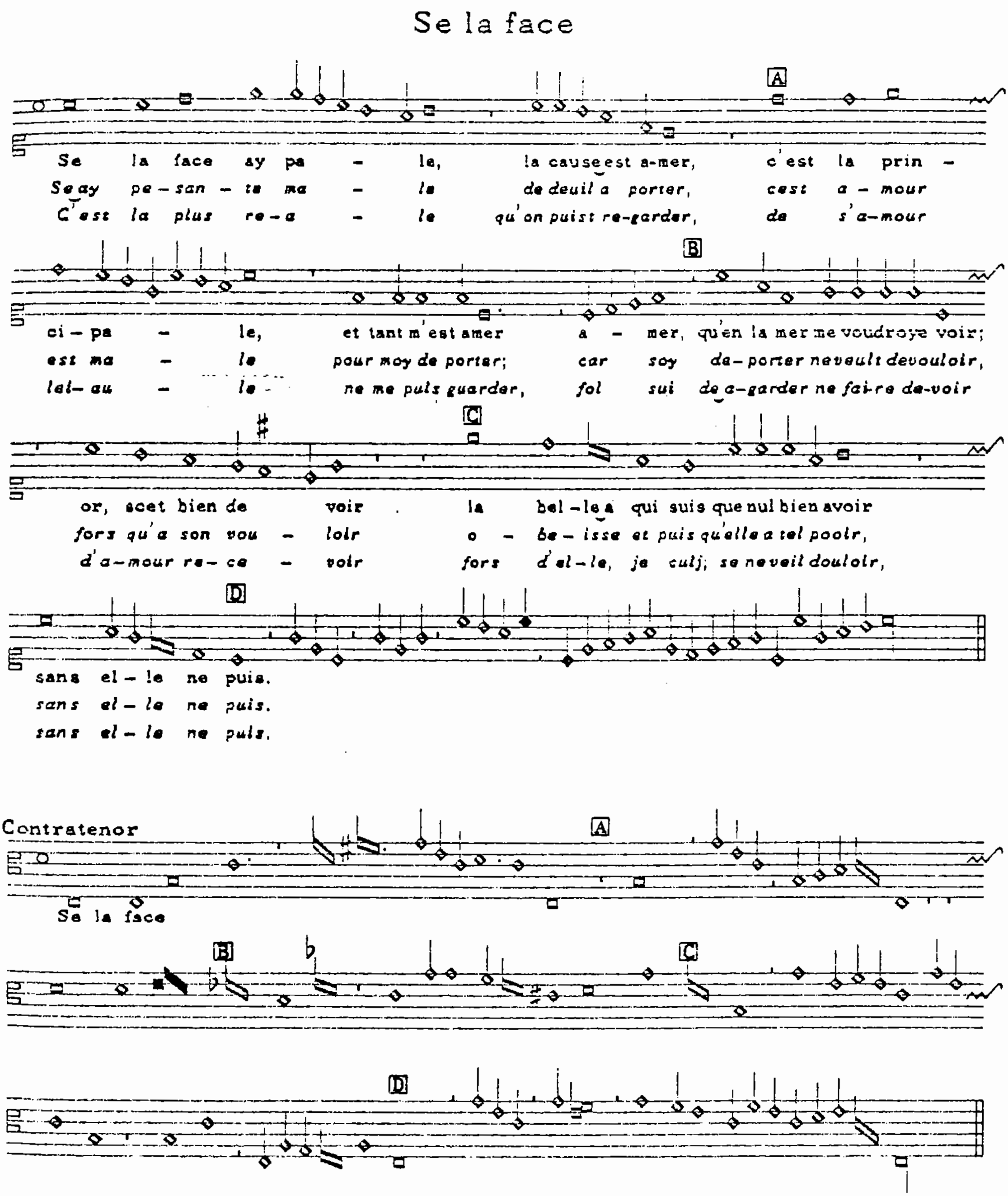
[GRÉTRY,ANDRÉ-ERNESTE-MODESTE]◦◦1741-1813

17. SCORE (PDP-10)

Versatec plotter



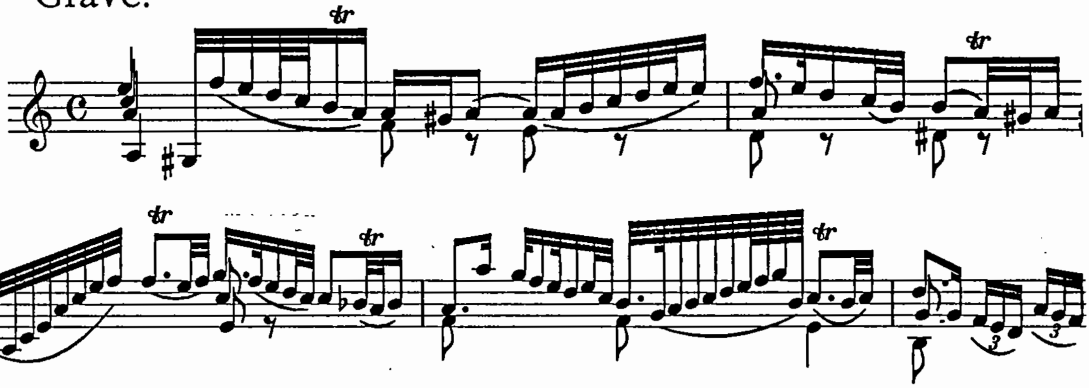
18. SCORE (PDP-10) **Reduction** **Versatec plotter**



19. SCORE (PDP-10) **Actual size** **Versatec plotter**

SONATA II.

Grave.



SONATA II.

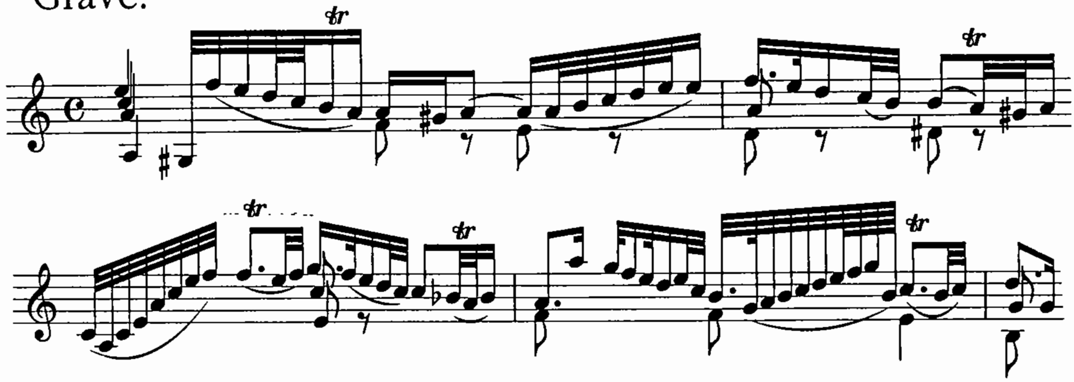
J. S. Bach

Grave.

21. Adobe Systems' music font (Macintosh) **Linotronics typesetter**

SONATA II.

Grave.



SONATA II.

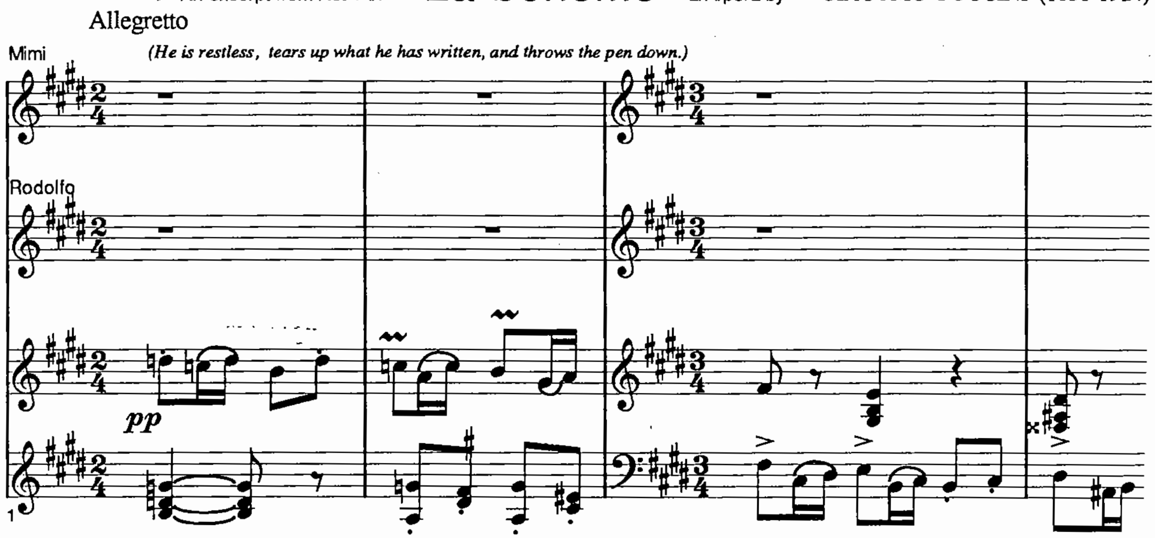
J. S. Bach

Grave.

G-minor Quintet by W.A. Mozart (k. 512)

G-minor Quintet by W.A. Mozart (k. 512)

An excerpt from Act 1 of **La bohème** an opera by GIACOMO PUCCINI (1858-1924)



An excerpt from Act 1 of La bohème an opera by GIACOMO PUCCINI (1858-1924)

24. Music read and performed by Waseda University's robot, Wabot-2

10人のインディアン

高田三九三 作詞
アメリカ民謡

News

This section of the *Directory* is intended to provide brief notices about constellations of activities which, taken together, form an ever more visible galaxy of studies pertaining to computer-assisted musicology. Some constellations reflect the efforts of musicologists to realize the benefits of the computer, some reflect the efforts in technical and scientific disciplines to address the needs of musicologists, and some reflect the efforts of scholars in other branches of the humanities to meet needs, particularly in the area of text processing, that are shared by many musicologists.

Academic Music Systems: An Update

In the context of an overview of input, storage, retrieval, and output of musical data, the 1985 *Directory* carried a review article on input methods, including the encoding systems that dominated much of the computer-related activity directed towards musicology in the 1960's and 1970's. In investigating input methods, we concentrated on non-commercial systems. As we turn our interest toward output methods, it is increasingly difficult to make a distinction between academic and commercial systems, since most music processing efforts that originated academically are now seeking commercial outlets. We have attempted, nonetheless, to preserve the distinction between these approaches, because the guiding perspectives remain distinct: academically inspired systems aim at quality and completeness, while commercially designed systems are oriented in the first instance toward entertainment applications and only incidentally serve particular academic purposes.

Our aim here is to give a brief report on systems, both old and new, that are currently in use in academic pursuits.

ALPHA/IRMA

Christoph Schnell's ALPHA system is a database system for musical information storage and retrieval originally designed for the Apple III. It is currently under revision for the Macintosh, in which context it is called IRMA (Information Retrieval for Multiple Musicological Applications). Data entry is accomplished using an ultrasonic digitizer in conjunction with a voice recognition device. The system also involves dual storage. The graphic information is stored as such, and the voice data is encoded in four formats--DARMS code, scale degree, interval sequence, and rhythmic sequence. Associated programs provide for searching, indexing, filing in a database format, and acoustic playback. The ALPHA system is described in Schnell's doctoral thesis [see Bibliography].

ALPHA and IRMA provide for printing with the commercial software called Professional Composer (version 2.0). Schnell also can reproduce fourteenth-century German neumes and white mensural notation [*Illustrations 9, 10*].

CODEX

CODEX is a program developed by Hugh Lavery to produce black and white mensural notation. Running on the Macintosh, it has been used at Dartmouth College and at Case Western Reserve University.

DARMS

Current DARMS activities are focused primarily on the theses of Bruce McLean (on storage structures for encoded information) and Stephen Page (development of a query system for encoded information). Both efforts are designed for IBM PC (XT) compatible equipment. McLean's programs are implemented in Pascal and Page's in Modula-2. At present, McLean's software is being converted from the "p" operating system to MS-DOS. McLean completed a "User Guide" for a preliminary version (0.2) of the DARMS software system in October. Completed elements of Page's thesis include an overview of music information retrieval, a design for a query system, a description of a syntax for a melodic (pitch and duration) pattern matcher, and a technical supplement giving an overview of the DARMS system.

Two plotter programs that produce incipits of Renaissance madrigals accept DARMS code: one is that of John Morehen at the University of Nottingham [*Illustration 14*] and the other that for the Zeta plotter developed at SUNY Binghamton in connection with Harry Lincoln's work [*Illustration 15*]. These programs run on mainframe computers.

Stephen Dydo is developing a high-level music printing system for IBM PC compatibles (currently linked with a Toshiba dot matrix printer) that uses DARMS encoding [*Illustration 6*].

FASTCODE

The primary user of FASTCODE is Leeman Perkins at Columbia University, whose application is the creation of a Busnois edition. No development work on FASTCODE has occured for several years, although some of its elements may be incorporated in commercial software programs designed by its main developer, Thomas Hall.

GUIDO

The GUIDO system at the University of Delaware, which originated in 1973, is devoted to instructional activities and involves a collection of diverse hardware and software (see the listing under "Hofstetter and Arenson" under **Applications/Music Analysis**).

IMS

Development of the Interactive Music System at the University of Illinois continues. This is a comprehensive system with applications in composition, analysis, scoring, printing, acoustical research, and musicology. The associated printing language called OPAL provides not only for representation but also for algorithmic manipulation of musical scores. LIME (Lippold's Interactive Music Editor) is a graphic screen editor that permits editing of scores from a music keyboard and touch screen panel. At present some capabilities of the system are being adapted to run on the NEC APC, the Macintosh, and the IBM PC, with printing capabilities for the HP LaserJet and the Toshiba P1350. A general description of the system was provided by Carla Scaletti in the *Computer Music Journal* 9/1 (1985), pp. 45-58. More specific information can be found in the M.S. theses of Lippold Haken and Kurt Hebel (University of Illinois, 1984). An example of the encoding (which is generated by playing on an electronic keyboard) and of dot matrix printout is shown in Illustration 11.

MEG

A Music Editing and Graphics system that could be used with either the Apple II or IBM PC lines was reported by Marco and Diego Minciacchi in the *Proceedings* of the 1984 International Computer Music Conference. It supported both dot matrix and plotter output [*Illustration 12*]. For entry from Apple II terminals, the alphabetic characters are redefined as pitch names. The programs are in machine code. This sytem has been used in the preparation of scores of contemporary music (*e.g.*, Stockhausen) published by Universal Edition in Vienna.

Music Processor

Etienne Darbellay's Music Processor for the Texas Instruments Professional microcomputer intends to develop his software to run on any MS-DOS system. Currently his Music Processor prints music (including plain chant and black and white mensural notation) using a Star Gemini-10X dot matrix printer. His program may soon be marketed by the Geneva firm Softarts.

Musicode

At Ohio State University, a simple encoding language called Musicode, developed in the 1960's and 1970's by William Poland and Thomas Whitney, was used by Fred Hofstetter in the 1970's and was extended by Ann Blombach (whence the name Musicode A) to facilitate her work in computer assisted instruction and analysis. Some of the data has been translated into MUSTRAN. Blombach is now involved in developing an analysis system (called MacGAMUT) that will work with Musicode2.

Musicsys/3600

Musicsys/3600 derives not strictly from an academic environment but rather from an artificial intelligence environment. A prototypical system with historical links to work done many years ago at the Massachusetts Institute of Technology, Musicsys/3600 is housed in the office of its originator, Bernard S. Greenberg, Technical Director of Symbolics, Inc. in Cambridge, Mass. The Symbolics 3600 on which it runs can provide sound output of up to six voices without a separate output device. This computer has a high resolution screen and mouse editing, and it can be linked to a laser printer. At present its music processing system is one-of-a-kind.

MUSTRAN

The current progeny of MUSTRAN, an encoding system developed at Indiana University by Jerome Wenker, issue partly from the instruction-oriented work of Gary Wittlich, the analysis programs of Dorothy Gross, and the music printing efforts of Donald Byrd, whose recently formed company, Automated Music Notation Systems, aims to create music printing software for the 512K Macintosh. Byrd's SMUT (System for Music Transcription) program, originally designed in ANSI FORTRAN for a CALCOMP 1037 computer at Indiana, is being adapted by Kimball Stickney (DEC) to run on the Macintosh.

Oxford Music Processor

Another university-cultivated music processing system is that of Richard Vendome at Oxford University. A mainframe-originated program that prints music by plotter is being adapted to run on the IBM PC and will be marketed by Oxford University Press as the Oxford Music Processor. It uses an independent alphanumeric code for input and editing but displays both the code and the music on the screen. The edition *Christ Church MS 89: Works by Peter Philips and Pieter Cornet* (Spanish Netherlands Music, I; [Oxford: John Brennan, 1983]) was made entirely using the original version of this system. Illustration 13 shows its current state of development using the Gould plotter with an IBM PC.

Plaine and Easie

Norbert Böker-Heil, director of the Music Analysis and Documentation section of the Staatlichen Institut für Musikforschung in West Berlin, developed a music printing system in the 1970's as an extension of Plaine and Easie code, which was developed in New York in the late 1960's and which has been used in its code form (as output) in some thematic catalogues. Böker-Heil's extension was used to produce the musical examples shown in a catalogue of musical manuscripts in a private collection [Hohenlohe-Langenburg; an intended segment of RISM Serie A/II] published in *Fontes Artis Musicae* XXV/4 (1978), pp. 295-408. Some principles of the encoding system used are explained on pp. 408-411. A plotter was used for the examples [see *Illustration 16*].

SCRIBE

SCRIBE is a system for the transcription, editing, and analysis of medieval, Ars Nova, and Renaissance music under development at La Trobe University in Victoria, Australia. It produces diplomatic facsimiles in neume or pitch notation, using a Huston plotter. It originated in the context of a broader study of scribal practice. John Stinson, the chief developer, is assisted by Brian Parish. VAX mainframes and Ericsson microcomputers are involved.

SCORE/MS

A microcomputer version of Leland Smith's SCORE program for editing and printing music, developed at Stanford University over the past 15 years, was to make its debut at a trade show in Chicago on June 15. Currently the program, which will be marketed by Passport Designs, is being adapted to run on the Tandy 2000, an IBM compatible microcomputer regarded by Smith as having superior screen graphics for its price. [Smith will offer a two-week course on "Music Printing on Small Computers" at Stanford in July 1986.]

The size-independent vector graphics originally developed for the DEC PDP-10 at Stanford's Center for Computer Research in Music and Acoustics (CCRMA) have been adapted in such a way as to permit printing at any resolution up to 2,000 dots-per-inch. Using the Postscript page description language (but not the Postscript music font), Smith has succeeded in extending the printing capability to the Apple LaserWriter without losing the capability of printing on the Versatec plotter or Mergenthaler typesetting equipment. Illustrations 17, 18, and 19 were produced on the Versatec plotter. Input with both the old and new versions is by alphanumeric code.

In its original version, SCORE can produce many unusual kinds of notation, including Beneventan neumes, mensural notation (18), and lute tablature (19). It can also easily convert music notated in such configurations to conventional notation. Pitch and rhythm can be uncoupled from each other and from other kinds of musical symbols. Smith hopes to provide a capability for user-defined notational systems by coupling a drawing tablet with the system. Similarly, he hopes to provide an option for real-time input and playback via MIDI instruments.

TAUMUS

TAUMUS is a musical language for reading, storage, processing, playback, and library management of musical material developed at the Musicological Division of CNUCE in Florence. Lelio Camilleri is the principal developer. This system derives or deduces durations, intervals and recurrence of thematic patterns from musical data. It can perform some metric and rhythmic analysis and some Schenkerian analysis. It can deduce pitch-class sets and set complexes. Currently the system houses samples of the music of 24 composers, including Frescobaldi, Bach, Handel, Mozart, Beethoven, Paganini, Brahms, Verdi, Wagner, Joplin, and Boulez.

troff

The **troff** system under development at Nottingham University is comprehensive in its orientation. Eric Foxley is developing a music printing preprocessor that incorporates his own fonts (in spline, or outline, form) to be used with a Chelgraph laser printer. Another component ("**music**") of the system provides a language for describing musical scores.

Unnamed systems

Gary Karpinski of Brooklyn College has been developing a music language in extended BASIC for MIDI input and output from a Yamaha keyboard linked with a Commodore 64.

Standards for Musical Information

ANSI

The American National Standards Institute has given official approval to the formation of an Ad Hoc Task Group to propose a standard for the interchange of musical information. Charles Goldfarb of IBM is Acting Chair. The first formal meeting is scheduled for July 28--Aug. 1, 1986 in Half Moon Bay, California, where Dave Kusek of Passport Designs will serve as host. A preliminary meeting in May 1985 included representatives of the music software industry, the motion picture industry, music copying services and local academic institutions with an interest in computer music.

The aims of the group are to facilitate (1) the integration of music with text and graphics in computer typesetting environments, (2) business presentations with the same requirements for integration, (3) computer-assisted classroom instruction and (4) performance training that involve aural components, and (5) transmission of performances and generation of on-demand sheet music via teletext and videotext systems.

It is proposed that the standard should incorporate both performance and score data (that is, both the aural and the visual representations). Musical works should be defined in the abstract (that is, without reference to timbre, etc.) and may be encoded only with printable characters, preferably as an extension of SGML [see below]. It is not anticipated that the creation of such a standard will disrupt the MIDI standard. Vis-à-vis score encoding schemes, however, the task force has adopted the view that "there is no dominant notation ... as scholars have tended to devise their own representations to meet specific needs." June 1987 is the target date for submission of a proposed standard to ANSI.

MDI

The Music Description Instruction set consists of an extension to the ANSI standard for text and image transmission and display, which is itself called NAPLPS (for North American Presentation Level Protocol Syntax). The primary designer of this protocol for storage and transmission of musical structure, process, and material was Laurie Spiegel. It does not directly include representations for music notation, because it depends on economy of storage to facilitate realtime transmission at low baud rates. In 1985 the development of MDI was taken over by the Department of Communcations of the Canadian government. For further information, contact Andrew Kwan.

MIDI

The Musical Instrument Digital Interface, adopted by manufacturers of electronic keyboard instruments in 1983, is designed primarily for communication between electronic musical instruments. Its emphasis is on the realtime transmission of digitally encoded mechanical information such as the playing of keys on a keyboard. The emergence of the MIDI standard has encouraged hardware and software designers to develop computer systems which can communicate with musical keyboards. Over the past year especially, the number of microcomputers with which a MIDI keyboard can be interfaced has increased significantly. The capabilities of a new generation of sound software are indicated in Christopher Yavelow's forthcoming article "MIDI and the Apple Macintosh." Information about MIDI related products is published regularly in the monthly *Bulletin* of the International MIDI Association.

As a standard, MIDI was not designed for general musical communication. Enharmonic representations of equivalent pitch such as E##, F# and Gb are not distinguished by the standard. Likewise, the realtime nature of the data collection process can introduce improper or erroneous rhythmic representations of musical events. For the creation of printed scores, correct harmonic spellings must be added either by algorithm or manually, and rhythmic representations must be checked and sometimes corrected. A significant extention of the MIDI standard would therefore be required to make it suitable for applications in music printing and music analysis.

MINI

Giovanni Debiasi of the Centro di Sonologia Computazionale at the University of Padua proposed a MINI (Musical Instrument Numerical Interface) standard as a compatible but friendly alternative to MIDI at the International Computer Music Conference held in Vancouver in August 1985.

MLA

The Music Library Association has a working group chaired by Carolyn Rabson on machine-readable representations of music. This group is examining the feasibility of encoding and electronically transmitting musical information for cataloguing purposes. The group met in Minnesota in February but did not adopt a standard at that time.

SGML

Standardized General Markup Language is a generic code for the production aspects of text publication. Derived from Charles Goldfarb's in-house markup language for IBM, the current draft version of SGML is being considered for adoption by the International Standards Organization. When authors comply with the code for designating paragraphs, headings, punctuation, and the like, publishers can quickly substitute codes that will make the completed document conform to their house style. SGML also has the potential to facilitate the creation of "spin-off" books and articles. SGML is currently in extensive use in Europe and the United Kingdom but has not been readily adopted in humanities publishing in the United States.

Through the auspices of the International Standards Organizations, a number of extensions to include non-alphanumeric characters (for example, mathematical symbols and non-Roman alphabets) are under study. The ANSI task force on music information interchange represents one of these efforts.

Events

A set of talks and discussions on "Computers and Music Research" will be held at the Computing Laboratory, Oxford University, on July 9 and 10, 1986. The topics to be considered include representation systems, database structures, query languages, analysis, methods of printing music by computer, and computer-assisted instruction. Ian Bent, Clive Broadbent, Alan Marsden, Stephen Page, Alastair Pearce, Richard Vendome, and Bruce McLean are the announced participants. Details are available from Page and Broadbent. (Some of the same persons participated in a seminar on the same subject organized by Oxford University and held at the Oxford University Music Faculty on April 30, 1986.)

A conference on music bibliography sponsored by Northwestern University on October 10 and 11, 1986, will include several talks related to computer applications. Among these are presentations by John Howard on RISM, by Barry Brook on thematic indices, by Michael Keller on the Italian lyric poetry collaboration, by Nicholas Temperley on indexing hymn tunes, and by Arthur Wenk on analysis. Kăren Nagy is the organizer.

The International Computer Music Conference will meet at the Royal Conservatory of Music, the Hague, from October 20th through 24th. An invited seminar on printing music by computer will follow at the Institut für Informatik der Eidgenössischen at the Technische Hochschule [the home of Pascal and Modula-2] in Zurich. It is being organized by Bruno Spoerri.

Stephen Page delivered a paper on "Recent Developments in Music Information Retrieval" at the International Conference on Data Bases in the Humanities and Social Sciences at Grinnell College (Iowa) in June 1985. Two papers on computer-assisted instruction and one on pitch-class analysis (by Roberta Russell) were given at the biannual International Conference on Computing in the Humanities at Brigham Young University (in Provo, Utah) during the following week.

Dorothee Hanemann and Christoph Wolff organized a three-day meeting of German Bach scholars to solicit ideas about the content and administration of a Bach Database. The meeting, on April 21-23, was hosted by Bärenreiter Verlag in Kassel. The discussion focused on the nature of the "edition" (a critical edition in preference to an *Urtext*), the musical elements beyond pitch and duration that should be represented, and the desirability of creating data banks of supporting text information concerning sources, scribes, texts, and the like. Walter Hewlett represented the Center for Computer Assisted Research in the Humanities at the meeting, which was widely publicized in the German press.

Programs of Study

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 of instructional materials, and statistical analysis methods. The program is available on both undergraduate and graduate bases.

Case Western Reserve University (Cleveland, Ohio) is in the process of establishing a Center for Music and Technology. It is an Apple-oriented facility that aims to provide facilities for sound synthesis, music printing, and computer-aided instruction as well as courses on software development.

The University of Nottingham (England) offers an M.A. degree in Computer Studies in Musicology. The curriculum includes courses in applied programming, analytical method, use of databases, and the history of applications in music. Ian Bent and John Morehen oversee the musicological aspects of the program.

Allen Forte introduced a graduate course on "The Use of the Microcomputer for Music Research" at Yale University in 1985-86.

At the University of Michigan David Crawford offers an introduction to computer assisted music research annually and Dale Monson used the database of opera librettos he is developing (ECOD) in a seminar there in the spring term of 1986.

Gary Wittlich of Indiana University offered a course on "Microcomputers and Music Instruction" at the Peabody Conservatory of Music in July 1985. He regularly teaches courses at Indiana University that involve computer-assisted analysis.

At the University of Washington, John Rahn (Music Theory) and Steven Tanimoto (Computer Science) jointly offered a course in the spring of 1986 on computer representations of music, with particular emphases on typesetting, interactive editing, and composing.

Online Communications

Alastair Pearce and Sandi Kirkham are initiating an electronic journal for graduate music students. Called MUSSTUD (for *Music Studies*), the journal will begin operation in 1987. It uses hardware (VAX) and software supplied by the British Library as part of a larger project (BLEND) designed to facilitiate scholarly electronic publishing.

A national discussion on music representation systems was initiated in the autumn of 1985 by John Maloney at the University of Washington. The ARPANET address is: jmaloney@washington.arpa.

Remote users can gain access to the TAUMUS system and other musicological software under development at CNUCE, Florence, via EARNNET. The service, called TELETAU, has been designed by Giovanni Nencini and Pietro Grossi, from whom a user's manual is available on request.

Prof. Dr. Helmut Schaffrath, Chairman of the Study Group on Information Retrieval of the International Council for Traditional Music, moderates an international discussion (in English) on computer projects in ethnomusicology. Messages may be sent to: JMP100 AT DE OHR Z1a (EARNNET).

The Center for Computer Assisted Research in the Humanities is now linked with BITNET and will be actively using it from September 1. Messages may be sent to: ccarh@berkeley.

Computer-Assisted Instruction

Computer-assisted instruction is a substantial field in its own right. For detailed information, readers should consult the *Journal of Research in Music Education*, the *Journal of Computer-Assisted Instruction*, and the *Newsletter* of the Association for Technology and Music Instruction (edited by Ken Bales). A music education group also functions under the auspices of the Small Computers and the Arts Network.

Although its primary focus is on sound synthesis, the *Computer Music Journal* also carries a substantial number of articles on computer-assisted instruction.

Current Technical Research

Wabot-2, a robot developed at Waseda University in Tokyo, plays music on an electronic organ that it "reads" with an optical scanning system built into its head. Its current repertory consists of children's songs with chordal accompaniments and a pedal part in one-page arrangements [see *Illustration 24*]. Dynamic discrimination and differentiated articulation appear to lie within its range of competence. The robot made its debut last summer at the International Conference on Advanced Robotics, in whose proceedings (pp. 477ff.) its vision system is described. A similar description ("Automated Recognition System for Musical Score") constitutes Bulletin No. 112 of the Science and Engineering Laboratory of Waseda University. An account is also forthcoming in the *Computer Music Journal.*

Among current projects related to acoustics, psychoacoustics, and artificial intelligence, we note briefly those of Nicholas Cook (Hong Kong) on aspects of timing in recorded piano performances, S. Emmerson (City University, London) on pitch and amplitude analysis, David Huron (Waterloo, Ont.) on kinesthetic analysis of piano performance, using an infra-red sensed grand piano, Edward Lisle (Center for Research on Perception and Cognition, Sussex), Bernard Mont-Reynaud (CCRMA, Stanford) on automatic transcription, and Barry Vercoe (M.I.T.) on electronic accompaniment that responds to changes in tempo of a live performer.

At Deakin University in Victoria, Australia, Richard Philcox (Mathematics) and B. J. Garner (Computing) are extending their work in artificial intelligence into the area of computer assisted musicology. They are especially interested in relating words, text, and symbols.

John Gourlay's proposal for "A Language for Music Description" (*Communcations of the Association for Computing Machinery* 29/5 [May 1986]) describes one current approach to providing a common basis for electronic printing, communication, and performance of music. Mills College in Oakland, California, has received a grant to pursue the goal of establishing a "hierarchical music specification language." The grant supports the design and implementation of a software environment for the "spccification, manipulation, and transformation of formal musical structures."

Dissertations in Progress

A significant number of theses, predominantly of analytical thrust, are in preparation. Their numbers are, from many perspectives, obscured by the fact that they are emerging from diverse academic disciplines, as noted in this listing.

* Don Cantor (Computer Science, Boston University) is interested in exploring the area of interactive musical analysis.

* Nicholas Carter (Music and Physics, University of Surrey) is investigating optical scanning techniques with a view toward producing a thesis on "The Electronic Input, Storage, and Output of Printed Music."

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

* Lounette Dyer (Computer Science, California Institute of Technology) is writing an M.Sc. thesis on computer representations of music.

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

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

* Samuel McKinney (University of Brussels) is starting a thesis on computer applications in musicology.

* Bruce McLean (Engineering, SUNY Binghamton) is currently completing his thesis on a storage structure for DARMS-encoded musical information. His canonizer creates a three-dimensional representation (or "cube") of the elements of information that constitute a two-dimensional musical score.

* Stephen Page (Computer Science and Music, Oxford University) hopes to complete his "Query System for Music Information Retrieval" by the end of 1986. An experimental version of the system will locate melodic and rhythmic patterns of arbitrary complexity in DARMS-encoded data. His approach favors description-oriented queries over special-purpose, single-task programs.

* Alastair Pearce (Music, King's College, London) is creating a series of general-purpose programs for retrieval of musical information in connection with a thesis on "Computer Applications in Music." The programs would permit searches for particular phrases, melodic and harmonic patterns, and so forth and are designed to give the user broad control over the kinds of data examined. Various methods of encoding are permissible.

* Brad Rubinstein (Computer Science, UC Berkeley) completed a thesis in May 1986 on data management of musical information. Among the topics considered were multiple views of data, musical knowledge representation in a database, representation of time lines and event hierarchies, and attribute inheritance.

* Christoph Schnell's thesis (Musicology, University of Zurich) on computer applications in musicology, with particular reference to his own ALPHA system, was accepted and published in German in 1985 [see Bibliography]. Parts of the work are scheduled for publication in English translation in 1986.

Resource List for Humanities Computing Information

The Office for Humanities Communication at the University of Leicester (U.K.) publishes a *Humanities Communication Newsletter* several times a year. It contains brief announcements concerning computer applications in many fields. Copies are provided free on request. The editor is May Katzen. OHC also facilitates and coordinates computer projects throughout the United Kingdom.

The Modern Language Association has recently published a book on *Computer-Aided Instruction in the Humanities* (1985; edited by Solveig Olsen). In addition to a very substantial bibliography, it contains many useful references to software and courseware, to university humanities departments that have undertaken specific projects, and to publications that report these kinds of information.

A newly formed Association for History and Computing met at Westfield College, London, from March 21 to March 23. Historians, publishers, and computer specialists from several European countries gave presentations.

A conference on mathematics and music was held in Darmstadt in November 1985.

The first issue of *Literary and Linguistic Computing*, the new journal of the Association for Literary and Linguistic Computing, was to appear in the spring of 1986. Word processing for humanities applications is among its areas of consideration. The editor is Gordon Dixon.

The British Academy, in cooperation with the British Office for Humanities Communication, has recently published a pamphlet entitled *Word Processing and Publishing: Some Guidelines for Authors.* Peter Denley is the author. The contents complement specific guidelines given by publishers. Copies may be obtained from the Publications Officer, the British Academy, 20-21 Cornwall Terrace, London NW1 4QP, England.

The Norwegian Computing Centre for the Humanities publishes a quarterly journal called *Humanistiske Data*, which considers both technological developments and specific applications.

The Office of Scholarly Communication and Technology, which was established by the American Council of Learned Societies in 1984, initiated a quarterly newsletter, *Scholarly Communication*, in June 1985.

The Society for Scholarly Publishing, which is devoted to the mutual interests of scholars, publishers, and librarians, heard a number of computer-related talks at its eighth annual meeting in San Francisco on May 28-30, 1986.

The Association for Computers and the Humanities will hold its annual meeting at Vassar College in Poughkeepsie, New York, from July 31 through August 2, 1986. Its focus will be on the teaching of "computers in the humanities" courses.

Computers and the Humanities is a quarterly journal reporting applications and *SCOPE* (*Scholarly Communication: Online Publishing and Education*) a bimonthly newsletter. Both are published by Paradigm Press.

Applications from 1980 to the Present

This listing of current and recent computer applications 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 forthcoming *Computer Applications in Music* (Los Altos, CA, 1986), which will contain more than 3,000 listings.

Our listing is divided into several sections, determined by whether the data is primarily textual or musical and whether the aim is primarily bibliographical or analytical. Occasionally the information received is insufficiently detailed to preclude the possibility of misclassification or misinterpretation. For computer-based discographies and studies primarily concerned with acoustics, perception, artificial intelligence, and classroom instruction, we suggest consultation of other sources.

Bibliographies and Indices of Text

Bent/Nineteenth-Century Music Theory
Title: *Bibliography of Nineteenth-Century Music Theory*
Scope: printed sources of music theory, 1750-1910
Head of project: Ian Bent
Place: Cripps Computer Centre, Nottingham University
Time: 1982--
Hardware: 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: *Printed Liturgy Books of the Renaissance*
Scope: sources in US and European libraries, 1450-1550
Head of project: David Crawford
Associate: James Borders
Place: University of Michigan
Time: *c.*1983--
Hardware: Amdahl mainframe
Database software: SPIRES

HillG/Historical Editions

Title: *A Guide to Music in Collected Editions, Historical Sets, and Monuments*
Aim: production of a complete bibliography of the contents of monumental editions, based on the model of the Heyer book
Head of project: George R. Hill
Associates: Garrett Bowles (software), Irving Godt, Richard Jones, Sterling Murray, Barbara Renton, and Gordon Rowley and others
Place: City University of New York
Time: 1986-8

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: 1988--
Hardware: NEC APC III
Software: custom

Murray/Examples

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
Hardware: Honeywell Sigma 9
Software: custom designed

Bibliographies and Indices of Music

Baron/French Airs

Title: *Inventory of French Air Collections*
Scope: listing and identification of duplicate melodies
Head of project: John Baron
Place: Tulane University

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
Hardware: DEC VAX
Associated Literature: "The Burning Salamander: Assigning a Printer to Some Sixteenth-Century Music Prints," *Notes* 42/3 (1986), 483-501.

Charnassé/Polyphony
Title: *The Bridgman File*
Scope: 80,000 incipits of polyphonic vocal music, 1420-1520, in manuscript sources [the file was begun for RILM]
Head of project: Hélène Charnassé
Place: Centre National de la Recherche Scientifique (Paris)
Hardware: Benson-plotter (music printing)
Associated Literature: "Towards a Data Base in Musicology: The Computer Processing of the Bridgman File," *Proceedings of the International Computer Music Conference, 1980*, 644-652

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

Davis/Concertos
Title: *A Thematic Identifier Catalogue of Eighteenth-Century Concertos*
Scope: comprehensive index of the standard repertory
Head of project: Elizabeth Davis
Place: New York University
Hardware: Cyber 170
Software: MUSTRAN encoding

Floyd/Black Music (Chicago)
Title: *Black Music Holdings in Chicago-Area Libraries*
Scope: union catalogue of books, music, recordings, photographs
Head of project: Samuel A. Floyd, Jr.
Associates: Marsha J. Reisser, Terry S. Koger
Place: Center for Black Music Research, Columbia College, Chicago
Time: 1985--
Hardware: Texas Instruments Business Pro (MS DOS)
Software: custom

Kennedy/Burgundian Chanson
Title: *Six Chansonniers: A Study of the Central Repertory of the Burgundian Chanson*
Scope: interest in determining degrees of melodic similarity between works (several hundred incipits)
Head of project: Duff Kennedy
Place: UC Santa Barbara (Ph.D. thesis in progress)
Hardware: Tandy 1000
Software: modified version of Hughes' chant code for programs in BASIC

LaRue/Symphonies
Title: *A Thematic Identifier Catalogue of Eighteenth-Century Symphonies*
Scope: comprehensive index of the standard repertory (100,000 records)
Head of project: Jan LaRue
Place: New York University
Time: 1982--
Hardware: Cyber 170
Software: MUSTRAN encoding

Lewis/Gardano
Title: *Antonio Gardano, Venetian Music Publisher, 1538-69*
Head of project: Mary Lewis
Associates: David McSweeney, Eric Sidoti
Place: Brown University
Time: *c.* 1983--
Hardware: Macintosh, Imagewriter, Laserwriter
Software: Professional Composer (modified version)
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*
Scope: 35,000 melodic incipits representing 6,000 works
Head of project: Harry B. Lincoln
Place: SUNY Binghamton
Hardware: IBM mainframe, Zeta plotter (music printing)
Software: DARMS encoding with programs in COBOL and PL/1
Associated Literature: "A Description of the Database in Italian Secular Polyphony held at SUNY-Binghamton, N.Y.," *Fontes Artis Musicae* XXXI/3 (1984); main index to be published by Yale University Press [see Illustration 15]

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
Software: DARMS encoding
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*
Scope: listing of textual and musical incipits of 300 works, based on a survey of 1,000 sources
Heads of project: Eleanor McCrickard and Carolyn Gianturco
Place: UNC at Greensboro
Hardware: Apple II
Software: Quick File (data entry), Apple Writer (editing)
Associated Literature: scheduled for publication by Pendragon

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 [see Illustration 14]
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 [plotter program available from author]

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

National Tune Index/Overview
Title: *National Tune Index*
Scope: the creation of a series of indices of secular music repertories from the 16th to the 20th centuries; completed projects published in microfiche; see separate listings
Originator: Kate Van Winkle Keller
Method: includes indices of text, scale degrees (numerical representation), interval sequence, stressed notes, and sources
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
Head of project: Kate Van Winkle Keller and Carolyn Rabson
Sponsor: compiled under the auspices of the Sonneck Society with support from the National Endowment of 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: Wind Band Music to 1830*
Scope: a listing and concordance of eighteenth-century wind music in American, Canadian, and British libraries
Head of project: Raoul Camus
Place: CUNY--Queensborough (with support from NEH)
Time: in progress

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: University of Queensland
Time: 1984--
Hardware: DEC-10
Access: printout available from the University

Selfridge-Field/Marcello
Title: *Benedetto Marcello (1686-1739): A Thematic Catalogue of His Works*
Scope: listing of textual and musical incipits of 700 works, based on a survey of 3,000 sources, with multiple indices and source filiation
Head of project: Eleanor Selfridge-Field
Place: CCARH, Menlo Park, CA
Time: 1984--
Hardware: HP-1000 (IBYCUS operating system), HP LaserJet
Software: custom designed by Walter B. Hewlett

Stinson and Griffiths/Fourteenth-Century Music
Title: *Fourteenth-Century Rêpertoire*
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), Huston 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)
Head 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--

Databases of Text

Baroni/Bolognese Libretti
Title: *Libretti of Works Performed in Bologna, 1600-1800*
Scope: multiple index of authorship and performing details of published libretti for operas, oratorios, and other musical performances (4,000 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)
Associated Literature: publication of index by Mucchi (Modena) scheduled for 1987

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--
Hardware: Olivetti

Griffin/Musical References in Italian Newspapers
Titles: *Gazzetta di Napoli* (1681-1725), *Avvisi di Roma*
Scope: creation of structured databases of information about music (composers, performances, works) in early Italian newspapers
Head of project: Thomas Griffin
Place: Palo Alto, CA
Access: CP/M discs; available by modem

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/ECOD [=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: 1984--
Hardware: Amdahl 5860
Database software: TAXIR
Access: designed for online searching by telecommunication from remote points (accounts through Michigan Terminal Service)

Monson/Singer Index

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

Mould/Harpsichord

Title: *Makers of the Harpsichord and Clavichord, 1440-1840* [3rd edn. of the study originally made by D. H. Boalch; forthcoming from Oxford University Press]
Scope: extensive revisions to be derived from a base of data recording the physical characteristics of 1500 harpsichords found worldwide
Head of project: Charles Mould

Perry-Camp/Mozart

Title: *Non-musical Markings in Mozart Autograph MSS*
Scope: a complete compilation of data (240 MSS to date)
Head of project: Jane Perry-Camp
Place: Florida State University
Hardware: Cyber 760
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
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
Hardware: IBM 3083B
Software: custom, in PL/1

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 bibliograhical record of the sources; view toward exploration of *topoi* in the texts and thematic families in the instrumental music
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
Hardware: IBM PC AT (all points) electronically linked
Software: SPIRES (text); music software under development
Access: RLIN (bibligrahical data)

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
Hardware: HP-1000 (IBYCUS operating system)
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; all works except Op. 5 currently stored
Place: Menlo Park, CA
Hardware: HP-1000 (IBYCUS operating system)
Software: custom designed by Walter Hewlett

Duffin/Dufay
Title: *Forty-Five Dufay Chansons from Canonici 213*
Scope: a performing edition in white mensural notation
Head of project: Ross Duffin
Place: Stanford University
Time: completed in 1977 (D.M.A. thesis)
Hardware: DEC PDP-10, Versatec plotter
Software: SCORE [see Illustration 18]

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

Chief reseracher: Andrew Hughes
Place: University of Toronto
Time: 1974--
Hardware: various S100 Z-80 machines
Software: custom designed encoding system to handle square and Gothic plainchant notation

Hultberg/Spanish Tablature
Aim: to implement the transcriptional tablature-to-standard-notation process developed earlier for larger systems on a Macintosh
Head of project: Warren Hultberg
Place: SUNY Potsdam
Hardware: Macintosh
Software: modified DARMS code with BASIC, Pascal, and PL/1
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)

NewcombA/Italian Instrumental Music
Scope: related to the Italian Lyric Poetry project described under Databases of Text
Head of project: Anthony Newcomb
Place: UC Berkeley

O'Maidin/Irish Music
Title: *Database for Retrieval and Analysis of Traditional 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, CITOH 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 with Gould plotter
Software: FASTCODE (adapted by Frank Esposito) with SPITBOL compiler
Associated Literature: *Newsletter* of the Columbia University Center of Computing Activities, Vol. 13/13 (Sept. 23, 1981)

Powers/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)
Hardware: IBM 3033
Software: FASTCODE (encoding) and 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, with David Fitzpatrick
Place: CCRMA, Stanford University
Hardware: PDP-10 (editing and page makeup); Commodore-64 (data entry); Versatec plotter (music printing)
Software: SCORE/MS with adaptations by Leland Smith; tablature facsimile script designed by Douglas Smith [see Illustration 19]
Time: 1983--

Wade *et al*/C. P. E. Bach
Title: *The Carl Philipp Emanuel Bach Edition*
Aim: to edit all the music of C.P.E. Bach and to provide extensive documentation on the sources
Head of project: Rachel Wade
Associates: Eugene Helm (with roughly 20 editors)
Place(s): University of Maryland
Time: 1983--2008
Hardware: IBM PC with Epson FX-80 and Gould plotter (6320)
Software: modified DARMS (encoding); Oxford Music Processor (printing)

Text Analysis

HillJ/Contrafacta
Title: *Italian Contrafacta*
Aim: identification of text parodies in musical settings, 1500-1750; program counts the number of syllables in each line (accent is not analyzed)
Head of project: John Hill
Place: University of Illinois
Time: 1985--
Hardware: IBM PC AT
Software: Savvy - PC (analysis)

Music Analysis and Analytical Methods

Balaban/Tonal Theory
Title: *A Computer Basis for Research on Western Tonal Music Theories*
Head of project: Mira Balaban
Place: SUNY Albany
Hardware: VAX 750
Software: C-Prolog
Associated Literature: "Foundations for AI Research of Western Tonal Music", *Proceedings of the International Computer Music Conference 1985* (Vancouver, forthcoming); "A Formal Basis for Research in Theories of Western Tonal Music - an AI Approach," *Communication and Cognition* (special issue on music and artificial intelligence, forthcoming)

Baroni/Chanson
Title: *Chanson*
Scope: analysis of eighteenth-century French songs, based on a sample of 100 melodies taken from a collection of 1760
Head of project: Mario Baroni
Associates: Laura Callegari, Carlo Jacoboni, Rossella Brunetti
Place: University of Bologna
Time: 1981-86
Hardware: Apple II (custom software)
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*
Scope: tries 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
Head of project: Mario Baroni and 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
Scope: investigation of the melodic features found in Legrenzi's *Cantate*, 1676
Head of project: Mario Baroni
Place: University of Bologna

Baroni/Melody
Title: The Study of Melody in European Music
Aim: to explore diverse repertories with a view toward defining the concept 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)

Berardinis/Pitch-Class
Title: software for pitch-class set analysis
Developer: Piero de Berardinis
Place: Studio di Sonologia Computazionale, Pescara
Hardware: Apple II

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
Hardware: Apple II+
Software: custom designed (in BASIC)
Associated Literature: "Centonization and Concordance in the American Souther Uplands Folksong Melody" (Ph.D. thesis, North Texas State University, 1984)

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" (forthcoming)

Brinkman/Melodic Process in Bach
Title: "The Melodic Process in Johann Sebastian Bach's *Orgelbüchlein*," *Music Theory Spectrum* II (1980), 46-77
Head of project: Alexander Brinkman
Place: Eastman School of Music (Rochester, N Y)

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)

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

Camilleri/Tonal Melody
Title: *Computer Generation of Tonal Melodies*
Scope: examination of theories of melody by means of a rule system
Head of project: Lelio Camilleri
Place: CNUCE (Florence), Musicology Division
Hardware: IBM 3081, Gould 32/27
Associated Literature: "Un sistema di regole per la generazione di semplici melodie tonali," *Quaderni di informatica musicale* II/7 (1985) [English translation available from author]

Camilleri/Music Analysis
Title: "A Software Tool for Music Analysis" in the *Proceedings of the International Computer Music Conference 1984* (forthcoming, Paris, Eratto)
Scope: creation of an anlytical 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--
Hardware: IBM 3081, Gould 32/27
Software: TAUMUS

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: 1985-88
Hardware: IBM 3081, IBM PC
Software: TAUMUS

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

Colombo/Harmonic Analysis
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
Hardware: Sinclair QL

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 stylstic relationship to the music of Corelli and Vivaldi (105 incipits each)
Head of project: Alison Crerar
Place: Heriot-Watt University
Software: 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*
Scope: 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: 1984-88
Hardware: Microbee; HP Thinkjet; Epson FX-80

Software: dBaseII, Plaine and Easie code, and custom program (INFIND) for matching similar 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 Computer 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)

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

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
Hardware: 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
Hardware: CDC mainframes
Software: MUSTRAN with SNOBOL4

Hewlett/Pitch Representation
Title: "A System for Numeric Representation of Musical Pitch" (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: 1984-86
Hardware/Software: Device independent

Hofstetter and Arenson/GUIDO
Title: GUIDO Music Learning System
Aim: comprehensive system for music theory and ear training; development of video-disc system for teaching theoretical concepts in standard repertory
Heads of project: Fred Hofstetter and Michael Arenson
Place: University of Delaware (Office of Computer-Based Instruction)
Time: 1973--
Hardware: IBM PC, Macintosh, PLATO
Software: TenCORE (IBM PC), TUTOR (PLATO)
Associated Literature: "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" [includes extensive list of music teaching software for the Apple II], *Computers and the Humanities* 18/3 (1984), 157-164 (Arenson)

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
Hardware: IBM PC and Macintosh
Software: custom ("Tonotechnie") by Roland Hutchinson

Jackson/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)
Hardware: Amdahl 4700
Software: custom designed encoding system with FORTRAN

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

Jungleib/Modes
Title: *Music Possible* (Los Altos, CA., 1985)
Scope: a digital analysis of tonality listing all conceivable 2-, 3-, and 4-notes 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

Karpinski/Music Theory
Title: "The Application of Music Theory in Programming CAI," IEEE Press, 1985
Author: Gary Karpinski

Kassler/Tonal Theory
Title: *Explications of the Theories of Tonality of A.F.C. Kollmann and Heinrich Schenker*
Head of project: Michael Kassler
Hardware: Canon A-200
Software: APL-Plus (music encoding and analysis)

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)
Hardware: IBM PC
Software: custom (MUSET), based on numeric input

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

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
Hardare: Macintosh

Levenson and Kendall/MAESTRO
Title: *MAESTRO*
Scope: development of system for teaching harmony
Heads of project: Irene Levenson, Roger Kendall
Place: UCLA
Time: 1984-89
Hardware: Apple IIe, Macintosh, LaserWriter
Software: MIDIGRAPH1 (custom) for encoding
Asociated Literature: "Horizontal and Vertical Content Ordering in Computer Aided Music Instruction" (in progress)

Ligabue/Jazz
Title: *Rules of Jazz Improvisation*
Aim: definition of a system of rules capable of providing a model of jazz improvisation
Head of project: Marco Ligabue
Place: Florence Conservatory
Time: 1985--

Hardware: Gould 32/27, Yamaha CX-5
Software: TAUMUS
Associated Literature: "Un sistema di regole per l'improvvisazzione jazzistica" in *Atti del VI colloquio di informatica musicale* (Naples, 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

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 II, Epson MX-80

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
Hardware: ICL 2984
Software: custom (DARMS-related)

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/Handel's Notation

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
Associate: Jennifer Nevile
Place: University of New South Wales
Time: 1983 - 87
Hardware: DEC VAX 11/780; NEC APC
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

Russell/Atonal Analysis
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)
Hardware: Apple II

Schulenberg/C.P.E.Bach
Title: *C.P.E. Bach: Critical Edition*
Scope: collation of variants in sources of keyboard concertos
Head of project: David Schulenberg
Hardware: 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: 1983-86
Hardware: DEC VAX (text); Macintosh with Yamaha DX-7 (music)
Software: custom designed by David Epstein and Kate Fissell in C with UNIX operating system

Silbiger/Modality - Tonality
Title: *Emergence of the Major-Minor Key System*
Scope: data derived from works by Gabrieli, Monteverdi, Frescobaldi, Froberger, Corelli
Head of project: Alexander Silbiger
Associate: J. Michael Allsen
Place: University of Wisconsin; Duke University
Time: 1983-6
Hardware: Apple II and IIe
Software: numerical representation in BASIC

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
Hardware: Apple II and IIe
Software: numerical representation in BASIC
Associated Literature: "Tipi tonali nella musica di Frescobaldi," *Ferrara Frescobaldi Congress Report*, forthcoming

Solomon/Set Analysis
Title: *Music Set Analysis* (software)
Developer: Larry Solomon
Place: University of Arizona
Hardware: Apple II

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

Stech/Microanalysis
Title: *A Computer-Assisted Approach to Micro-Analysis of Melodic Lines* in *CHum* XV/4 (1981)
Scope: 3,000 records
Head of project: David Stech
Place: University of Alaska (Ph.D. thesis, U. of Michigan, 1976)
Hardware: IBM mainframe

Steel/Troubadours
Title: *Evolution of a Musical Style: Early and Late Troubadours*
Scope: compares repertory of twelfth and thirteenth-century Provencal troubadours in diverse neumatic notations
Head of project: Matthew Steel
Place: Kalamazoo, MI
Time: in progress
Hardware: IBM PC XT
Software: custom designed encoding system, with 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)

Trowbridge/Chanson

Title: *The Fifteenth-Century French Chanson: A Computer-Aided Study of Styles and Style Change*
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 Trowbridge
Place: University of Illinois (Ph.D. thesis, 1982)
Software: LMIL with COBOL

Wenk/Debussy Grammar

Title: *A Grammar of Debussy's Melodic Practice*
Aim: to write a formal grammar for Debussy's melodic practice, based on the analysis of a corpus of 92 initial phrases of instrumental music
Head of project: Arthur Wenk
Place: Université Laval (Quebec)
Time: 1986
Hardware: Texas Instruments Professional Computer
Software: Music Processor (in 'C')
Associated Literature: "Parsing Debussy: Proposal for a Grammar of His Melodic Practice" (forthcoming)

Recent Literature about the Discipline

Baroni, Mario and Laura Callegari (eds). *Musical Grammars and Computer Analysis.* Florence: Olschki, 1984.

Charnassé, Hélène. "Les bases de données en musicologie," *Fontes Artis Musicae* XXXI//3 (1984).

Davis, Deta. *Computer Appplications in Music.* Los Altos, CA: William Kaufmann, [1986].

Drummond, Philip J. "Developing Standards for Musicological Data Bases," *Fontes Artis Musicae* XXXI//3 (1984).

Gross, Dorothy. "Computer Applications in Music Theory: A Retrospective," *Computer Music Journal* VIII//4 (1984).

Haus, Goffredo. *Elementi di informatica musicale.* Milan, 1984. [Contains chapters on music representation, printing, and computer analysis.]

Hiller, Lejaren and Burt Levy. "General System Theory as Applied to Music Analysis--Part I" in *Musical Grammars and Computer Analysis* (Florence, 1984).

Roads, Curtis. "An Overview of Music Representations" in *Musical Grammars and Computer Analysis* (Florence, 1984).

Wittlich, Gary, John Schaffer, and Larry R. Babb. *Microcomputers and Music.* New York: Prentic Hall, 1986. [Introduction to programming concepts and to applications in instruction, graphics, and sound, with sample programs in BASIC for the Apple II, IBM PC, and Commodore-64.]

Schnell, Christoph. *Die Eingabe musikalischer Information als Teil eines Arbeitsinstrumentes: Ein Beitrag zur Computeranwendung in der Musikwissenschaft.* Bern: Peter Lang, 1985.

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A Note on CCARH

The Center for Computer Assisted Research in the Humanities is an independent facility engaged in the development of computer assisted methodologies intended for specific academic purposes. It was formally established in 1985.

There are four areas of activity in musicology--(1) experimentation with hardware and software related to the processing of musical data, (2) the development of databases of large musical repertories and supporting documentation, (3) the identification of areas of scholarship that could be aided significantly by emerging technology, and (4) the coorindation of information concerning technical developments and applications.