Software

Software for Printing Music

Each spring CCARH sends out to the 75 or so developers of music printing software on its mailing list a packet of musical examples exhibiting problems which are special from a typographical point of view and essential capabilities from a musicological perspective. The developers have a window of approximately three months' time in which to respond. The solicitation is accompanied by a form requesting specific information about the hardware and software environment in which the program is run. This information is used in compiling the short descriptions that follow.

Developers often report in detail on those aspects of their products that are especially competitive. Heavily advertised products that are listed but not shown here are missing because no contribution was made. We have noted products that we learned of too late to contact. Some printing capabilities built into broad-spectrum MIDI programs are not oriented towards the needs of classical music.

Some developers respond every year; others prefer to respond only when new features have been added to their programs. Most software for printing classical music comes from small firms with few employees. Human problems such as illness, manpower shortages, equipment failure, and relocation sometimes undermine their efforts to respond punctually. Such difficulties prevented four potential contributors from meeting the deadline this year. We also report with regret the tragically premature death of Kimball Stickney, whose work on *High Score* was reported in previous issues, in May 1990.

Over the six years in which we have made this solicitation, the quality and availability of programs to print music have been enormously increased, but some of the issues in which users take the most interest remain incompletely addressed. Readers of *CM* are therefore encouraged to consult earlier issues to get a fuller picture of these issues. Since all developers are virtuosos at operating their own programs, the difficulty of duplicating the illustrations is a separate matter from assessing the quality of the output. Readers are urged to test programs personally before buying them. Prospective users may wish to consult these recent scholarly writings:

- Garrett Bowles reviews "Music Notation Software for the IBM-PC" in *Notes* 46/3 (March 1990), 660-79. The programs included are *The Copyist III PC*, *DynaDuet*, *MusicPrinter Plus*, *The Note Processor*, *Personal Composer*, *SCORE*, and *Theme: The Music Editor*. The review is organized thematically. Attention extends to installation, documentation, online help, MIDI compatibility, symbol sets, screen editing, part extraction, transposition, page formatting, and special features. Communication concerning this review appears in *Notes* 47/1 (1990), 254-56.

■ Malcolm Butler and Nicholas Cook write on "Music Processing on the IBM: A Review of Available Systems" in *Current Musicology* No. 44 (1990), 61-98. Their article covers *The Note Processor*, the *Oberon Music Editor*, *Personal Composer*, *SCORE*, and *Theme: The Music Editor*. Each program was tested on an excerpt from Schumann's *Drei Romanzen*, Op. 94, and a Schenkerian graph and is considered separately. A generous number of examples is provided. There is a summary table of features. An update is planned.

■ Eric Graebner, Timothy Taylor, and Peter Allsop provide multiple user reports of *SCORE*, *HB Music Engraver*, and *Professional Composer* in *Musicus*, 1/1 (June 1989), pp. 39-87. Each author has different motivations for using such programs and reaches different conclusions.

■ Jon Grøver of the University of Oslo has recently completed a three-volume "Computer-Oriented Description of Music Notation." It is available at a modest cost from *Musikus*, Dept. of Music, University of Oslo, PO Box 1017, Blindern, N-0316 Oslo 2, Norway.

■ Keith A. Hamel describes "A Design for Music Editing and Printing Software based on Notational Syntax" in *Perspectives of New Music* 27/1 (1989), 70-83. Hamel is the developer of *NoteWriter*, but his article is a general one examining the strengths of a graphical approach to music representation for the purpose of printing.

Current and Recent Contributors

This listing concentrates on systems that have been represented by illustrations over the past three years and incorporates definitions of terms needed to understand the accounts given. Additional systems that are now dormant were cited in the *1987 Directory*, pp. 27-34. Music printing programs advertised in popular music magazines are listed here only if they have a demonstrated capability for handling classical music of moderate complexity.

A-R Music Engraver. A-R Editions, Inc., 801 Deming Way, Madison, WI 53717 (608-836-9000). A commercial version of the music typesetting system used by this publisher for its own editions and musical examples for academic journals has been developed for professional music publishing and is now available by license. Tom Hall is the principal developer. This version of the program, for the UNIX operating system, uses the NeWS and OpenWindows interfaces on the Sun SPARC workstation with a high resolution

monitor (1600 x 1280). A version for the Sun-3 is also available. Music input is done alphanumerically with a modified version of DARMS; files may be created on networked PC-AT compatibles. Music can be edited on the screen. Scanned images from Macintosh PostScript programs can be imported.

A music notation library developed by A-R and multiple text fonts created by Mergenthaler are cross-licensed and available for use with the program. PostScript printers and typesetters are supported. The output shown is 1270 dpi from a Linotron L-300.

Alpha/TIMES. Kesselhaldenstr. 73, CH-9016 St. Gallen, Switzerland (41-71-35-1402). An integrated input and analysis system by Christoph Schnell for the Apple Macintosh line. TIMES stands for Totally Integrated Musicological Environment System. An unusual input method (voice recognition device with light pen) permits accurate reproduction of non-common notation, including neumes. The system incorporates graphics editors, a font editor, and a communication system. Illustrated in 1988 and previous years. No submission provided in 1989 or 1990.

Amadeus Music Software GmbH. Rohrauerstr. 50, Postfach 710267, D-8000 München 71, Germany (089-7855310). This product, originally developed by Kurt Maas, is commercially available for the PDP-11/73 and the Atari Mega ST4. Both alphanumeric and MIDI input are supported, the latter facilitating acoustical playback. Most data are stored as ASCII files. Screen editing is provided. Output (for dot matrix and laser printers, plotters, and phototypesetters) is scalable to a resolution of 1000 dots per inch.

Berlioz. Logiciel "Berlioz", Place des Lavoirs, F-30350 Lédignan, France (33-66-83-46-53). This is a series of three programs by Dominique Montel and Frédéric Magiera which are written in C for the Macintosh. The first program is for input, the second for layout, and the third for graphic editing. Input is created graphically. Extensive provisions for layout and graphic editing are provided. PostScript files for output to laser printers and phototypesetters are generated. *Berlioz*, which is in use at the printing establishment s.a.r.l. Dominique Montel, is also available for licensing.

CCARH. 525 Middlefield Rd., Ste. 120, Menlo Park, CA 94025 (415-322-7050). The Center's music representation system supports the development of electronic transcriptions and editions of a large quantity of musical repertory, chiefly from the eighteenth century. Input is from an electronic keyboard; alphanumeric code is used to provide non-acoustical information. A corollary music printing system, developed by Walter Hewlett, has been used to produce performing scores of several major works by Handel and Telemann. These capabilities are currently being implemented on a UNIX workstation. CCARH's input code was shown in the *1987 Directory*, p. 20.

Comus. Comus Music Printing and Publishing, Armthorpe, Tixall, Stafford ST18 0XP, England (0785-662520). The proprietary music printing program developed by John Dunn for this firm uses DARMS encoding of data with some newly devised extensions. The current version produces device-independent output in UNIX plot(5) format, which can be directed to screens, plotters, and laser printers.

The Copyist III. Dr. T's Music Software, 220 Boylston St., Suite 260, Chestnut Hill, MA 02167 (617-244-6954). Three versions of this commercial program for Atari, Amiga, and IBM PC compatibles are offered by Dr. T's. "III" is the most comprehensive version and the one best suited to academic applications. MIDI input and output are supported. Files can be converted to Tagged Image File Format (TIFF), a compressed representation of graphics information, and Encapsulated PostScript (EPS). Output supports PostScript and Ultrascript printers as well as the Hewlett Packard LaserJet Plus and plotters. *The Copyist* interfaces with a number of popular sequencer programs. The developer is Crispin Sion.

Dai Nippon Music Processor. Dai Nippon Printing Co., Ltd., CTS Division, 1-1 Ichigaya Kagacho 1-chome, Shinjuku-ku, Tokyo 162-01, Japan (Fax: 03-266-4199). This dedicated hardware system for the production of musical scores was announced three years ago and an illustration was last provided in 1988. Input is alphanumeric. Screen editing is supported. Output files can be sent to MIDI instruments, to PostScript printers, to a Digiset typesetter, or to the Standard Music Expression (SMX) file format used in music research at Waseda University. The Wagner example shown here was produced on a PostScript printer, while the German song ("O Tannenbaum") with Hiragana text underlay was produced on a Digiset typesetter. Kentaro Oka is the current manager.

Dal Molin Musicomp. 67 Florence Avenue, Oyster Bay, NY 11771 (516-922-7458). Armando Dal Molin has spent a lifetime in the effort to make music printing more efficient. More than 500,000 pages of music have been printed using equipment of his design. Examples were shown in 1988 and the internal code was indicated in the *1987 Directory*, p. 17. Dal Molin's Musicomp terminal is used by Belwin Mills Co.; a DOS version utilizing an auxiliary keypad for pitch entry is part of a larger package tailored to individual needs of existing users. The developer remains in contact with the Center and is eager to exchange ideas about computer music notation with other programmers but was unable to provide a contribution for this year.

Darbellay Music Processor. See **WOLFGANG**.

DARMS is an encoding system that originated in the 1960's. Various dialects have been used in several printing programs including those of A-R Editions, *The Note Processor*,

and systems developed at the State University of New York at Binghamton by Harry Lincoln and at the University of Nottingham, England, by John Morehen. A sample of the code was shown in the *1987 Directory*, p. 12.

Deluxe Music Construction Set. Electronic Arts, 1820 Gateway Drive, San Mateo, CA 94404 (415-571-7171). This software program for the Macintosh line of computers produces PostScript files. Developed by Geoff Brown, it was last shown in 1987.

DynaDuet. DynaWare, 950 Tower Lane, #1150, Foster City, CA 94404 (415-349-5700). *DynaDuet*, a music printing program by Chris Geen for the IBM PC, accepts MIDI or alphanumeric input. The program's capabilities for classical music printing are under development. Output for 24-pin dot matrix printers is provided.

EASY KEY. John Clifton, 175 W. 87th St., Ste. 27E, New York, NY 10024 (212-724-1578). *Easy Key* simplifies the use of Jim Miller's *Personal Composer* input and printing program.

ERATO Music Manuscriptor. See under *Music Manuscriptor*.

ESCORT. Passport Designs, 625 Miramontes Street, Half Moon Bay, CA 94019 (415-726-0280). *Escort* facilitates input from a MIDI device to the *SCORE* printing program published by Passport.

EUTERPE. 99 rue Frédéric Mistral, F-03100 Montluçon, France (70-036903). *Euterpe* is a printing system under development by Michel Wallet. It forms part of an integrated system for encoding, printing, and analysis on the Macintosh. Special attention has been devoted to lute music and late Byzantine music. Transcription and conversion capabilities for German lute tablature to staff notation, based on programs by Bernard Stepien, were shown in 1988. The printing of Byzantine notation with text underlay in Cyrillic characters is shown in this issue.

FASTCODE. An encoding language of the 1970's developed at Princeton University for white mensural notation. An example of plotter output from 1981, first shown in 1985, is repeated in this issue.

Finale. Coda Music Software, Wenger Music Learning Systems, 1401 E. 79th St., Bloomington, MN 55420-1590 (612-854-1288). *Finale* has a broad range of capabilities related to music transcription and printing. MIDI files can be imported and exported. It provides immediate screen transcription of two-handed music. Four-part works played in two-stave arrangements may be "exploded" into four parts. Conversely, multi-voice

music can be "imploded" to a piano reduction. Versions for the Apple Macintosh and the IBM PC are currently available; a version for the NeXT is under development. Data may also be entered alphanumerically. Finale's Enigma Transportable Files (ETF) are text files used to facilitate printing. *MusicProse* is a subset of *Finale* features made available at reduced cost and generally suited more to popular than to classical music.

Coda offers several music fonts—*Petrucci* for conventional notation, *Rameau* for subscripted chord names and basso continuo figures, *Seville* for guitar tablature, and *Newport* for jazz and percussion notation. *Finale* also provides support for mensural notation. PostScript printers are supported.

Phil Farrand developed the original program. Tim Herzog contributed illustrations in 1989 but has now left the firm, which failed to respond to enquiries in 1990.

Graphic Notes. See *Music Publisher*.

HB Music Engraver. HB Imaging, Inc., 560 South State Street, Orem, UT 84057 (801-225-7222). This printing program, distributed by HB Imaging, Inc., runs on the Apple Macintosh. Input is alphanumeric and utilizes redefinition of the QWERTY keyboard. HB output is for PostScript printers; a custom font called "Interlude" is available from the company. This program can convert files originated by another program, Mark of the Unicorn's *Professional Composer*. No contribution was received in 1989 or 1990.

HyperScribe. Coda Music Software, 1401 E. 79th St., Bloomington, MN 55420-1126 (612-854-1288). This product transcribes MIDI input to a Macintosh screen. It complements other products from Coda.

Interactive Music System (IMS). CERL Music Group, University of Illinois, 103 S. Mathews, #252, Urbana, IL 61801-2977 (217-333-0766). This extensive system has been under development at the University of Illinois since the early 1970's. It is based on the PLATO system, although extensions for the Macintosh and other microcomputers have been made in recent years. Music can be input from an alphanumeric code or from a synthesizer. The IMS was recently used to create a score and parts for the 1989 San Francisco Opera production of Vivaldi's *Orlando furioso* and to prepare a catalogue of music holdings of the Accademia Filarmonica in Bologna. Its printing capability was last shown in 1987, when its input and intermediate codes were given on pp. 18-9. A commercial version for the Macintosh is under development.

Laboratorio Informatica Musicale. Via Moretto da Brescia, 9, 20133 Milan, Italy. The LIM printing system, under development by Goffredo Haus, Luigi Finarelli and associates at the University of Milan, utilizes an Apple Macintosh. The system is designed to accept

data in several codes and formats and forms part of a larger enterprise described on p. 127.

la mà de guido [Guido's Hand]. Apartat 23, E-08200, Sabadell (Barcelona), Spain (34-3-716-1350). This music printing software for IBM PC XT and AT computers uses an alphanumeric input system based on a redefined QWERTY keyboard (shown in the *1988 Directory*, p. 48). It is now being marketed as an input system for SCORE. MIDI playback and analysis are supported. Graphic output is by HPGL plotter or for PostScript printers of resolutions up to 2700 dpi. The developer is Llorenç Balsach.

Masterscore. Steinberg Jones, 17700 Raymer St., Ste. 1001, Northridge, CA 91325 (818-993-4091). This transcription program accepts MIDI input and outputs to various dot matrix printers by the firms Atari, Epson, NEC, and Star. It runs on an Atari ST. Shown in 1989.

MTeX is a set of fonts for music typesetting with the TeX document description language on mainframe computers. They were developed by Angelika Schofer and Andrea Steinbach at the Rheinische Friedrich-Wilhelms-Universität in Bonn. The set is available for DM 25 at Wegler Strasse 6, D-5300 Bonn, Germany.

MUSED. Oslo, Norway. This research system under development at Oslo University supports interactive analysis and music printing. Programs currently run on a VaxStation II. Examples of its representation and in-house printing system were shown in 1988. Commercial programs for music printing are also now in use.

Music Manuscriptor. Erato Software Corp., PO Box 6278, Salt Lake City, UT 84152-6278 (801-328-0500). This program operates as part of an integrated workstation for composition and orchestration. Setup requires an IBM PC compatible microcomputer, a digitizer tablet, and special graphics boards supporting a resolution of 800 x 1000 pixels. Pitches are entered as MIDI data; rhythmic assignment is automatic. Pattern storage (1000 slots) is provided for composition. Text underlay is available. Lines and pages can be justified automatically. A Breitkopf and Härtel font is available.

This product is compatible with two desktop publishing programs, *Ventura Publisher* and *Aldus Pagemaker*. Two laser printers, the Canon LBP8-11 and the Hewlett Packard LaserJet II, are supported. Erato takes pride in the compactness of its music files. The sizes of the complete files for the examples were as follows: Josquin—8 kilobytes, Bach Canon 1—3.4 kilobytes, Canon 2—3.2 kilobytes, and Wagner—8.7 kilobytes.

Music Publisher. Repertoire Pty. Ltd., 49A Stephens Terrace, St. Peters, 5069 Australia (618-363-2600). This program, developed by Trevor Richards for the Apple Macintosh,

requires the use of a separate "presto pad" for input. Previously offered by Graphic Notes, it provides output for PostScript printers and typesetters. Examples were shown in 1988. No contribution was received in 1989 or 1990. The US distributor is InterSoft, 200 7th Ave., Suite 225, Santa Cruz, CA 95062 (408-476-1753).

MusicPrinter Plus. Temporal Acuity Products, Inc., 300 - 120th Avenue N.E., Bldg. 1, Bellevue, WA 98005 (800-426-2673). A manufacturer of interactive systems for rhythmic drill and other music teaching products, TAP's music printing program has evolved from one originally designed by Jack Jarrett for the Apple II to one for MS DOS machines. Version 3.0 permits MIDI entry of data; previous versions relied on graphic assembly of a score on the screen. The playback choices are quite sophisticated and extend to much subtlety of articulation. Playback can be in realtime or steptime, which can be forwards or backwards. Dot matrix, laser, and ink jet printers are supported. Wide-carriage output on the BJ-130 provides 360 dpi resolution.

MusicProse. See *Finale*.

Musicwriter II. See **The Portable Musicwriter**.

MusiKrafters. MusiKrafters, PO Box 14124, Louisville, KY 40214 (502-361-4597). This software company offers special-purpose products by Robert Fruehwald for musical excerpts and unusual notations for the Apple Macintosh. Input is alphanumeric and may be edited on the screen. PostScript files are produced. Its shape-note and tablature capabilities were shown in 1988 and a HyperText program for musical information management was shown in 1989. No contribution was received in 1990.

MusScribe. See *NoteWriter*.

MUSTRAN. This alphanumeric code was developed at Indiana University by Jerome Wenker in the 1960's. Music printing capabilities were extended by Don Byrd; music encoded in MUSTRAN has been used for analytical programs by Dorothy Gross, Gary Wittlich, and others.

Nightingale. Opcode Systems, 3641 Haven Avenue, Menlo Park, CA 94025 (415-321-8977). Don Byrd's program for music notation, shown in previous years, runs on the Apple Macintosh and is soon to be released. *Nightingale* uses MIDI input. Byrd is in residence at the Center for Research on Concepts and Cognition, headed by Douglas Hofstadter, at Indiana University in 1990-91. Output has been shown in four previous issues.

The Note Processor. Thoughtprocessors, 584 Bergen Street, Brooklyn, NY 11238 (718-857-2860). Stephen Dydo's program for IBM PC compatibles accepts both alphanumeric and MIDI input; data can be edited either through code revisions or by using a mouse. The input is a slightly modified version of DARMS; an example of *NP*'s representation scheme was shown in the *1987 Directory*, p. 13. Numerous dot matrix printers as well as the Hewlett Packard DeskJet and LaserJet printers are supported. Optically scanned data from the Ottawa group [see p. 42] is printed via this program.

NoteWriter. Passport Designs, 625 Miramontes, Half Moon Bay, CA 94019 (415-726-0280). This commercial product for the Apple Macintosh is the heir of *MusScribe* (shown in 1988) and has been developed by Keith Hamel of Richmond, BC. *NoteWriter* is used to typeset the musical examples in *Perspectives of New Music* and in the popular music publications of the GPI Corp. in Cupertino, CA. Hamel describes his approach to music printing in the Winter 1989 issue of *Perspectives*.

Oberon Music Editor. Oberon Systems, PO Box 4179, Boulder, CO 80306-4179 (303-459-3411). This program for IBM PC compatibles is available as a stand-alone product or on a license basis. Entry is alphanumeric and supports printing only. A custom font, Callisto, and a multi-size font set called Publisher Series are available. A shape-note version of the Editor is also available. Output devices supported include the Hewlett Packard LaserJet and DeskJet series as well as various 9- and 24-pin dot matrix printers. Musical examples can be integrated with *WordPerfect* files and output to PostScript printers. Compatibility with *Ventura Publisher* is currently being implemented. Although Oberon is intended primarily for transcription and printing, those wishing to build data analysis tools around the Oberon music file format can receive assistance from Joel Grossman at the above address.

PARD. PARD S.r.L., Via Cavalcante, 8, I-20127 Milan, Italy. This music printing system, under development in 1988 by Walter Prati and Giorgio Ceroni, was mainframe based, with plotter output. Examples of its work were shown in 1988.

Personal Composer. Jim Miller, PO Box 648, Honaunau, HI 96726 (808-328-9518). This program by Jim Miller for the IBM PC line accepts MIDI input and outputs Postscript files. See the *1987 Directory*. No contribution was received in 1988, 1989, or 1990. See also *Easy Key*.

Philip's Music Scribe (PMS). 33 Metcalfe Road, Cambridge CB4 2DB, England (44-223-65518). This program by Philip Hazel for the Acorn Archimedes workstation uses alphanumeric input and produces PostScript files for output. Acorn products are currently available in the UK and Europe. *PMS*, which is available by license only, has extensive

capabilities for accommodating the needs of parts and scores derived from a common file. Staves can be overlaid, permitting four-part choral music to be shown on two staves, for example. Up to four verses of text underlay can be accommodated. Slur control is extensive. Basso continuo figuration is supported. Time signatures can be switched off. All characters found in the *PMS* music font set are also available for use in text strings. The output shown is from an Apple LaserWriter (300 dpi).

Plaine and Easie. This melodic input code developed by Barry Brook and Murray Gould in the late 1960's remains important because of its extensive use in thematic indexing projects, especially the manuscript cataloguing effort of the International Inventory of Musical Sources (RISM) coordinated in Frankfurt, Germany. Diverse printing programs for RISM data have been written. Output from one by Norbert Böker-Heil was shown in the *1986 Directory*, p. 19. A program for conversion of *Plaine and Easie* code to CCARH files has recently been written by Brent Field. Documentation of the code is available from RISM Zentralredaktion, Sopienstr. 26, D-6000 Frankfurt-am-Main 90, Germany.

PLAINSONG. Surrey, England. PLAINSONG is a series of programs for transcription, analysis, and printing of music in black square neumatic notation on a four-line stave with C, F, D, or G clefs. It is under development by Catherine Harbor and Andy Reid at Royal Holloway and Bedford New College (Computer Centre, Egham Hill, Egham, Surrey, UK TW20 0EX; C. Harbor@vax.rhbnc.ac.uk). PLAINSONG runs on the IBM PC. Dot matrix and PostScript laser printers may be used.

The Portable Musicwriter. Music Print Corp., 2620 Lafayette Drive, Boulder, CO 80303. This method for printing musical examples, developed by Cecil Effinger, a recognized pioneer in music printing technology, requires an IBM Wheelwriter. The resolution is 104 dpi vertically and 120 dpi horizontally. Music is represented alphanumerically. Slurs are added by hand.

Professional Composer. Mark of the Unicorn, 222 Third St., Cambridge, MA 02142 (617-576-2760). This commercial product for the Apple Macintosh has been poorly represented in previous years because of its failure to provide any material other than advertising copy. Its one contribution was shown in 1988.

SCORE. Passport Designs, 625 Miramontes Street, Half Moon Bay, CA 94019 (415-726-0280). Deriving from an academic research system at Stanford University, Leland Smith's SCORE program for IBM PC compatibles is now in use by major music publishers such as Schott and several performing organizations. SCORE is also being used to produce the collected works of J.-B. Lully. Optically scanned musical data from

the University of Surrey have been converted to SCORE data for printing. The input is alphanumeric and requires separate passes for pitch, rhythm, and articulation. Forty music fonts are available. There is a PostScript text font compatibility. The SCORE input code was shown in the *1987 Directory*, p. 14. See also *Escort, la mà de guido,* and *ScoreInput*.

ScoreInput. Modular Music, 6800 Red Top Road #1, Takoma Park, MD 20912-5920 (301-270-1095). ScoreInput is a program by Paul Nahay to generate input for Leland Smith's SCORE program either from a MIDI keyboard or through redefinition of a QWERTY keyboard. The developer claims that it is faster and more accurate than other front ends for SCORE. ScoreInput writes one ASCII file that instructs SCORE to assemble the score and save each system to its own graphics file.

ScoreWriter. Sonus Corp., 21430 Strathern St., Ste. H, Canoga Park, CA 91304 (818-702-0992). This is a MIDI input transcription program for the Atari. No information on output devices was provided. Shown in 1989.

SCRIBE. Scribe Software Associates, La Trobe University, Bundoora, Victoria 3083, Australia (03-479-2879). The academic research system developed jointly by La Trobe and Melbourne Universities for fourteenth-century music is oriented mainly toward database management of musical repertories. It runs on IBM PC AT-compatibles. It handles entry, display, retrieval, and analysis. Its capability for producing facsimiles of sources with any Hewlett Packard compatible plotter extends to colored notation. A plotter driver for round notation is under development. Single attributes (e.g., pitch) may be searched. User-entered data can be merged with pre-packaged data for analytical use. The program is available by license to both individuals and institutional sites and runs in IBM PC compatibles. The original software development was by John Griffiths; John Stinson is the head musicologist. The current software developer is Brian Parish. User support is available by fax (03-478-5814) and electronic mail (musjs@latvax8.lat.oz).

Staatliches Institut für Musikforschung. Tiergarten Str. 1, D-1000 Berlin 30, Germany. Music printing programs written in FORTRAN in the early 1970's by Norbert Böker-Heil for IBM 360 input and output from a Digiset T 41 typesetter are currently under revision. The new programs will be written in C, will operate initially under MS DOS and later under the UNIX operating system, and will be PostScript compatible. The existing system has been used to produce scores for music publishers. Questions regarding its use may be directed to the firm of Satz-Rechen-Zentrum in Berlin. Some special capabilities of the system for contemporary music were shown in the *1988 Directory,* pp.122-5.

Renaissance mensural notation that runs on a Macintosh Plus with HyperCard. Transcriptions are assembled on the screen from graphic elements. The price is extremely modest. Examples including "illuminated" initials, ligatures, and white mensural notation were shown in 1989.

Synclavier Music Engraving System. PO Box 546, 49 N. Main St., White River Junction, VT 05001 (802-295-5800). The Music Engraving System offered by New England Digital Corp. is designed exclusively for use with its Synclavier digital audio system. Information can be entered alphanumerically, via MIDI input, or by on-screen assembly. Some special capabilities, including shape notes and tablatures, are available. PostScript files are produced. Gregg Sewell, an engraver at 518 N. Cherry St., Florence, AL 35630 (205-764-6212), has provided examples for recent issues of this publication.

TELETAU. Pisa and Florence, Italy. *TELETAU* is an integrated system for musical data management initially developed at CNUCE in Pisa; it is now maintained jointly with the Florence Conservatory. It has a library of 800 encoded works and numerous analysis programs. Details of its encoding system were shown in the *1987 Directory*, p. 22. See the index for other information related to this system.

THEME, The Music Editor. PO Box 8204, Charlottesville, VA 22906 (804-971-5963). This commercial product, developed by Mark Lambert for the IBM PC, has been used extensively in academic settings. Its alphanumeric input system uses a redefined keyboard (shown in 1988). It has a provision for MIDI input and for conversion of alphanumeric files to MIDI output. Optimization of page layout is automatic. Binary-encoded data sets are available to users. *THEME* has recently moved to new premises.

TIFF. The Tagged Image File Format (TIFF) facilitates interchange of graphics files between programs. Musical notation created with a printing program that provides this option can be exported to a word processor program, for example. Other graphics file conversion formats include *DXF*, which supports AutoCAD, *EPS*, Encapsulated PostScript, which creates files for a PostScript printer, and *HPGL*, a Hewlett-Packard Graphics Language Plotter File.

Toppan Scan-Note System. Toppan International Group, Iwanami Shoten Annex Bldg. 2-3-1, Kanda Jimbocho, Chiyoda-ku, Tokyo 101, Japan. The Toppan system originated in Aarhus, Denmark, where it was developed by Mogens Kjaer. It is at present a proprietary system that accepts electronic keyboard input and prints music with a laser phototypesetter. Toppan Printing Co. Ltd. contracts with major music publishers and has produced some recent volumes of the *Neue Mozart Ausgabe*. Illustrations were shown in 1987.

produced some recent volumes of the *Neue Mozart Ausgabe*. Illustrations were shown in 1987.

WOLFGANG. Société Mus'Art, Case Postale 26, CH-1242 Satigny, Geneva, Switzerland. This academically oriented music processor, developed by Etienne Darbellay for IBM PC compatibles, became commercially available within the past year and was awarded the Swiss Prize for Technology for 1990.

It was illustrated in 1988 and previous years. The keyboard is fully user definable. Screen resolutions to 1664 x 1200 are supported. Files can be converted to TIFF compressed or uncompressed formats and used with such desktop publishing programs as *Ventura Publisher* and *Aldus Pagemaker*. Dot matrix and LaserJet output is supported. PostScript support is under development, as is an interface for MIDI input. An interface with the ADLIB sound driver exists.

WOLFGANG has the ability to represent and reproduce plain chant, mensural notation (black and white, ligatures), and the unmeasured *style brisé*. It also supports automatic reduction to a two-stave transcription of up to five voices and permits the creation of polylingual scores requiring Arabic, Cyrillic, and Gothic (as well as Roman) characters.

Comments on the Illustrations

Edmund Correia, Jr.

Each year's examples have introduced new problems. This year the set pieces were short quotations from (1) Bach's *Musical Offering*, (2) the *Agnus Dei* III from Josquin's *Mass of the Blessed Virgin*, and (3) Act One of Wagner's *Götterdämmerung*.

The canons from *The Musical Offering* present several cases of non-standard placement of clefs and signatures. It was not noticed until studying the responses of our contributors that our source for this example, the *Bach Gesellschaft* edition, contains a small error. The second of the two canons used ends with a time signature which was inverted rather than reversed left-to-right (as were the key signature and clef). Although some contributors discovered and corrected this error, it should be assumed that the others were faithfully reproducing the example as requested.

More significant differences may be discovered in the settings of the lengthier Josquin and Wagner pieces. It was permissible here to shorten the excerpts somewhat, if that would allow for a more readable, less congested appearance. The main problem in the Josquin is the placement of bar lines between the staves, a practice often found in scholarly editions of Renaissance music to reduce accentual emphasis based on barring. Those who could not support this feature were asked simply to use conventional bar lines.

Spacing between staves and systems, and between vocal lines and corresponding text also contributes to the differences in clarity and overall appearance.

We were pleasantly surprised that so many contributors were willing to confront the daunting tangle of slurs, ties, tuplets, tremolos, arpeggiation, dynamics, accidentals, and other details encountered in the Wagner piano transcription. The results are good to excellent, yet (understandably) only one setting is completely free of errors or omissions. Fingering numbers offer an interesting point of comparison: size, font style, and placement vary widely, and some solutions are probably an improvement over our source edition.

Among the free choices, #27 displays text underlay in Hiragana [the name of the translator is in Kanji in the upper left], #28 includes elements of colored notation in the music of Frescobaldi, #29 uses all seven shapes of the shape-note system developed to facilitate the learning of sacred music in the rural American South and Midwest, #30 shows an automatic transcription into conventional notation of German lute tablature, and #31 demonstrates a capability for simultaneous handling of texts in Greek and Old Church Slavonic.

List of Illustrations

The illustrations are arranged alphabetically first by the surname of the composer and second by the surname of the contributor. Illustrations are unretouched. Printer designations identify the specific configuration used to produce the example. The originating hardware is indicate in this listing.

Bach: *The Musical Offering*

1. IBM PC	*Oberon Music Editor*
2. IBM PC	*Wolfgang*
3. IBM Wheelwriter	*The Portable Musicwriter*
4. PDP-11/73; Atari ST4	*Amadeus Music Software*
5. Erato workstation	*Erato Music Manuscriptor*
6. IBM PC	*SCORE*

Josquin: *Agnus Dei* from the *Mass of the Blessed Virgin*

7. IBM PC	*la mà de guido*
8. IBM PC	*Oberon Music Editor*
9. Archimedes workstation	*Philip's Music Scribe*
10. PDP-11/73; Atari ST4	*Amadeus Music Software*
11. Macintosh	*Berlioz*
12. Erato workstation	*Erato Music Manuscriptor*
13. IBM PC	*SCORE*
14. Sun workstation (Sun-3 or SPARC)	*A-R Music Engraving System*
15. IBM PC	*The Note Processor*

Wagner: from Act One of *Götterdämmerung*

16. Dai Nippon Music Processor	*Dai Nippon Music Processor*
17. IBM PC	*Wolfgang*
18. IBM Wheelwriter	*The Portable Musicwriter*
19. Archimedes workstation	*Philip's Music Scribe*
20. PDP-11/73; Atari	*Amadeus Music Software*
21. Macintosh	*Berlioz*
22. Atari ST	*The Copyist III*
23. IBM PC	*SCORE*
24. Synclavier	*Synclavier Music Engraving System*
25. Sun workstation (Sun-3 or SPARC)	*A-R Music Engraving System*
26. IBM PC	*The Note Processor*

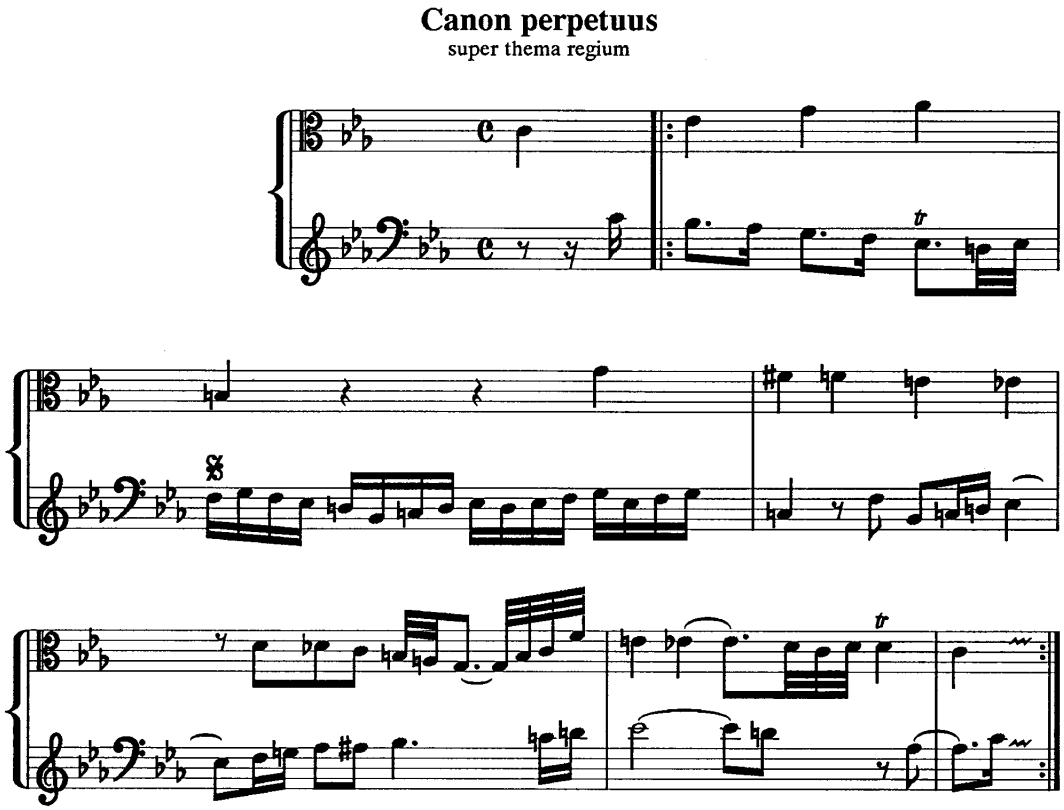
Free choices:

27. *Dai Nippon Music Processor*—folk song with Hiragana text underlay
28. *Wolfgang*—colored notation from the seventeenth century [Frescobaldi]
29. *Synclavier Music Engraving System*—hymn with shape notes
30. *Euterpe*—automatic transcription of lute tablature
31. *A-R Music Engraving System*—chant with Greek and Slavonic text underlay

Illustration 1

Contributor: Nancy Colton
Product: Oberon Music Editor
Running on: IBM PC compatibles

Output from: Hewlett Packard DeskJet
Size as shown: 100% of original



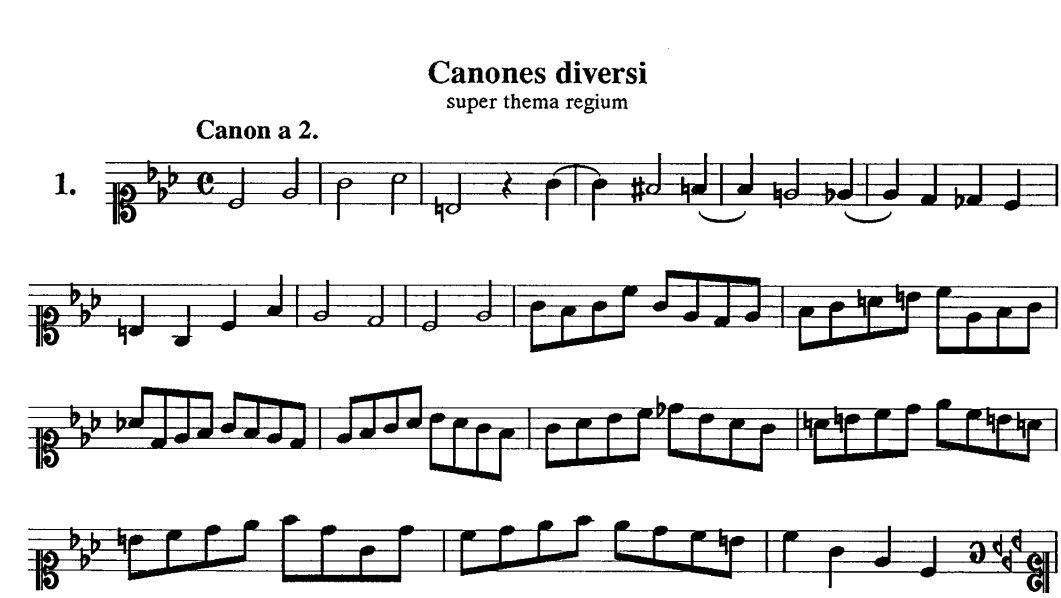
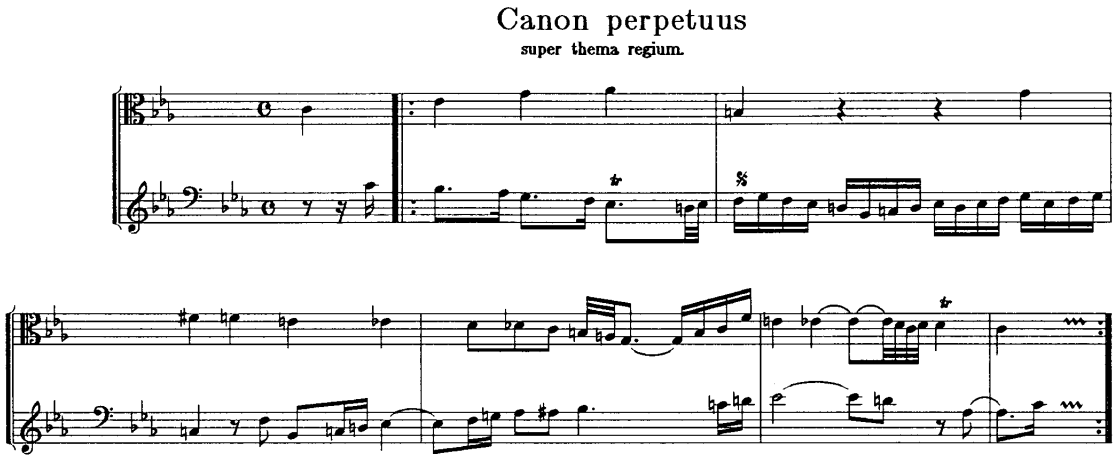


Illustration 2

Contributor: Etienne Darbellay
Product: WOLFGANG by Mus'Art
Running on: IBM PC compatibles

Output from: HP LaserJet III
Size as shown: 100% of original



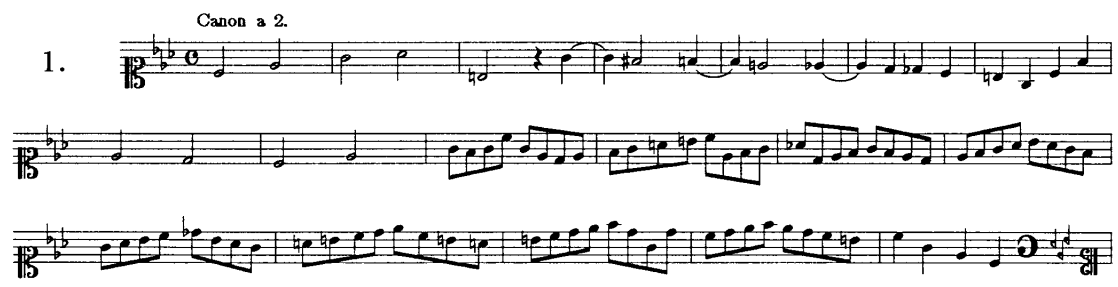
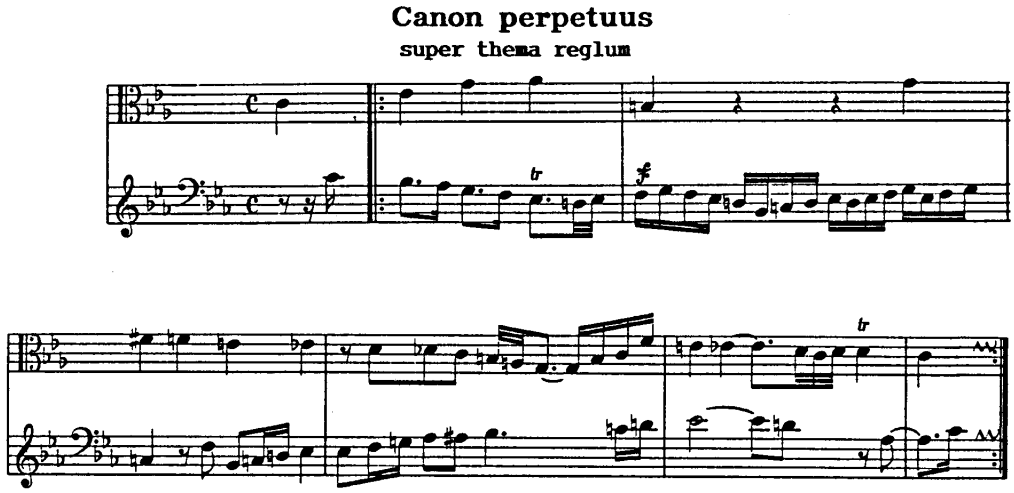


Illustration 3

Contributor: Cecil Effinger
Product: The Portable Musicwriter
Input device: The Portable Musicwriter

Output device: IBM Wheelwriter
Size as shown: 60% of original



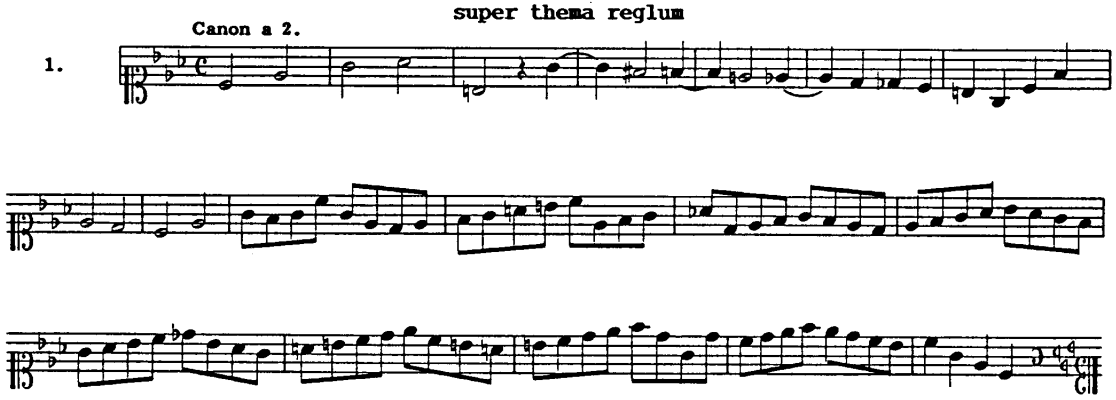


Illustration 4

Contributor: Kurt Maas
Product: Amadeus Music Software
Running on : a PDP-11/73; Atari Mega ST4

Output device: Amadeus ECRM Lasersetter (1000 dpi)
Size as shown: 100% of original

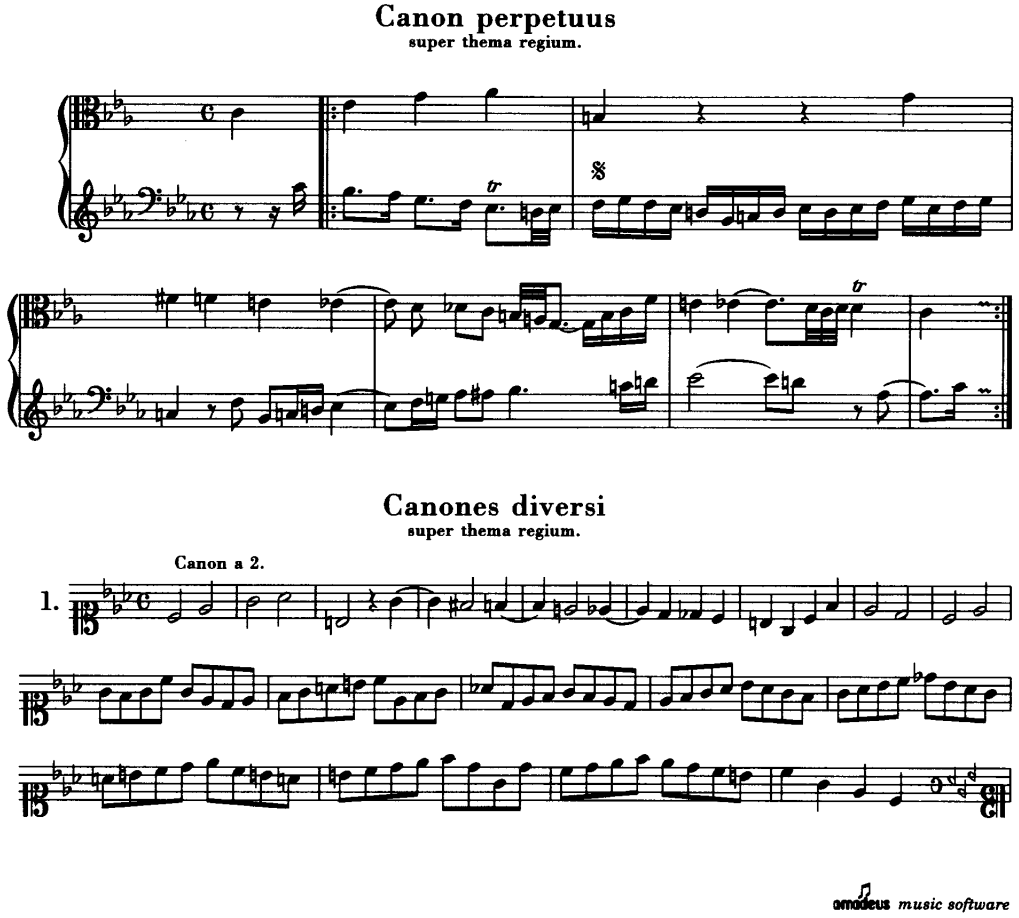
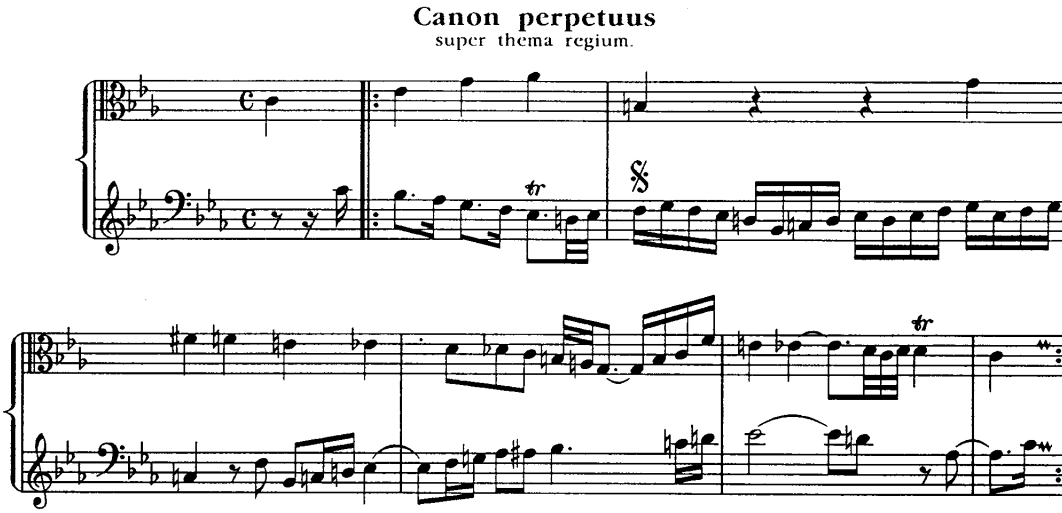


Illustration 5

Contributor: Jeffrey L. Price
Product: Erato Music Manuscriptor
Running on: Erato workstation

Output from: Hewlett Packard LaserJet II
Size as shown: 74% of original



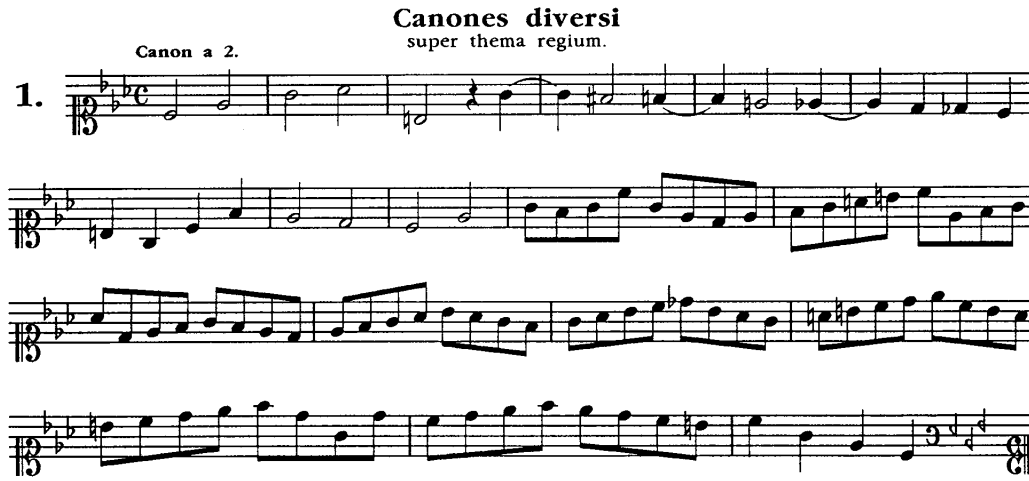
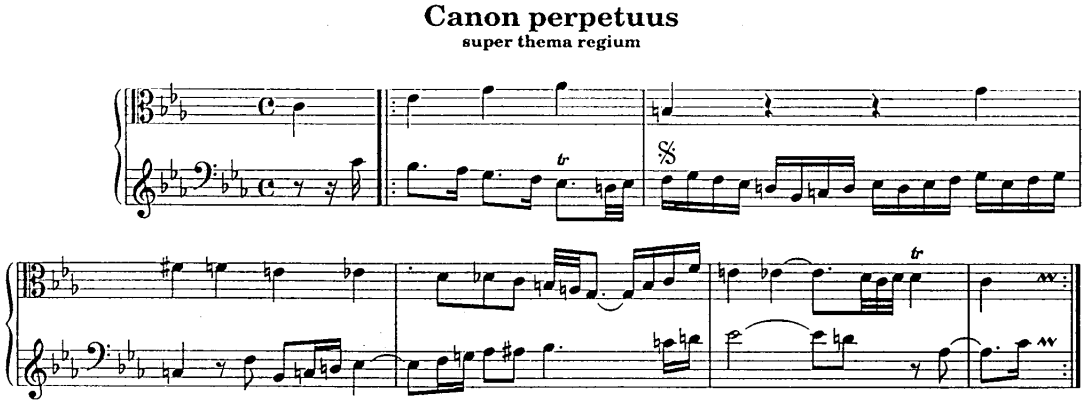
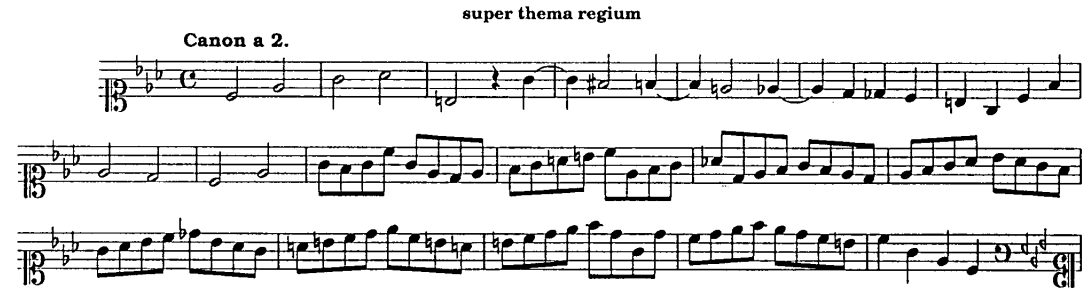


Illustration 6

Contributor: Leland Smith
Product: SCORE from Passport Designs
Running on: IBM PC compatibles

Output device: Verityper (1250 dpi)
Size as shown: 92% of original





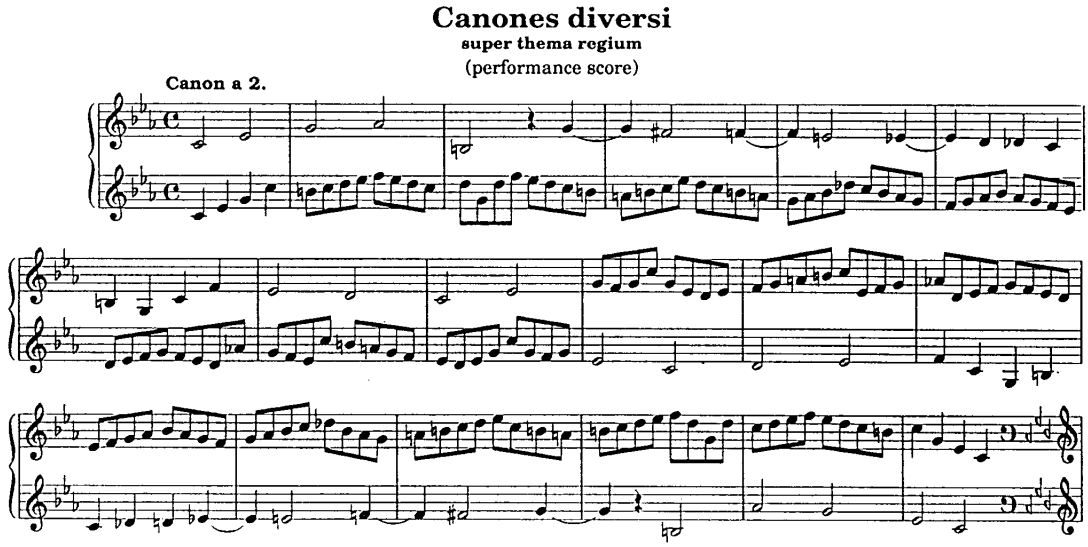


Illustration 7

Contributor: Llorenç Balsach
Product: la mà de guido
Running on: IBM PC/AT compatibles

Output device: QMS
Size as shown: 100% of original

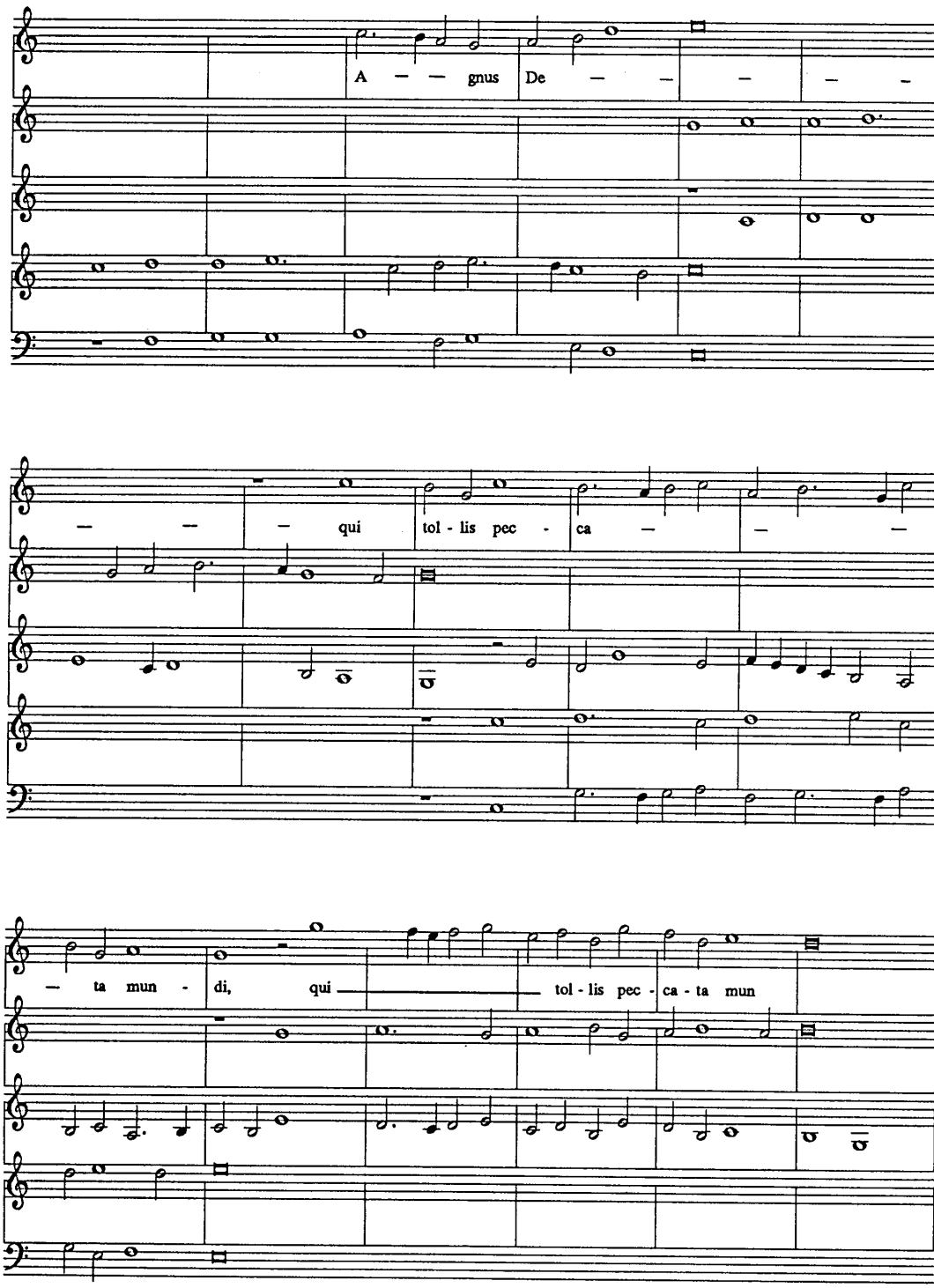


Illustration 8

Contributor: Nancy Colton
Product: Oberon Music Editor
Running on: IBM PC compatibles

Output from: Hewlett Packard DeskJet
Size as shown: 100% of original

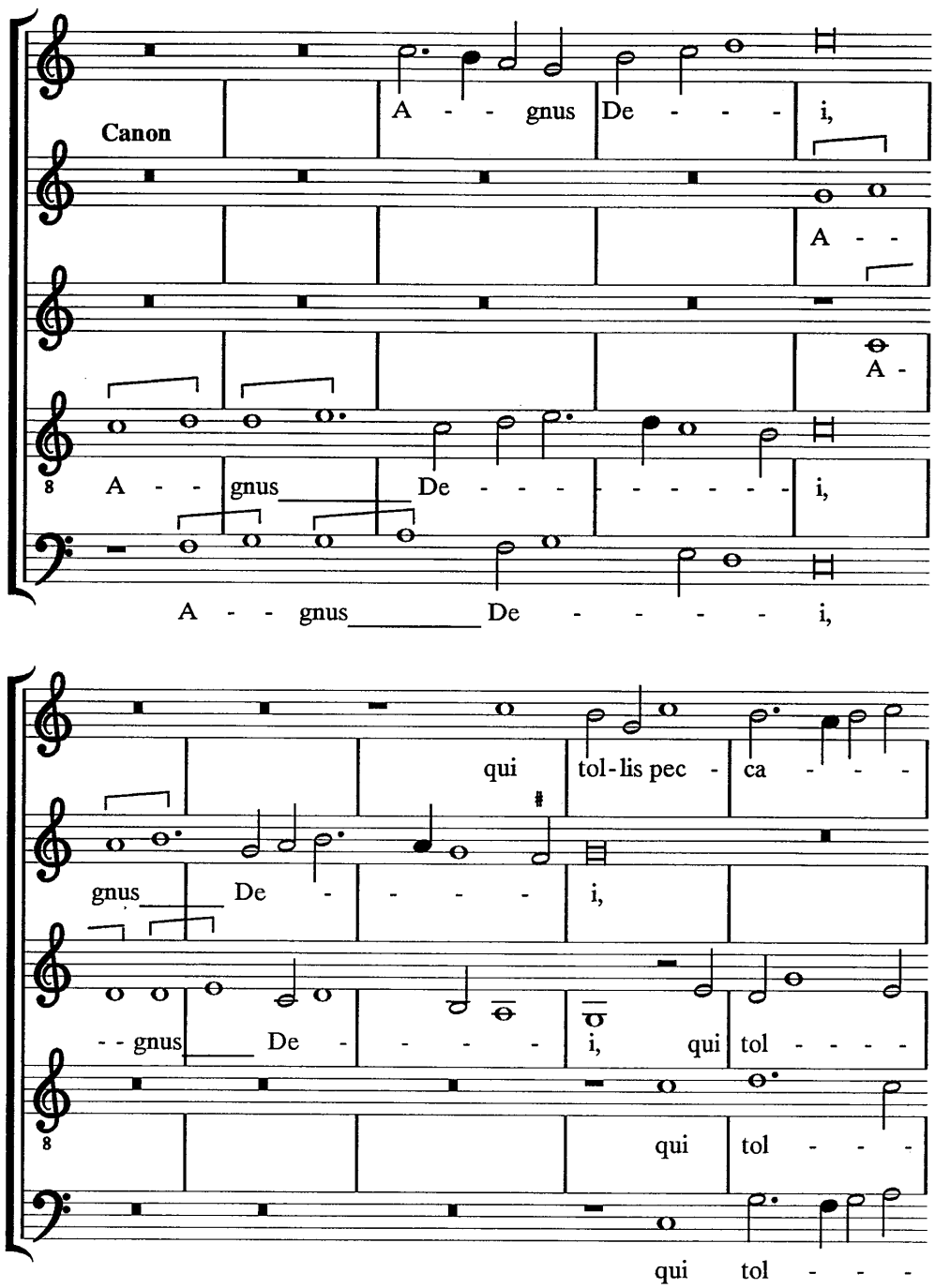


Illustration 9

Contributor: Philip Hazel
Product: Philip's Music Scribe
Running on : Acorn Archimedes workstation

Output device: Apple Laserwriter
Size as shown: 100% of original

Missa de Beato Vergine, Agnus Dei

Josquin

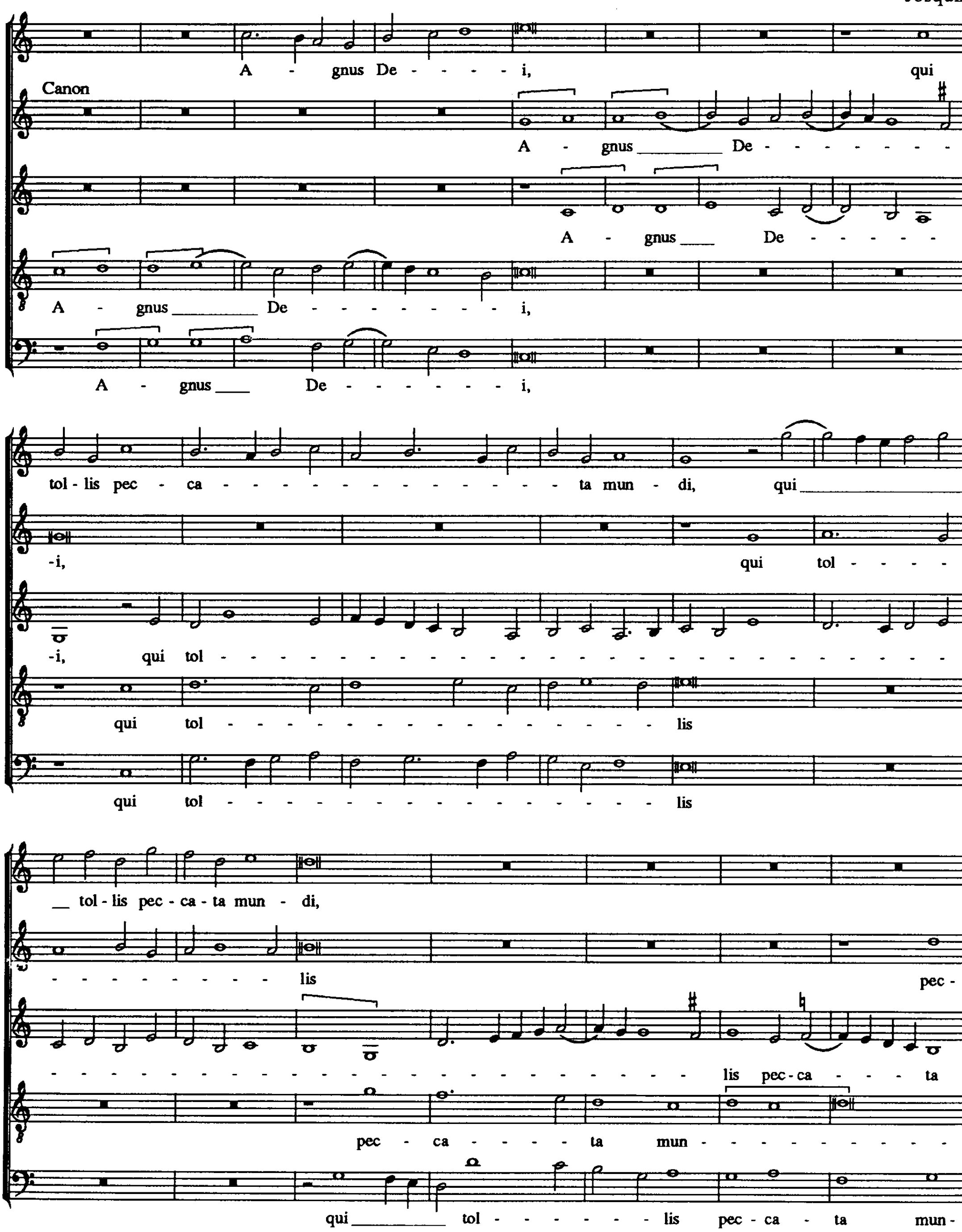


Illustration 10

Contributor: Kurt Maas
Product: Amadeus Music Software
Running on : a PDP-11/73; Atari Mega ST4

Output device: Amadeus ECRM Lasersetter (1000 dpi)
Size as shown: 100% of original

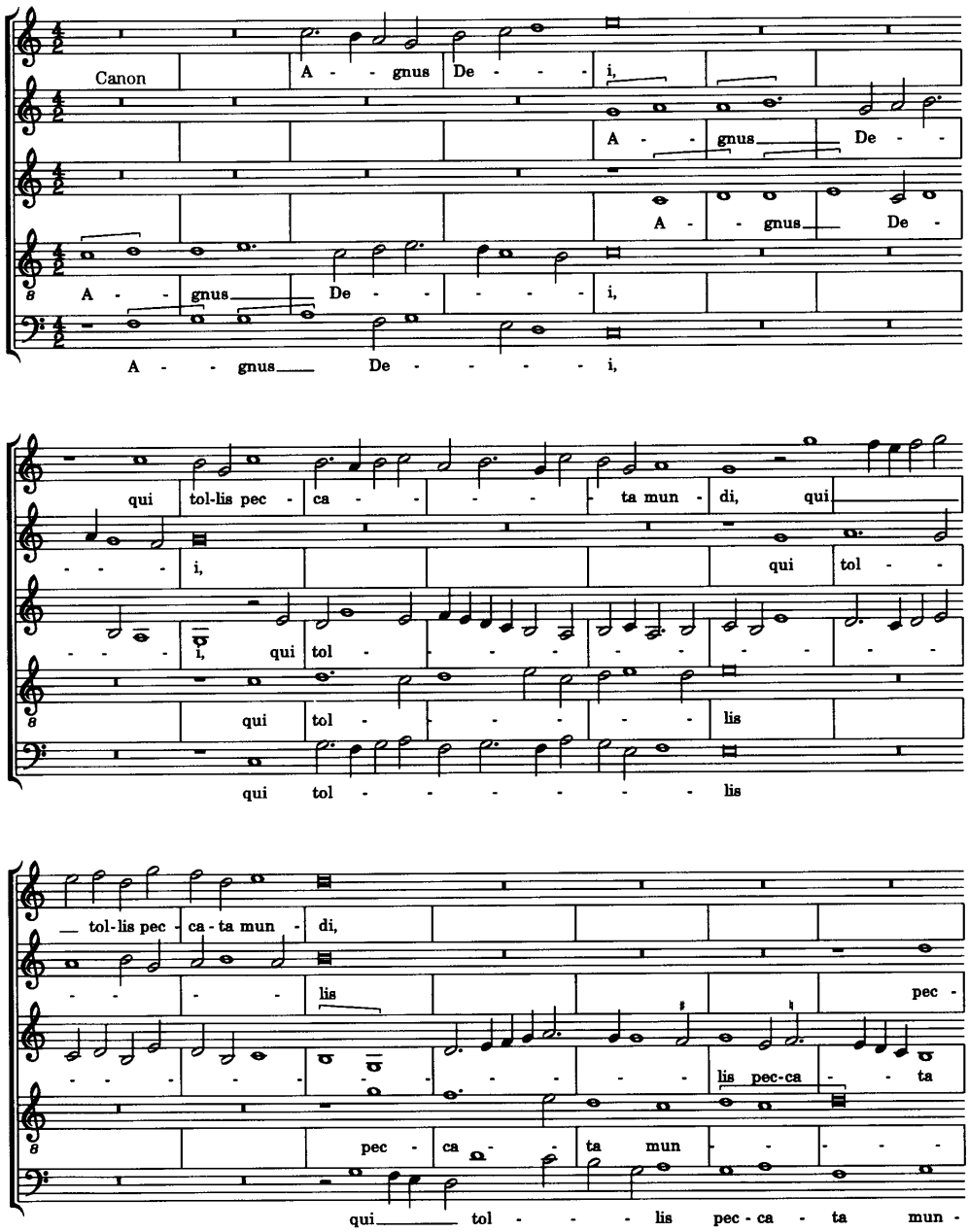


Illustration 11

Contributors: Dominique Montel, Frédéric Magiera
Product: Berlioz
Running on: Apple Macintosh

Output device: Linotronic 300
Size as shown: 100% of original

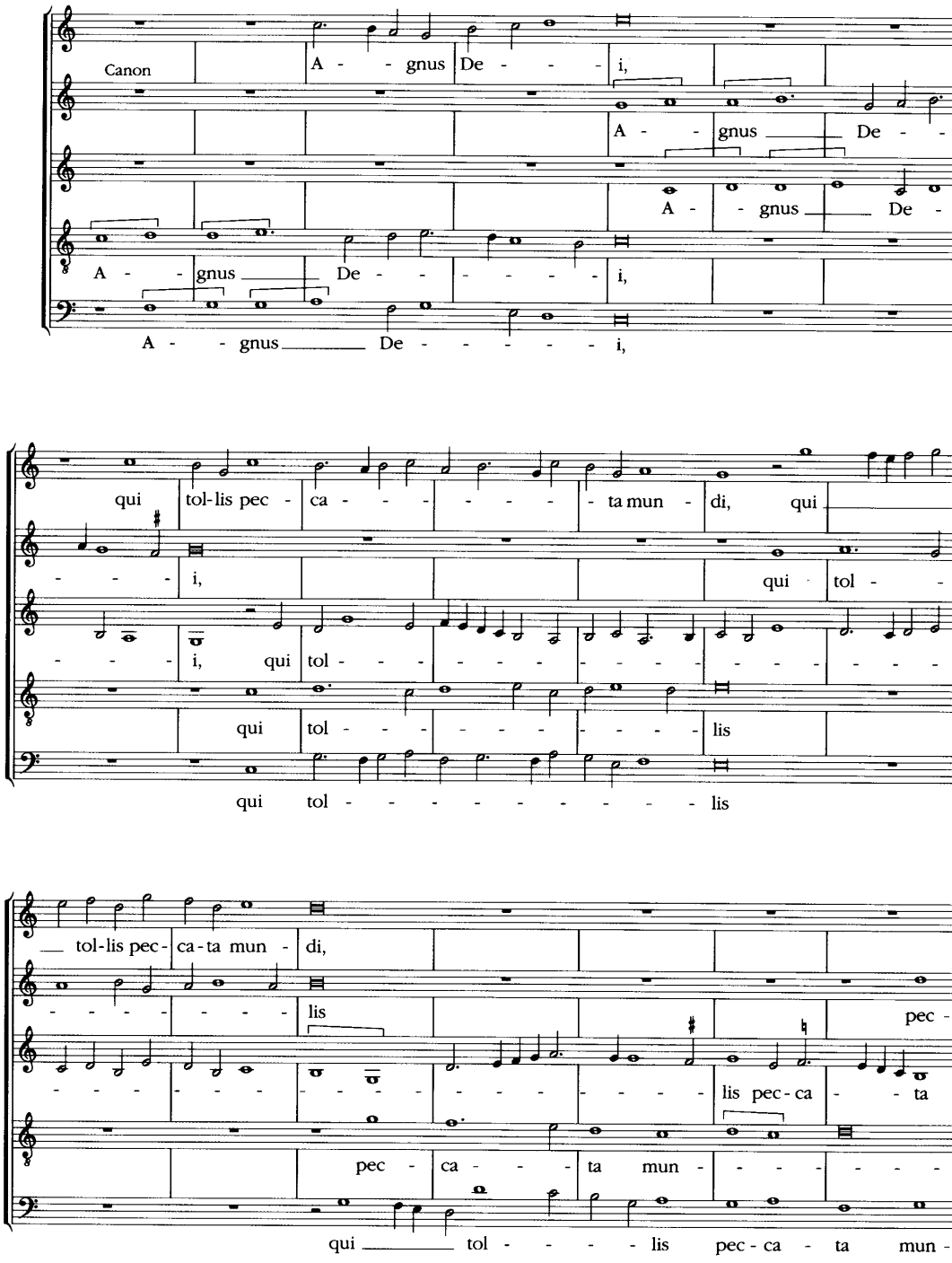


Illustration 12

Contributor: Jeffrey L. Price
Product: Erato Music Manuscriptor
Running on: Erato workstation

Output from: Hewlett Packard LaserJet II
Size as shown: 73% of original

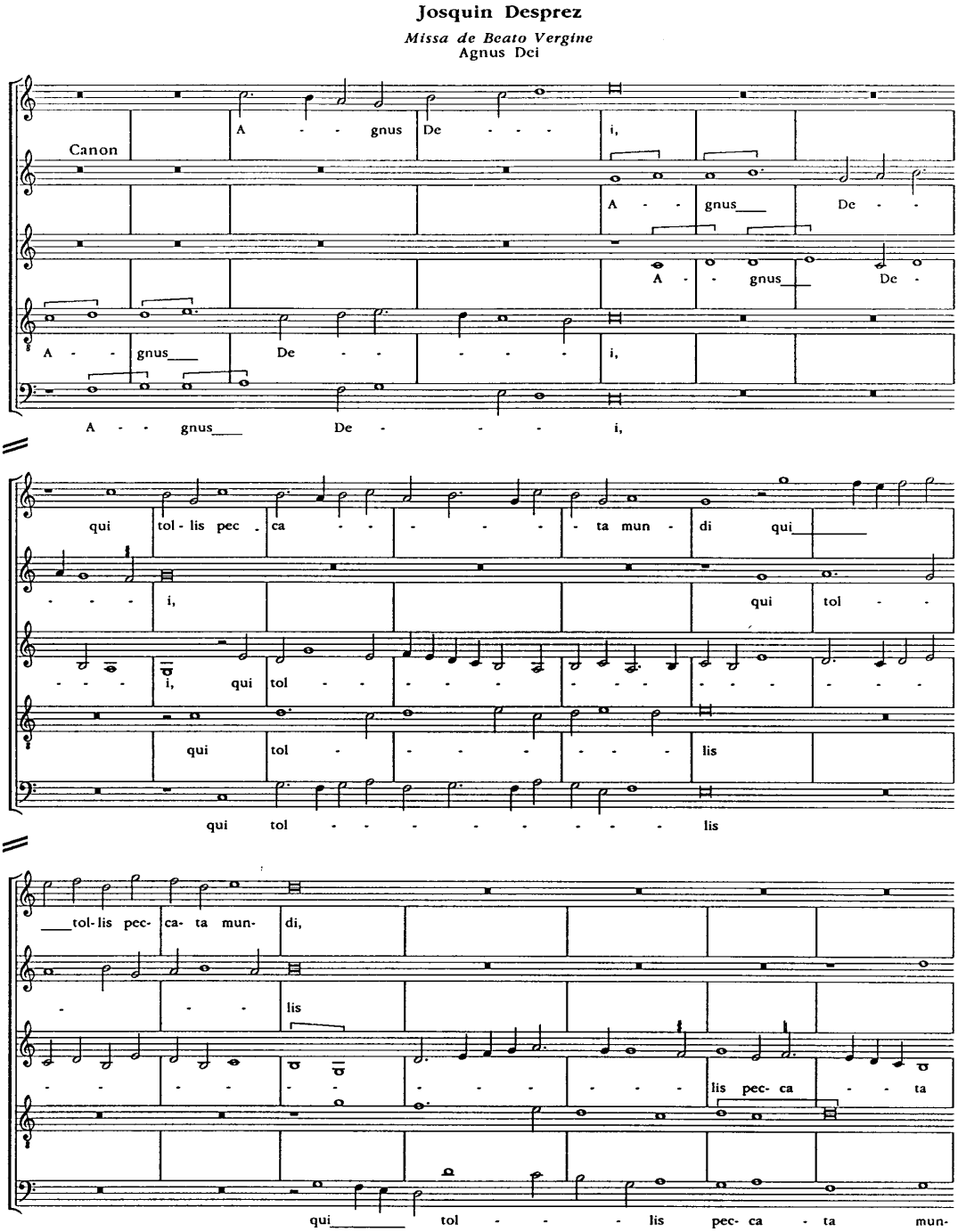


Illustration 13

Contributor: Leland Smith
Product: SCORE from Passport Designs
Running on: IBM PC compatibles

Output device: Verityper (1250 dpi)
Size as shown: 92% of original

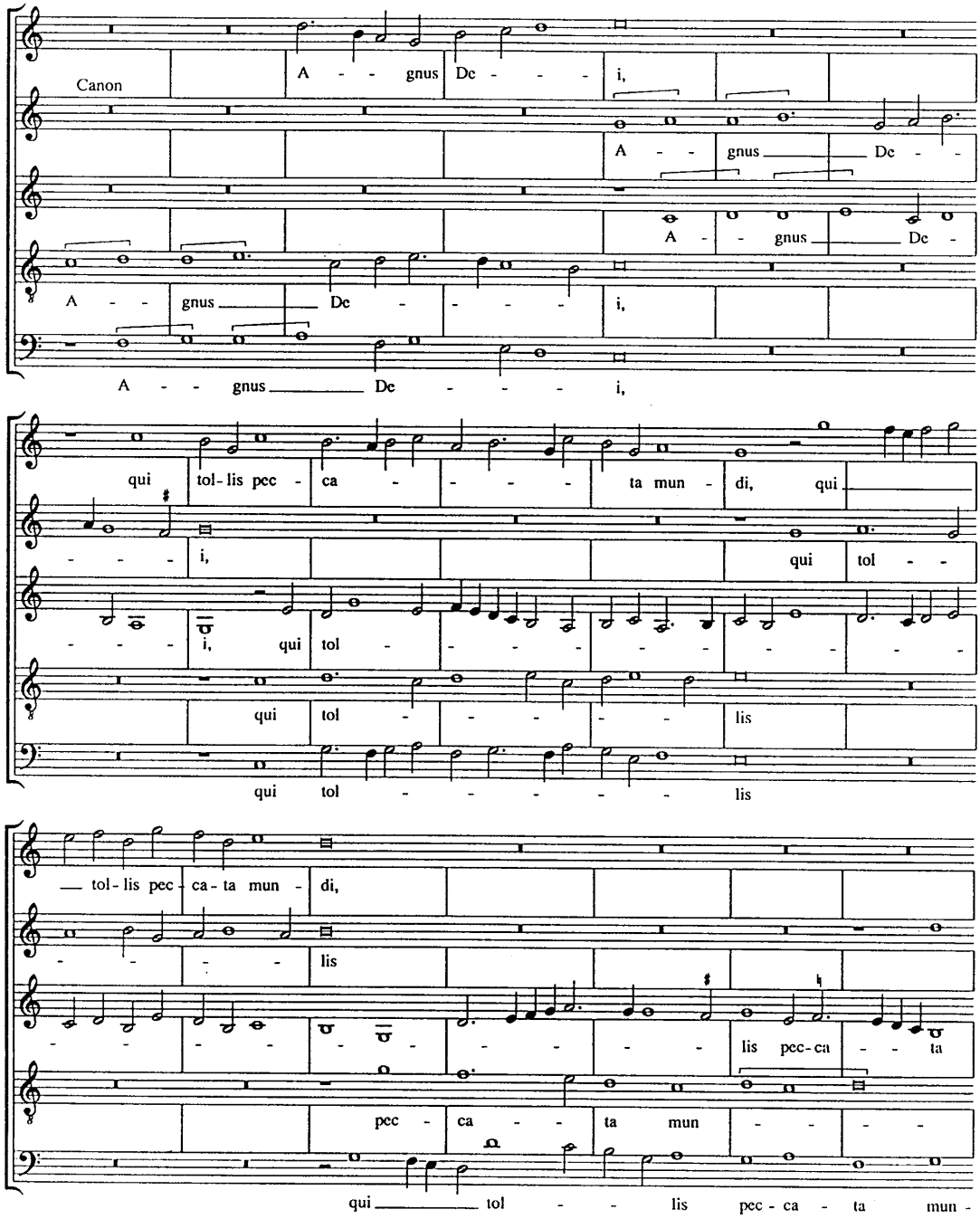


Illustration 14

Contributor: Rolf Wulfsberg
Product: A-R Music Engraving System
Running on: Sun-3 or SPARC station

Output device: Linotype L-300 (1270 dpi)
Size as shown: 100% of original

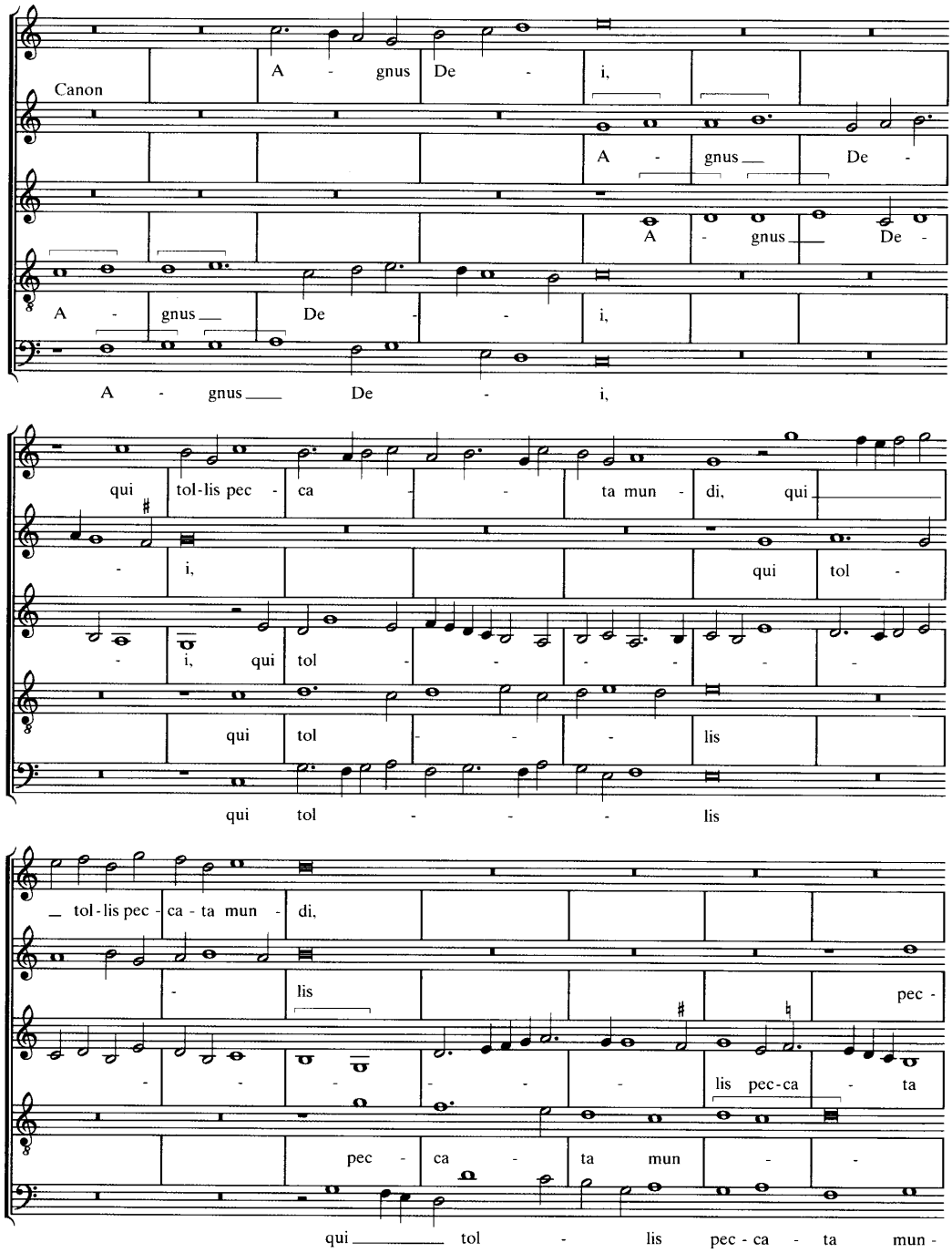


Illustration 15

Contributor: Stephen Dydo
Product: Thoughtprocessors' Note Processor
Running on: IBM PC compatibles

Output from: Hewlett Packard DeskJet
Size as shown: 100% of original

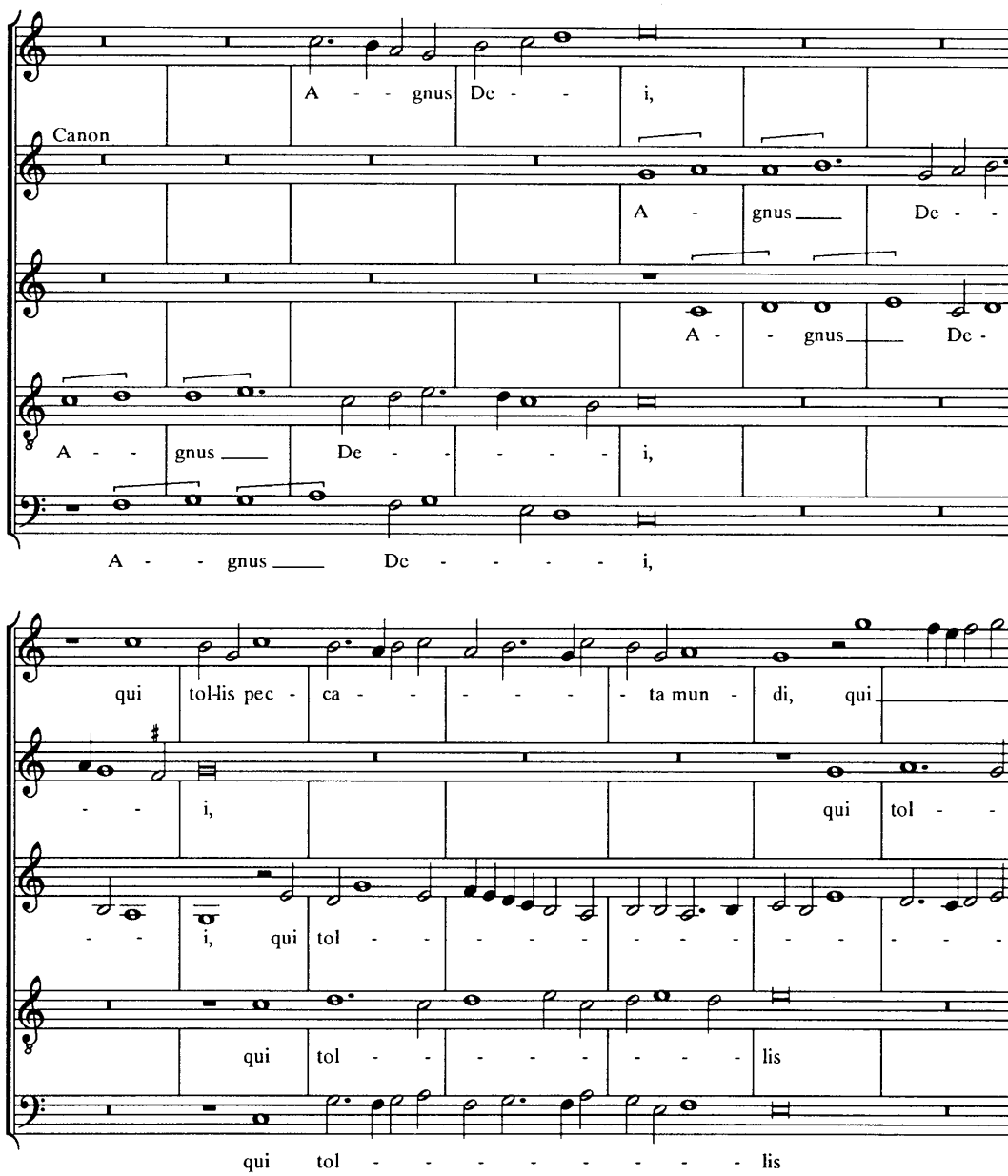


Illustration 16

Contributor: Dai Nippon Printing Co., Ltd.
Product: Dai Nippon Music Processor
Input device: Dai Nippon Music Processor

Output device: Hell's Digiset
Size as shown: 78% of original

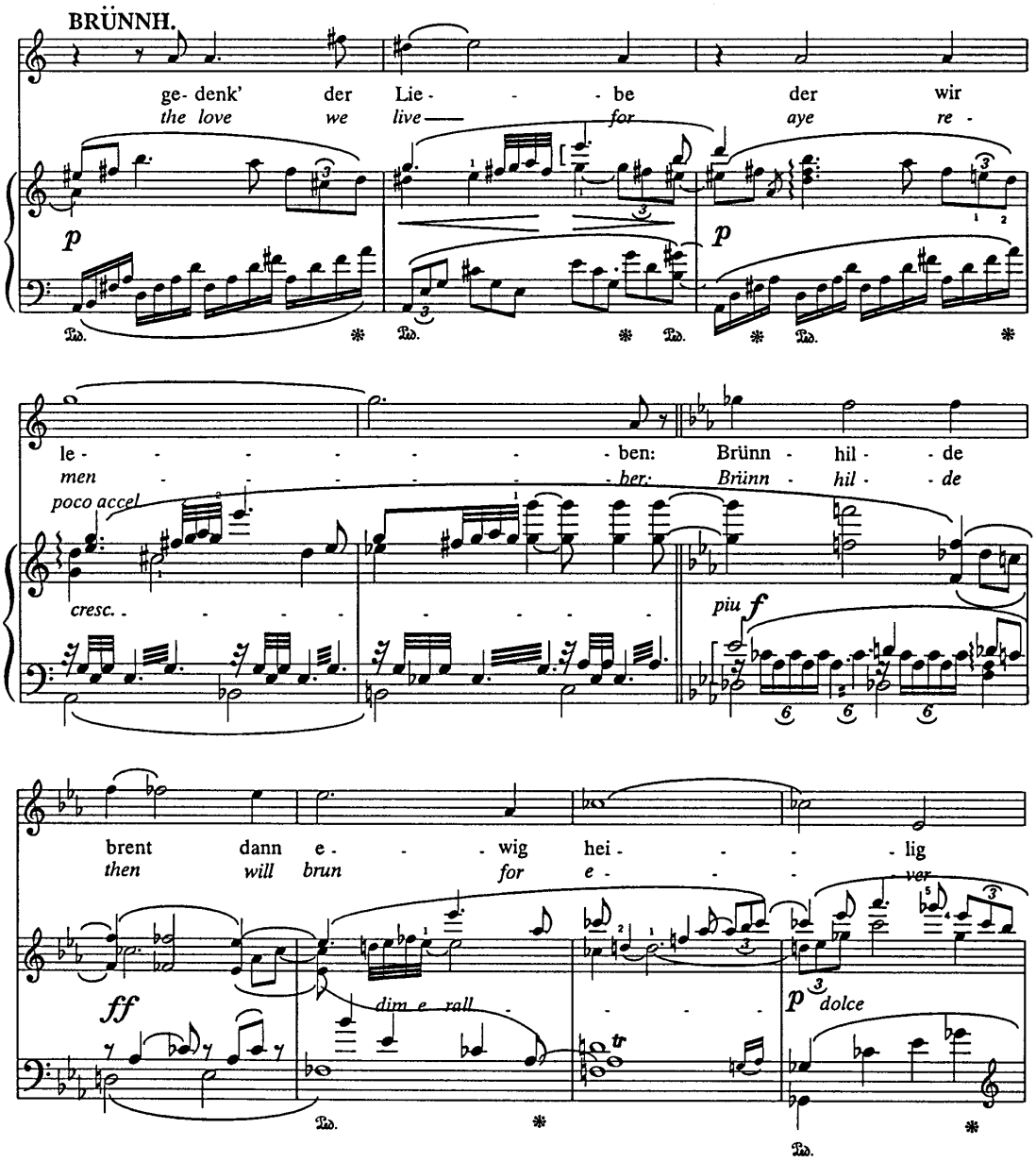


Illustration 17

Contributor: Etienne Darbellay
Product: WOLFGANG by Mus'Art
Running on: IBM PC compatibles

Output from: HP LaserJet III
Size as shown: 100% of original

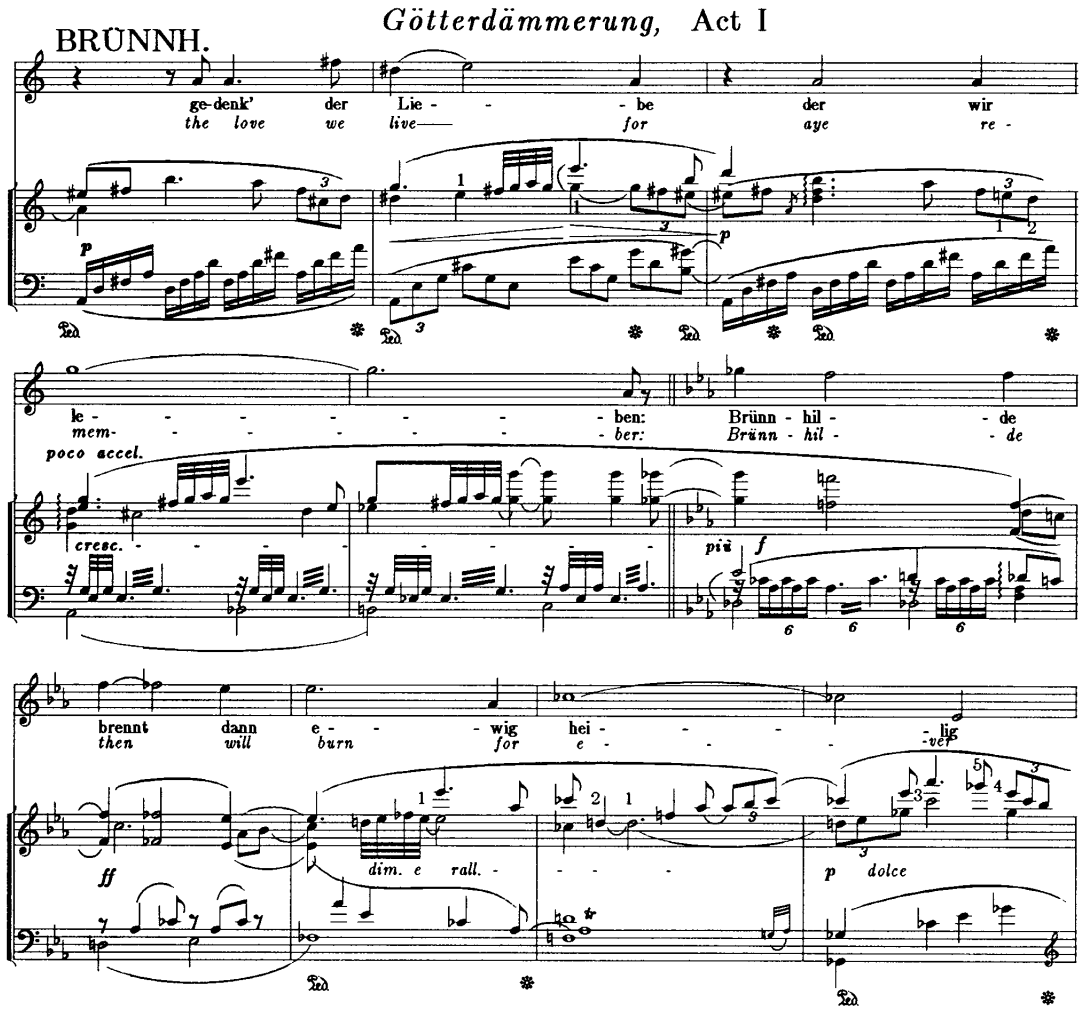


Illustration 18

Contributor: Cecil Effinger
Product: The Portable Musicwriter
Input device: The Portable Musicwriter

Output device: IBM Wheelwriter
Size as shown: 60% of original

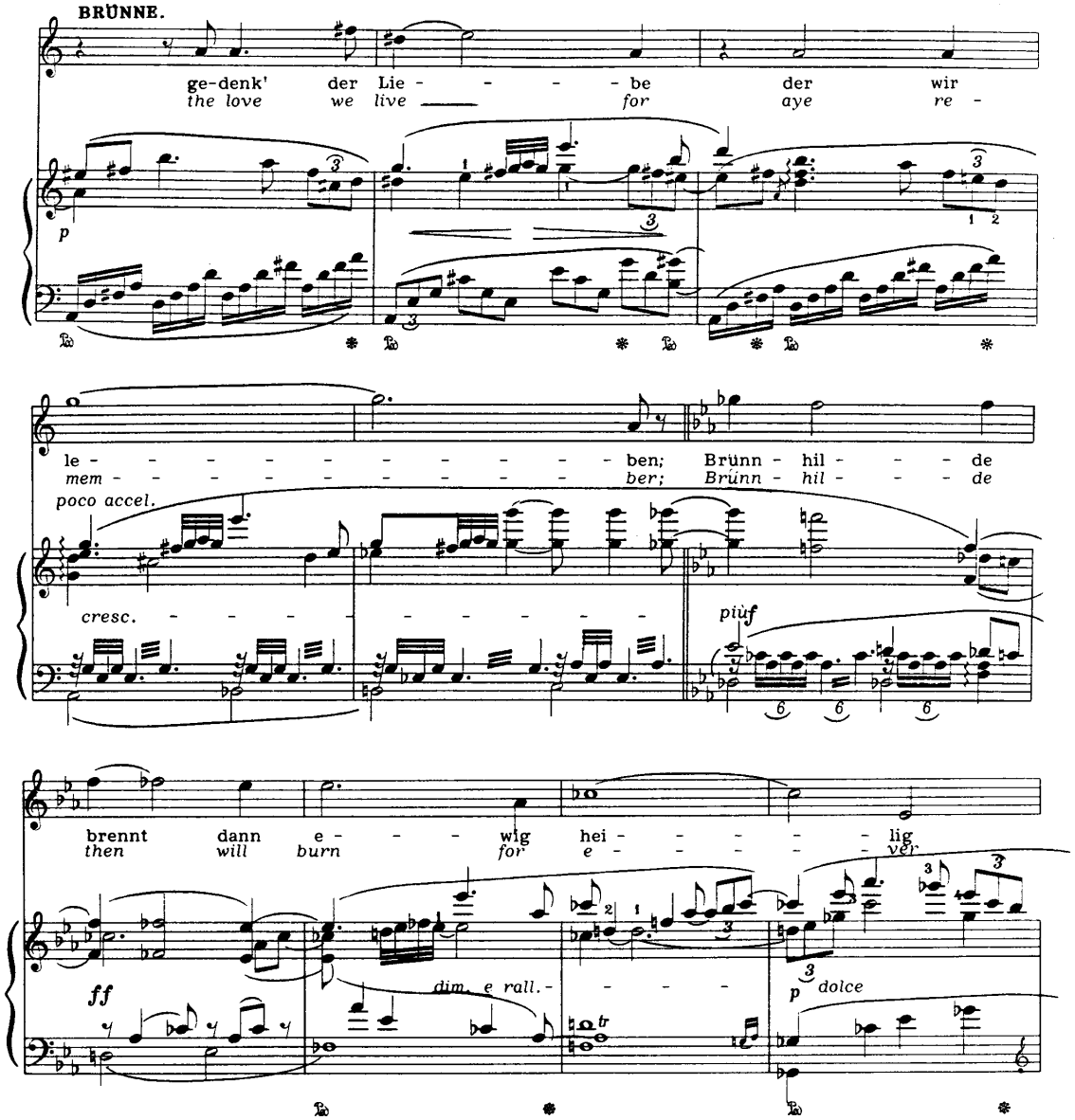


Illustration 19

Contributor: Philip Hazel
Product: Philip's Music Scribe
Running on: Acorn Archimedes workstation

Output device: Apple Laserwriter
Size as shown: 78% of original

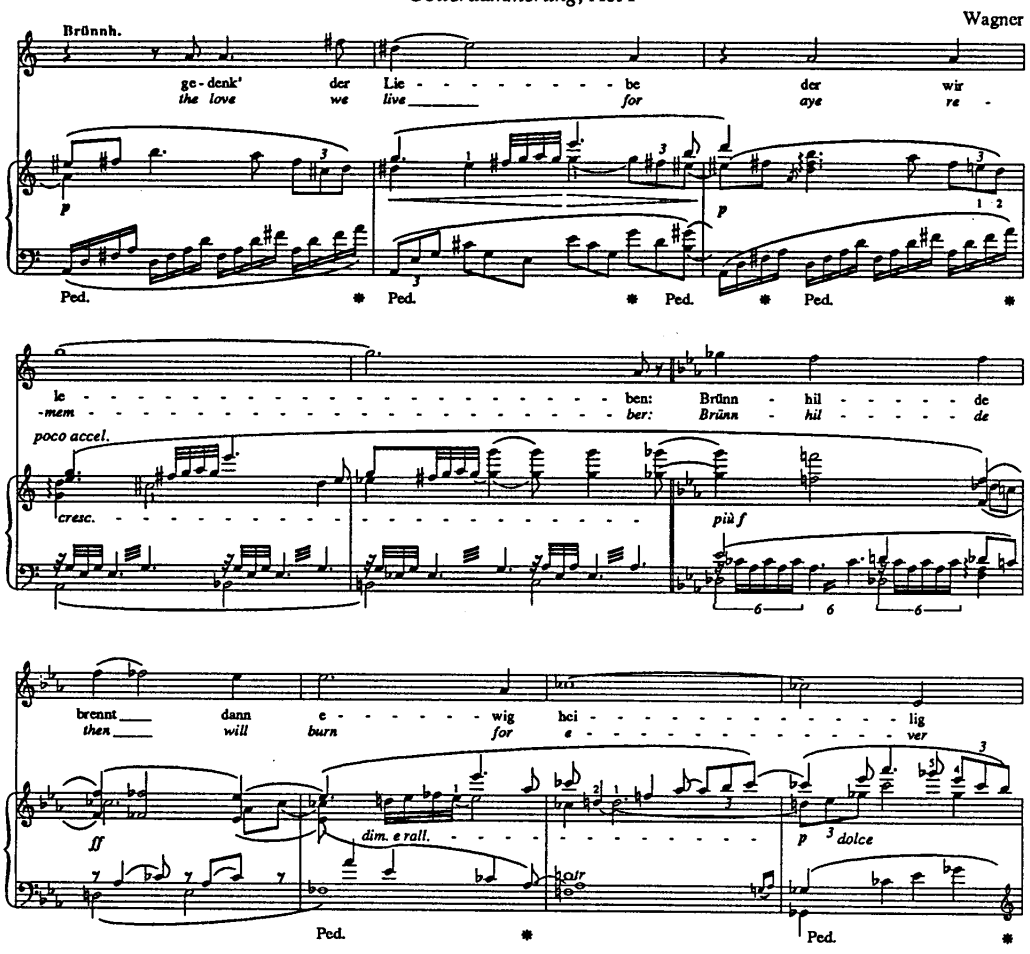


Illustration 20

Contributor: Kurt Maas
Product: Amadeus Music Software
Running on: a PDP-11/73; Atari Mega ST4

Output device: Amadeus ECRM Lasersetter (1000 dpi)
Size as shown: 100% of original

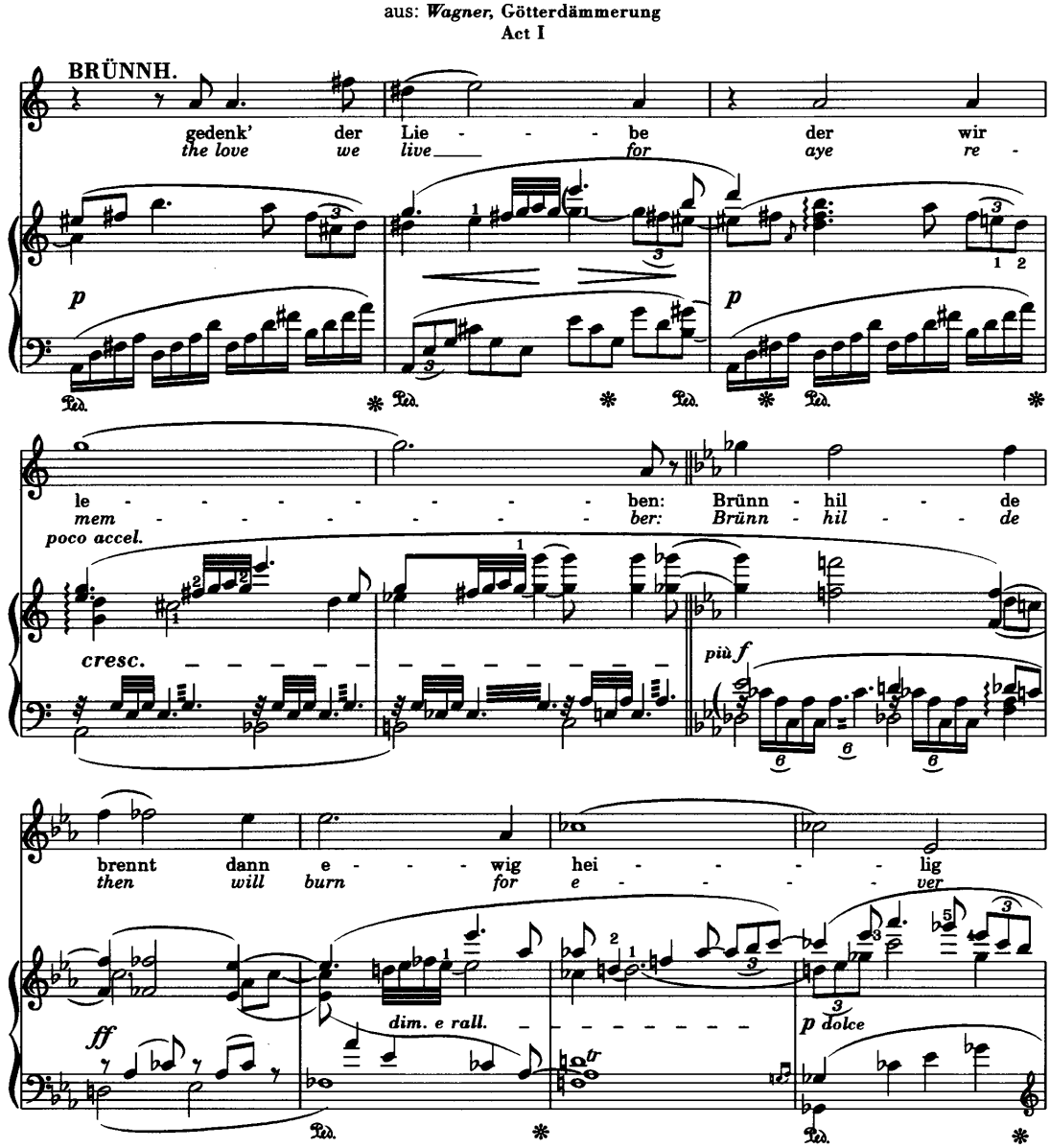


Illustration 21

Contributors: Dominique Montel, Frédéric Magiera
Product: Berlioz
Running on: Apple Macintosh

Output device: Linotronic 300
Size as shown: 75% of original

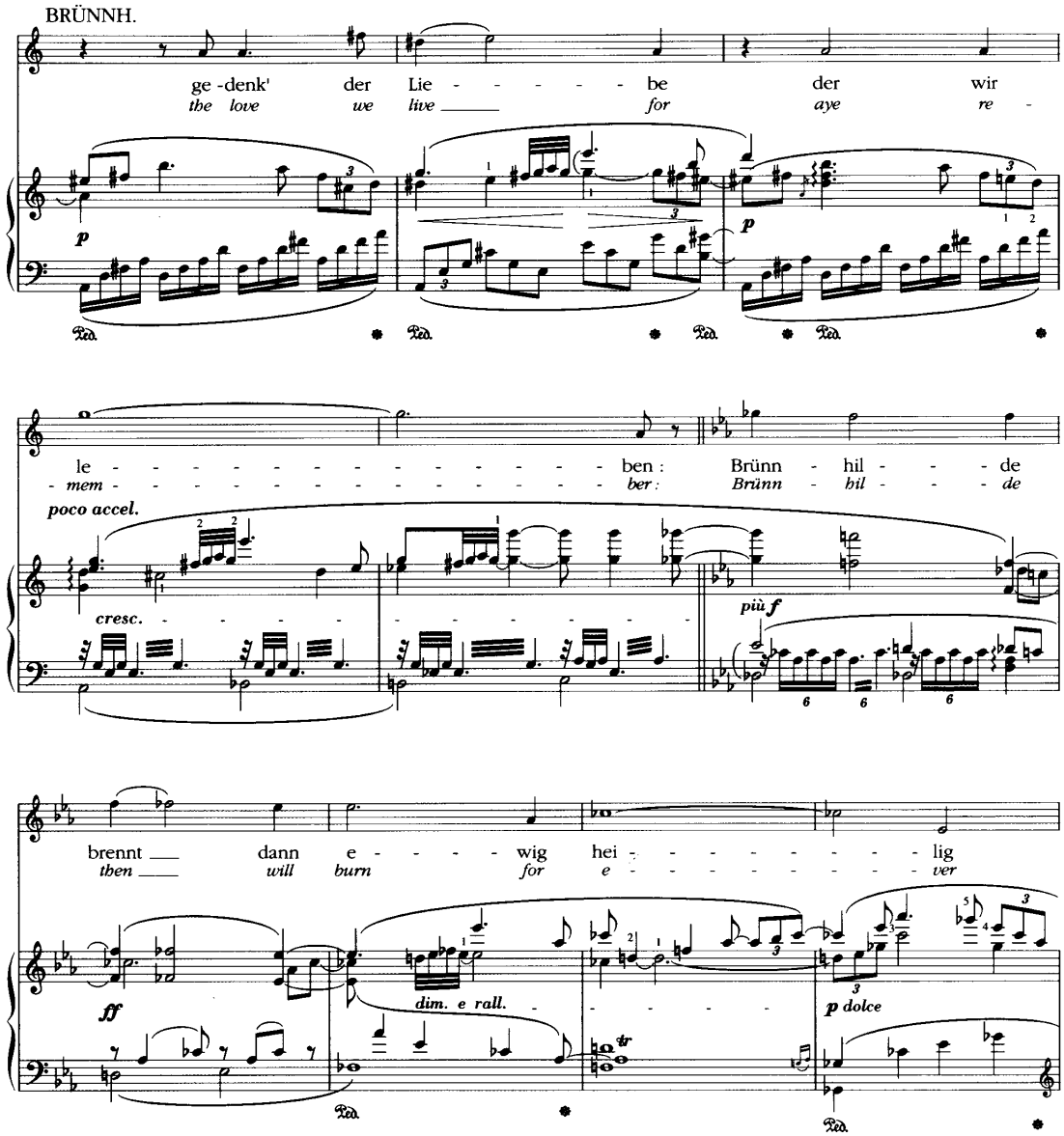


Illustration 22

Contributor: Crispin Sion
Product: The Copyist [from Dr. T's Music Software]
Running on: Atari ST

Output device: QMS PS 800+
Size as shown: 78% of original

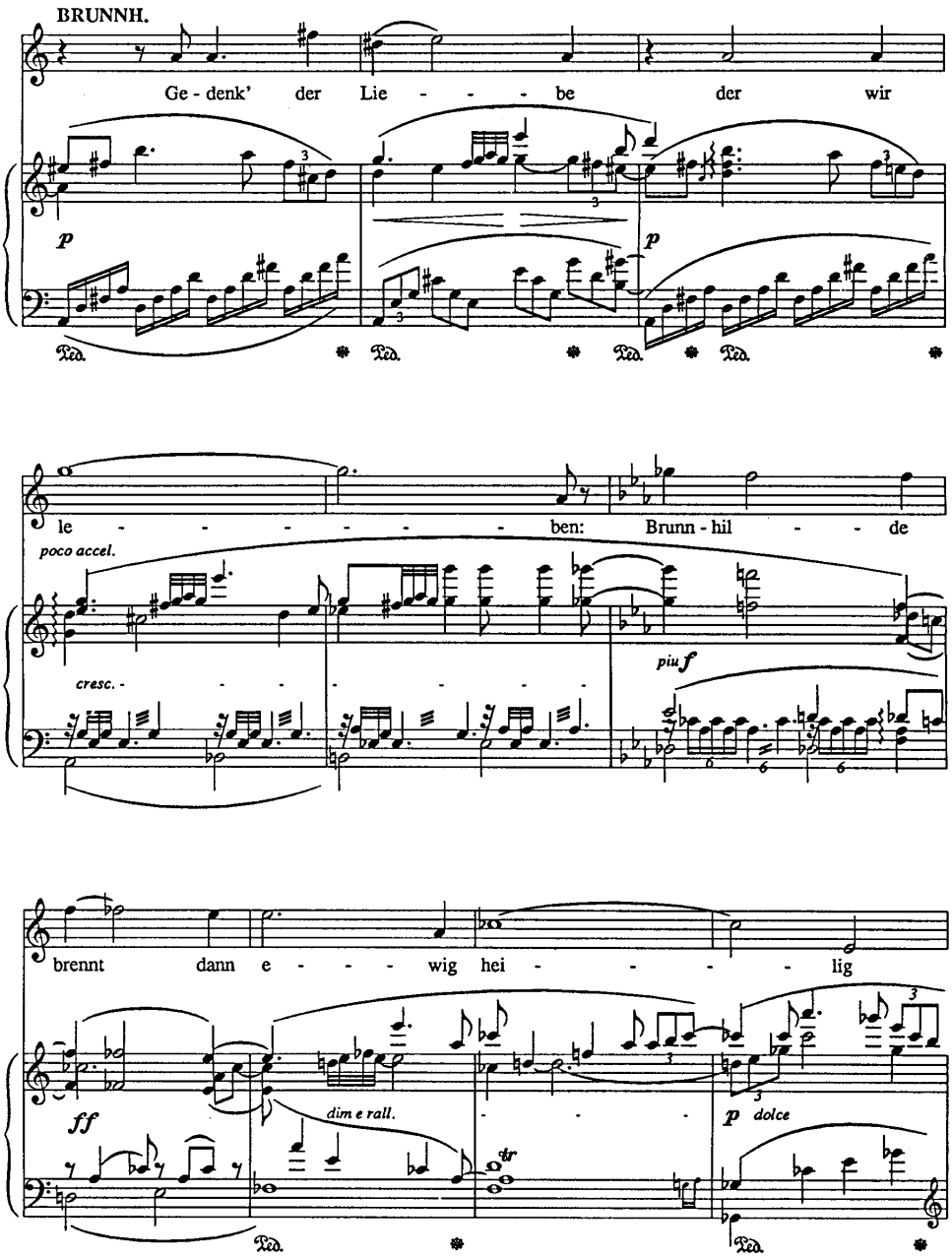


Illustration 23

Contributor: Leland Smith
Product: SCORE from Passport Designs
Running on: IBM PC compatibles

Output device: Verityper (1250 dpi)
Size as shown: 92% of original

#3. Wagner
Götterdammerung, Act I

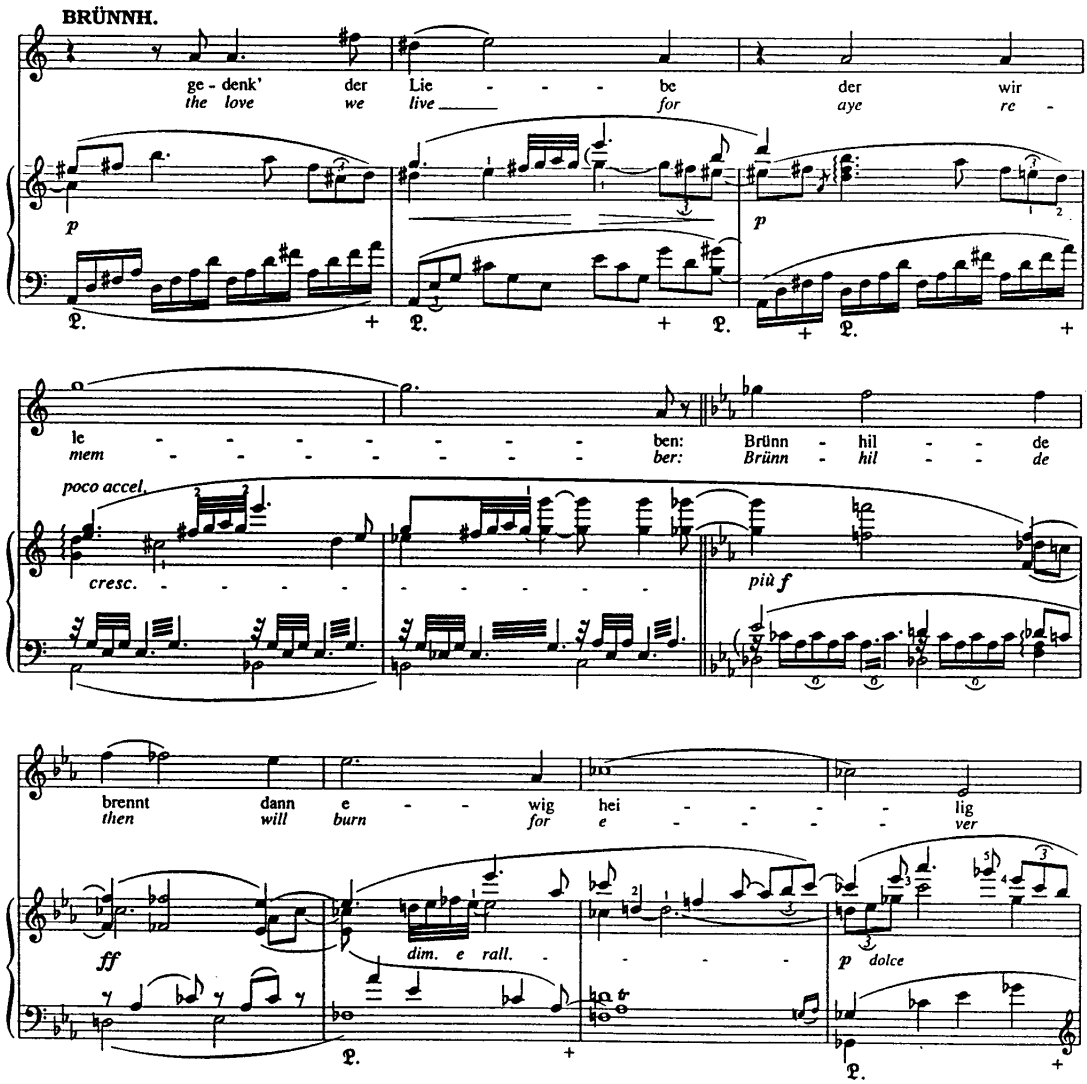


Illustration 24

Contributor: Alan Talbot
Product: Synclavier Music Engraving System
Input device: Synclavier Digital Audio System
Output device: Linotronic 100 Imagesetter (1270 dpi)
Size as shown: 100% of original
Engraver: Gregg Sewell

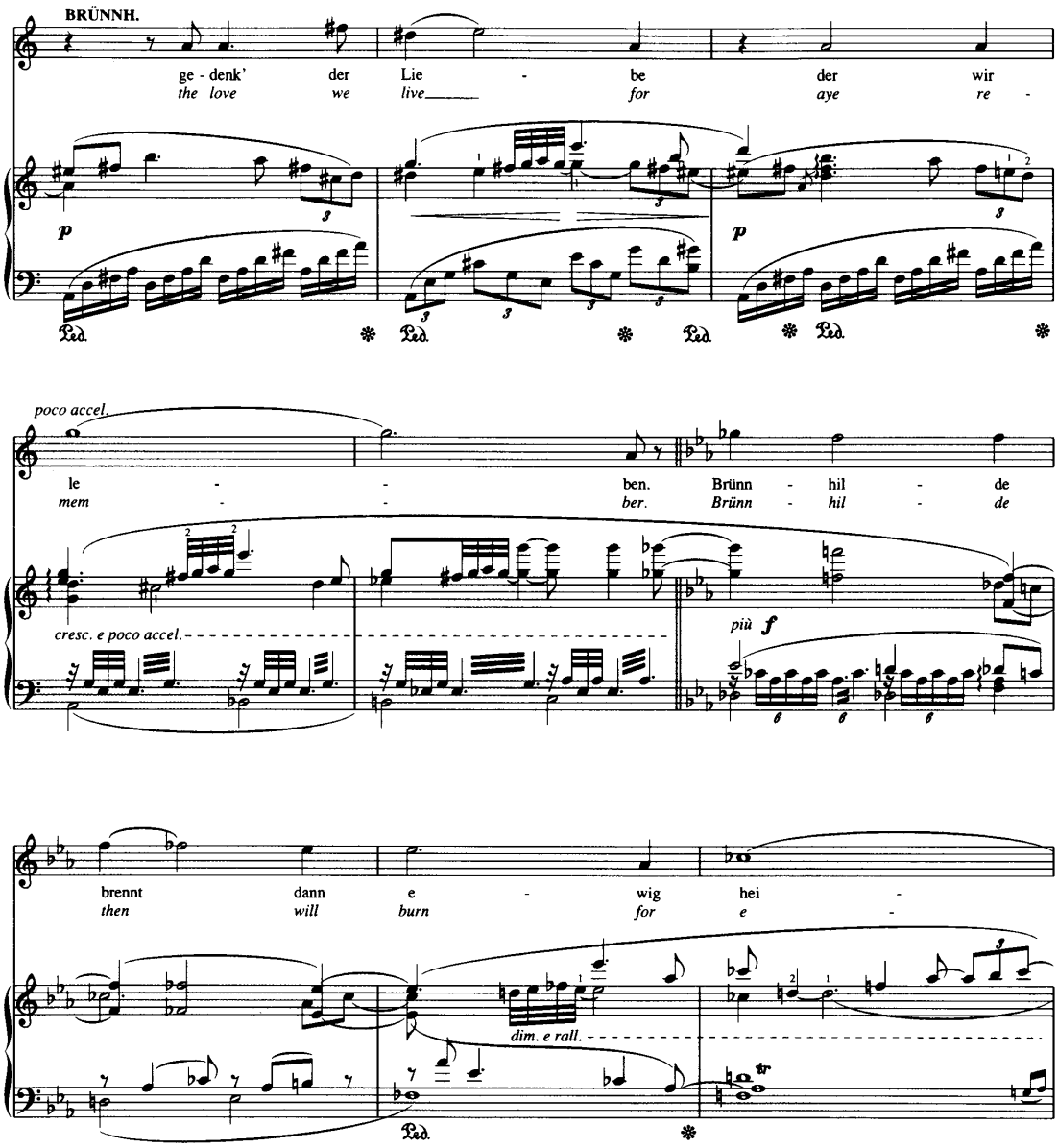


Illustration 25

Contributor: Rolf Wulfsberg
Product: A-R Music Engraving System
Running on: Sun-3 or SPARC station

Output device: Linotype L-300 (1270 dpi)
Size as shown: 100% of original

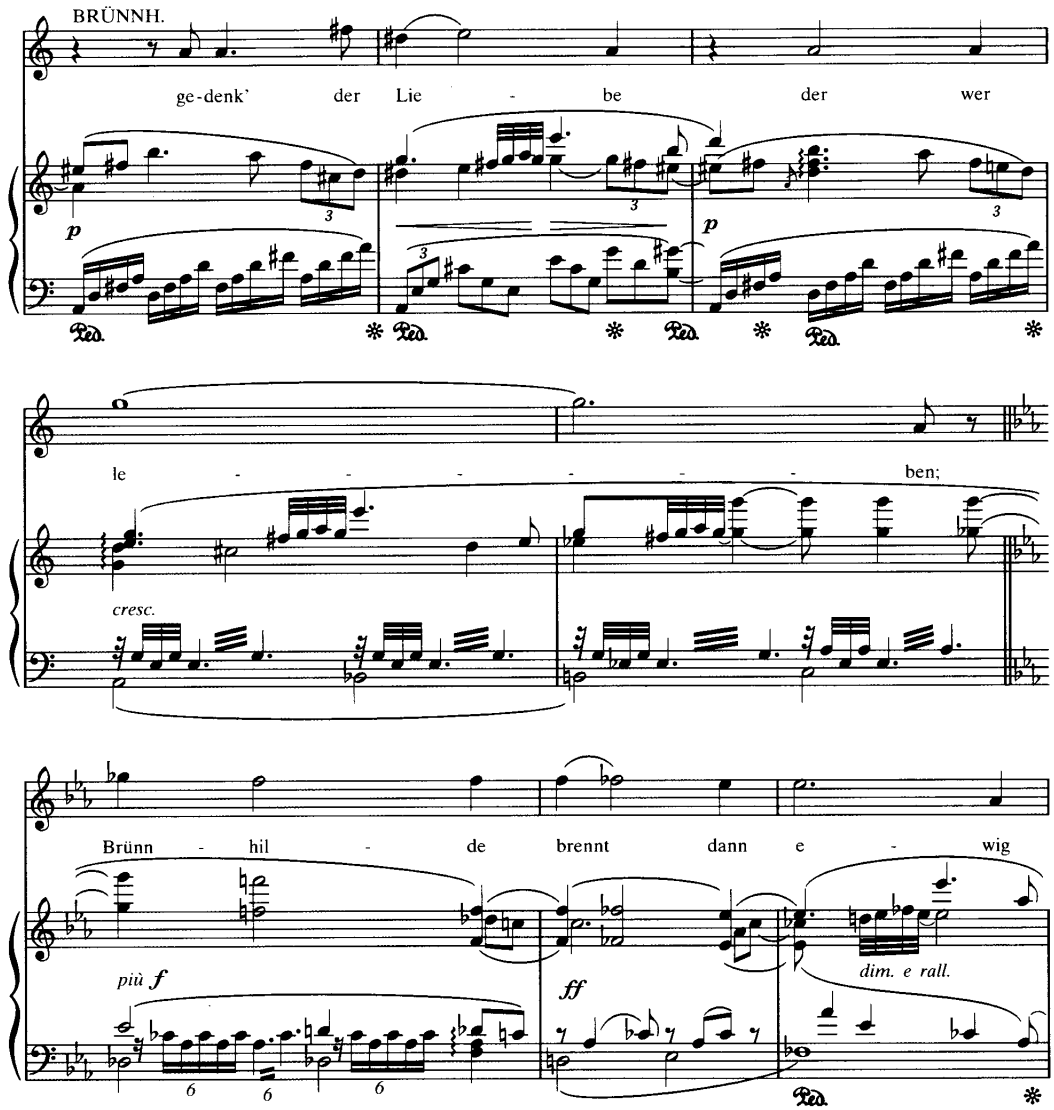


Illustration 26

Contributor: Stephen Dydo
Product: Thoughtprocessors' Note Processor
Running on: IBM PC compatibles

Output from: Hewlett Packard DeskJet
Size as shown: 100% of original

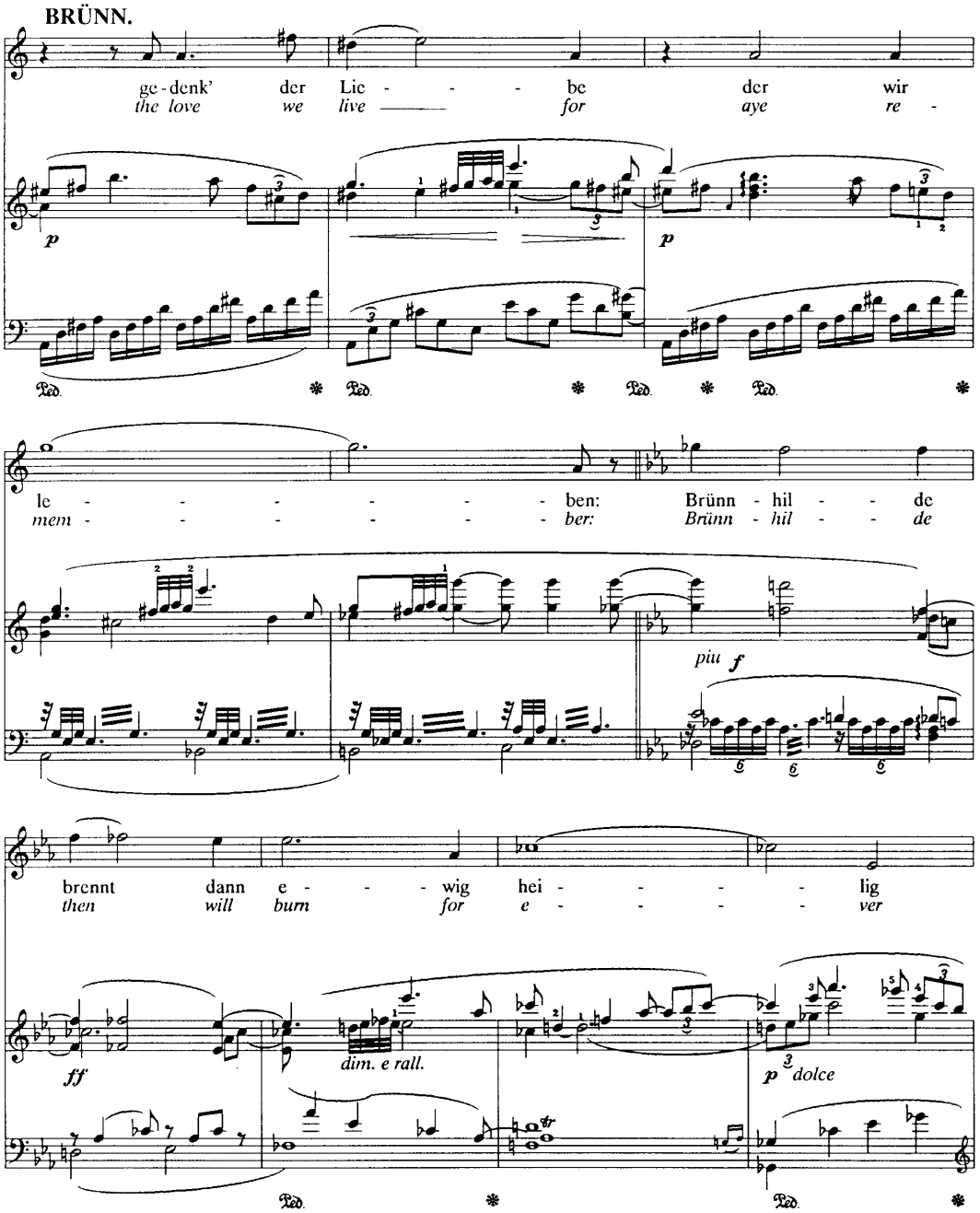


Illustration 27

Contributor: Dai Nippon Printing Co., Ltd.
Product: Dai Nippon Music Processor
Input device: Dai Nippon Music Processor

Output device: Sony LBP, NWP-533
Size as shown: 78% of original

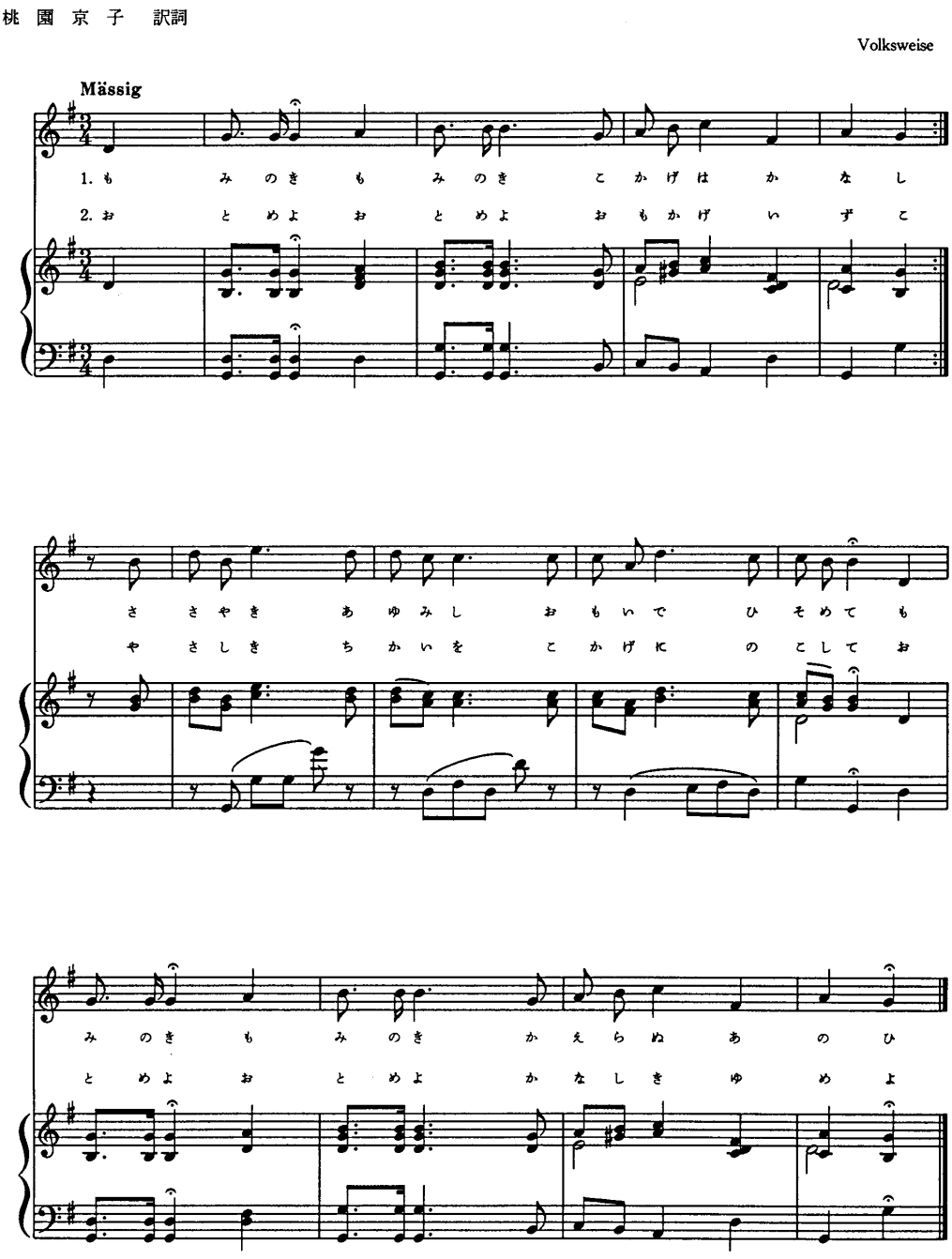
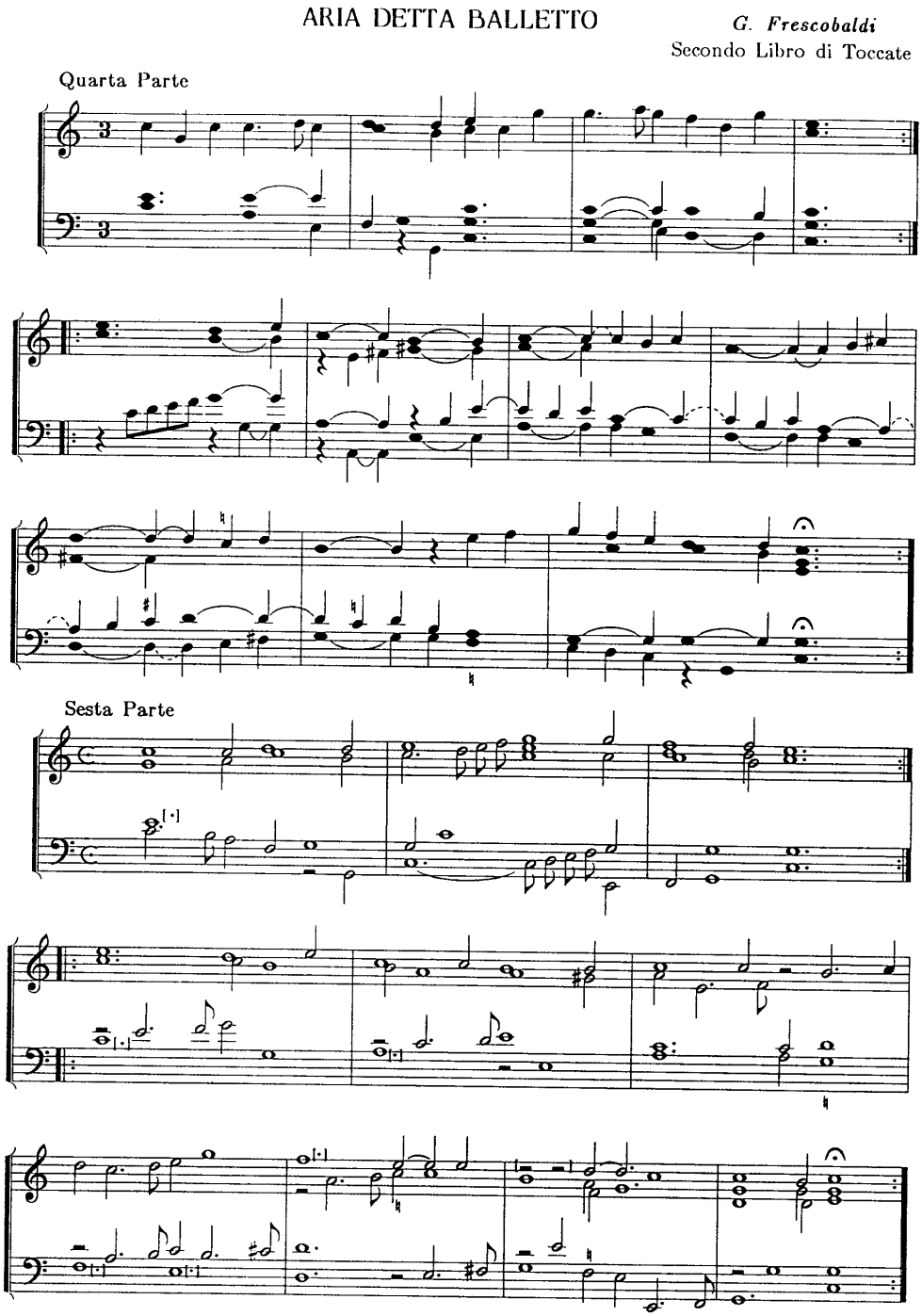


Illustration 28

Contributor: Etienne Darbellay
Product: WOLFGANG by Mus'Art
Running on: IBM PC compatibles

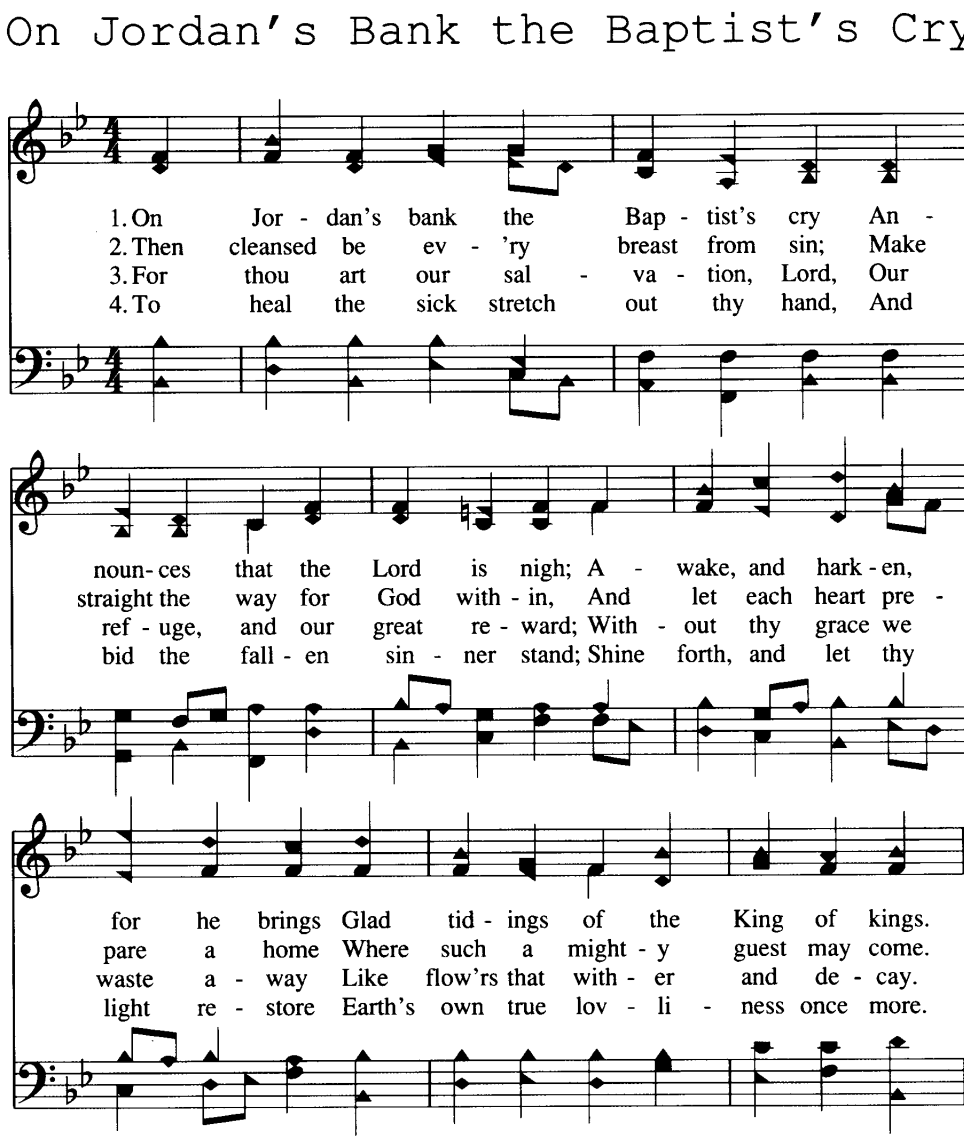
Output from: HP LaserJet III
Size as shown: 70% of original



The filled whole notes and void eight notes shown here constitute "colored" notation expressing accents that contradict the assigned meter [see p. 261]

Illustration 29

Contributor: Alan Talbot
Product: Synclavier Music Engraving System
Input device: Synclavier Digital Audio System
Output device: Linotronic 100 Imagesetter (1270 dpi)
Size as shown: 100% of original
Engraver: Gregg Sewell



5. All praise, eternal Son, to thee,
Whose advent doth thy people free;
Whom with the Father we adore
And Holy Spirit evermore.

Illustration 30

Contributor: Michel Wallet
Product: Euterpe (for ERATTO interface)
Running on: Apple Macintosh

Output device: Hewlett Packard LaserJet
Size as shown: 67% of original

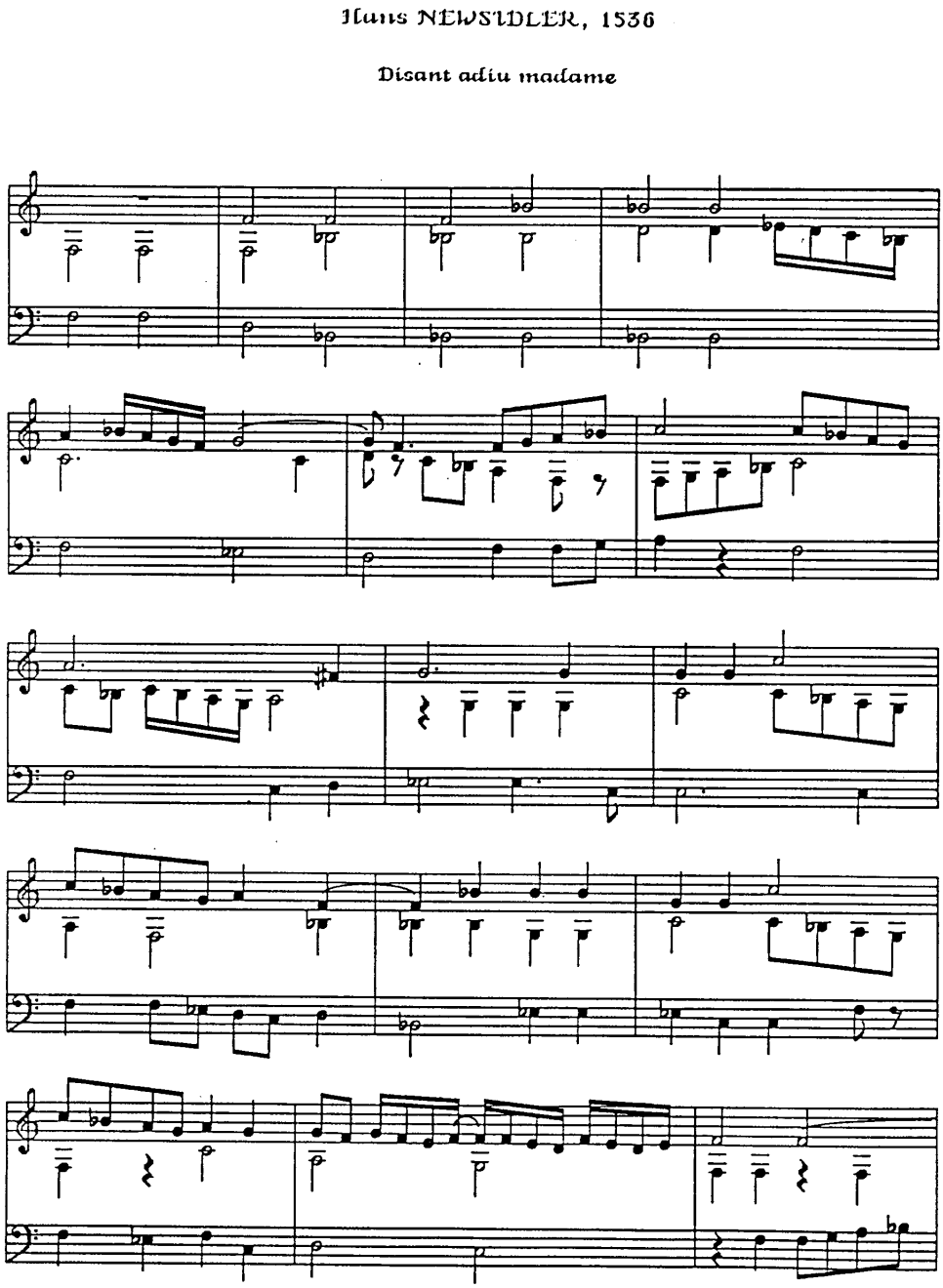


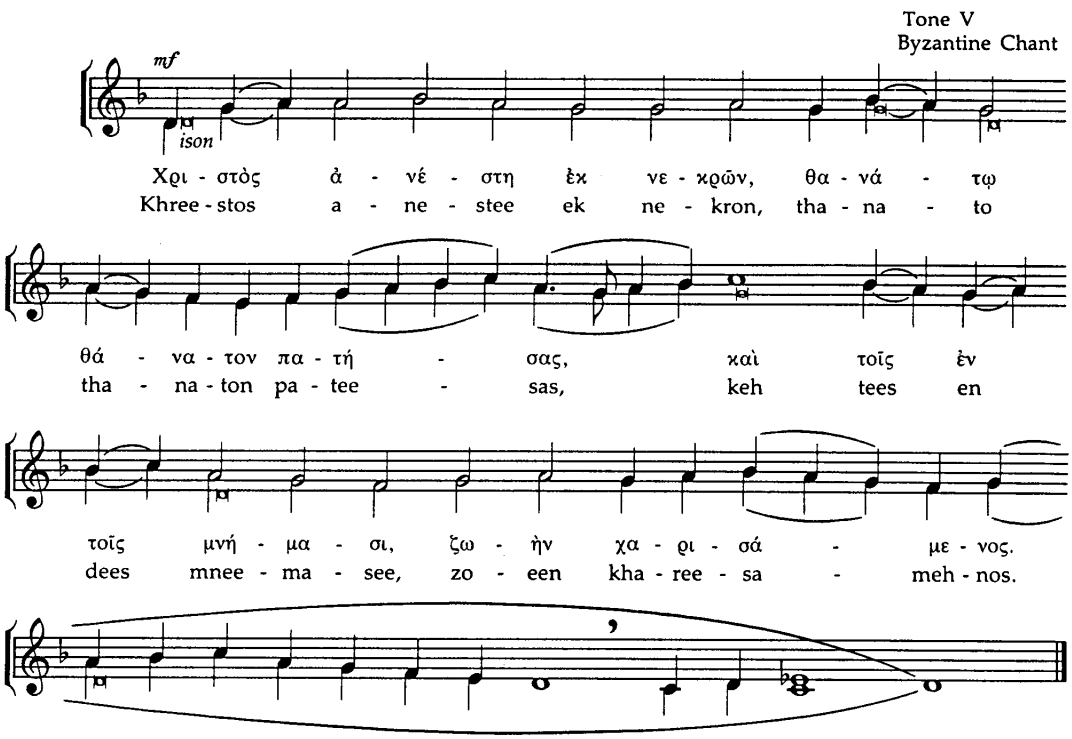
Illustration 31

Contributor: Rolf Wulfsberg
Product: A-R Music Engraving System
Running on: Sun-3 or SPARC station

Output device: Linotype L-300 (1270 dpi)
Size as shown: 78% of original

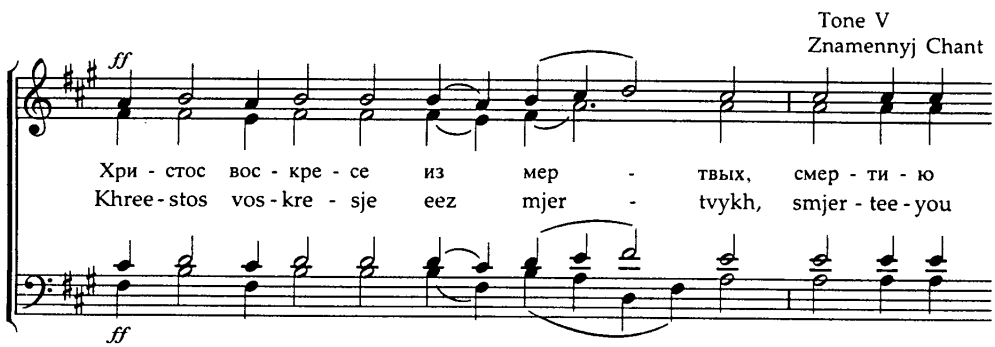
Paschal Troparion

(In Greek)



Paschal Troparion

(In Church Slavonic)



Dance Notation Software

The Hungarian dancer Rudolf von Laban developed a now widely used system of movement notation in the early part of this century. Labanotation is read from bottom to top. It may be laid out in multiple columns and these may be interleaved with conventional staff notation that is rotated 90 degrees counterclockwise.

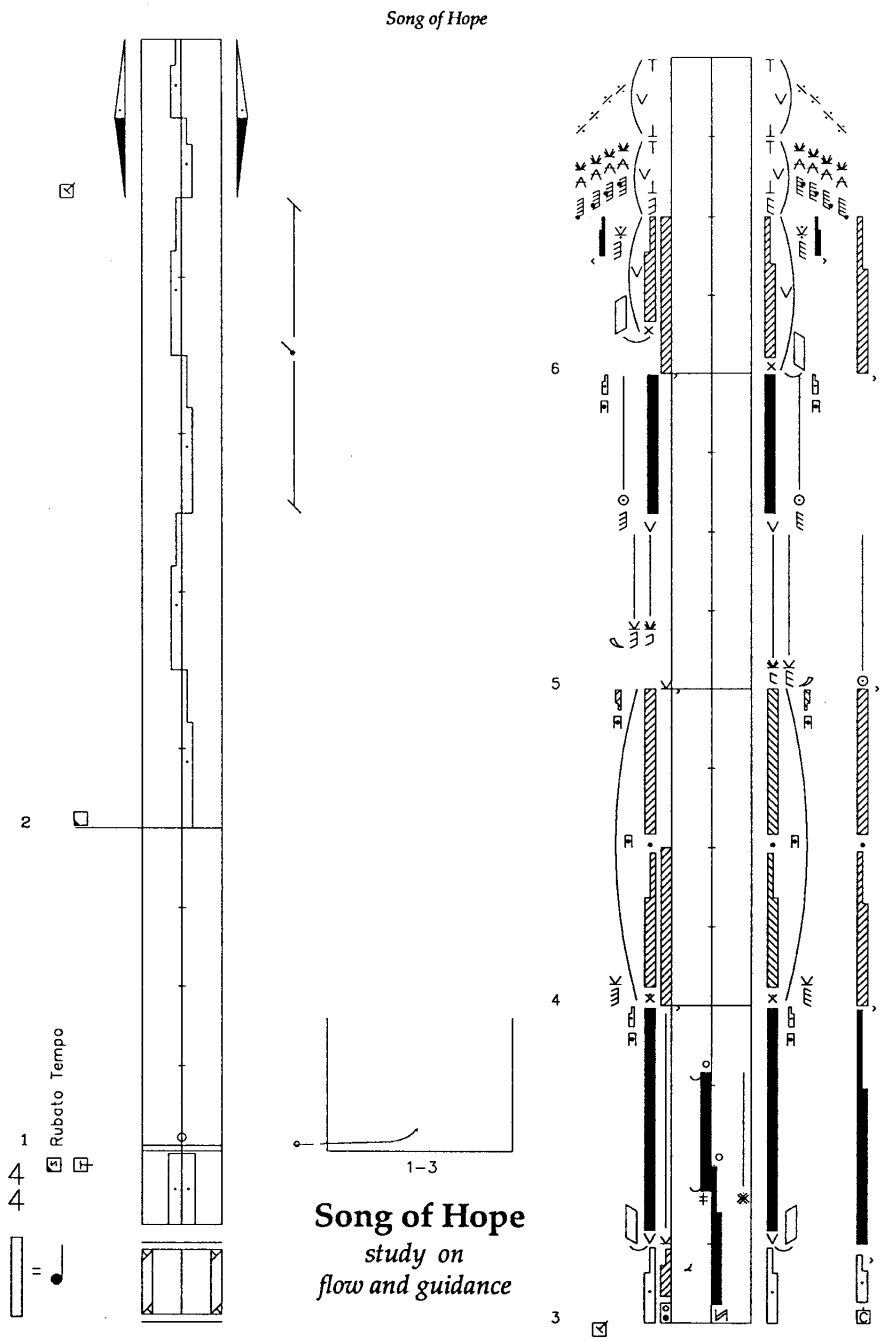
Labanotation comprises two kinds of symbols—those of constant size (pins, pre-signs, and space measurement signs) and those of variable length (directions, rotations, and pathways). Early efforts to computerize the drawing of Labanotation were made at the Moore School of Electrical Engineering in Philadelphia, at the University of Iowa, and by Elsie Dunin (*LC's LN*) at the University of California at Los Angeles. Two fully functional programs to print Labanotation, *Calaban* and *LabanWriter*, are described and illustrated on the following pages.

Programs for dance notation not based on Laban's system include two developed in Canada—the University of Waterloo's *MacBenesh*, using the left-to-right Benesh system, and Simon Fraser University's *Compose*, which uses stick figures—and one in England, *Kinotate*, a program for the BBC microcomputer developed at the Birmingham Polytechnic.

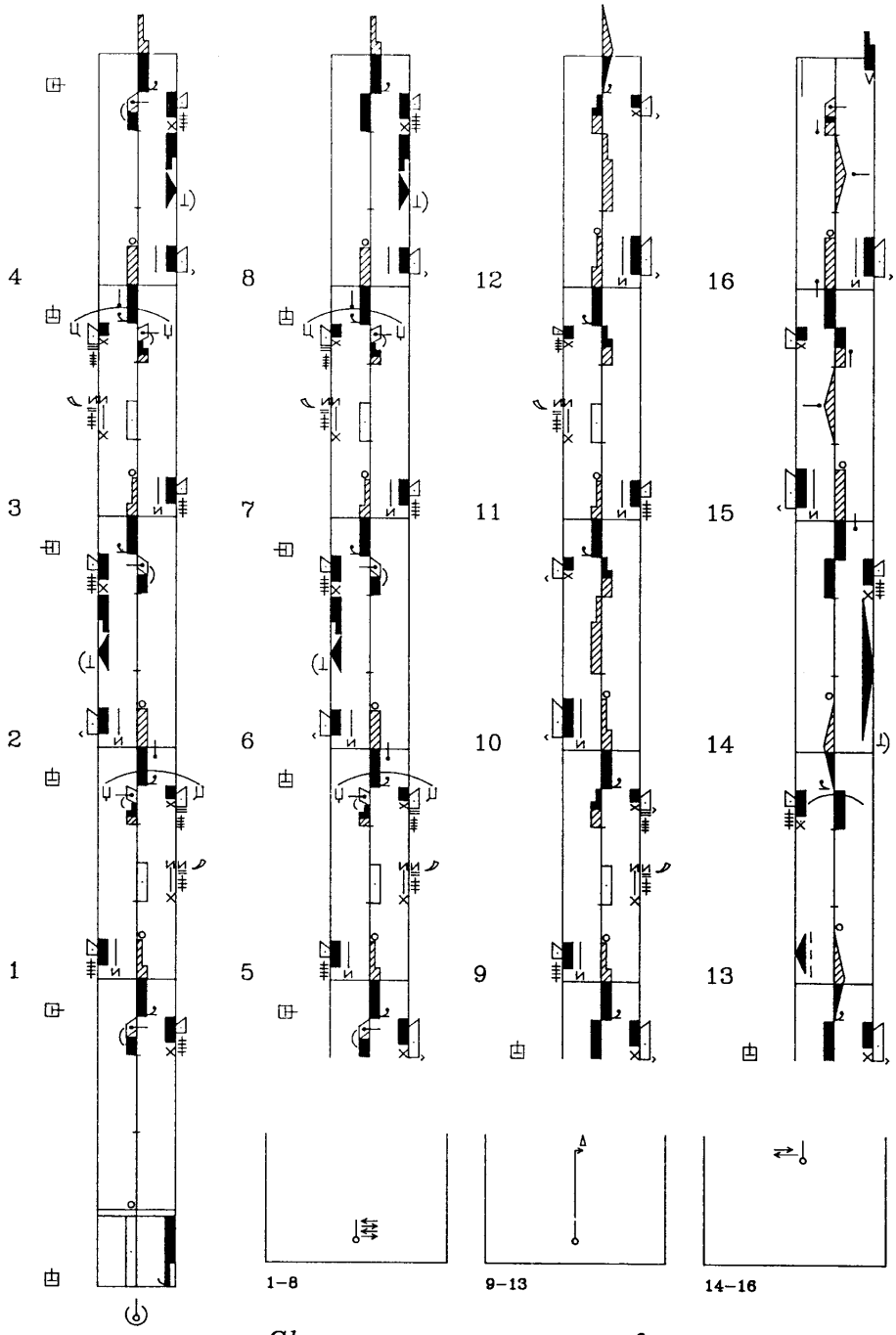
Calaban

Calaban, developed by Andy Adamson at the University of Birmingham (England), is a Labanotation implementation of computer-aided design. It is intended for professional choreographers and dance researchers. It runs on both IBM equipment with AutoCAD and on the Macintosh IIx. Information is entered into the computer with a digitizing tablet. This tablet is overlaid with a grid showing the location of the notation symbols, which are selected from a library of dance symbols in common usage. A personal library of frequently used movements may be defined to facilitate both the creation of scores and the structural analysis of stored works.

Final copy may be produced by a graphics plotter, a laser printer, or a phototypesetter. Commercial desktop publishing programs enable notation created with AutoCad to be integrated into larger documents. Scores of as many as 100 pages have been created using *Calaban*. Information on *Calaban* can be obtained from Andy Adamson, Department of Drama and Theatre Arts, The University of Birmingham, PO Box 363, Birmingham B15 2TT, UK (021-414-6005).



Labanotation for "Song of Hope" was produced by *Calaban* using a Macintosh IIx computer. The output from an Apple LaserWriter IINT.



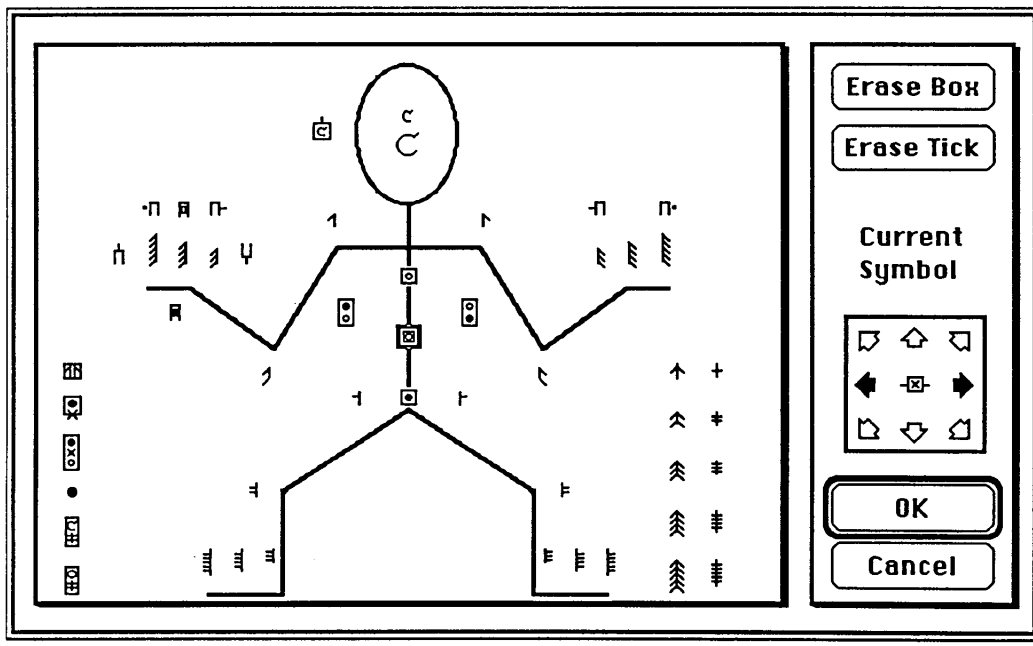
Labanotation for "Chaconne pour une femme" was created by *Calaban* using an IBM PC AT. The output is from liquid ink pens in a flatbed plotter.

LabanWriter

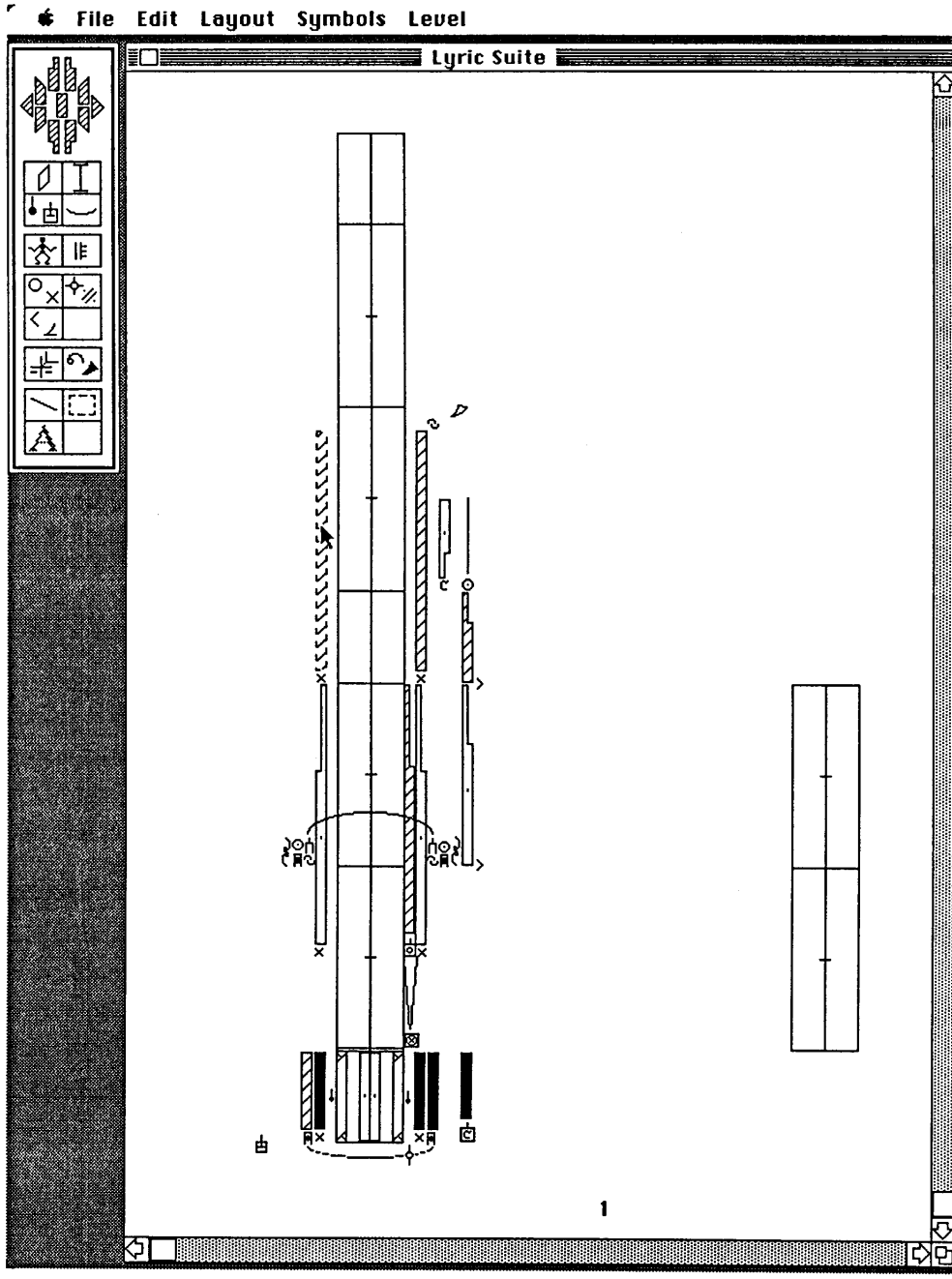
LabanWriter, which is described as a word processor for Labanotation, has been developed at the Ohio State University by George Karl and Scott Sutherland. Their work has been sponsored by the Dance Notation Bureau Extension, directed by Lucy Venable. The program runs on Apple Macintosh computers. More than 600 symbols provide references to moving parts of the body, types of movements, their directions, and durations. Users can also add symbols of their own. *LabanWriter* documents can be exported to painting, drawing and word processor files for further modification. The project, which was initiated in 1984, has received support from The Ohio State University, from the Department of Dance, and from the Andrew W. Mellon Foundation. The first score was produced in the spring of 1989.

The program has also been used in an anthropology project at Indiana University to record the sign language of the Plains Indians. If it follows in the path of manually drawn Labanotation, it may be used for notating gymnastics events, time-and-motion studies, animal behavior, physical therapy exercises, computer animation, and designs for robotics control.

LabanWriter is available without charge, with the provision that any copies made by users include both the manual and the software. For a small subscription fee, updates will be sent as they become available. For further information contact *LabanWriter*, Department of Dance, 1813 N. High St., Columbus, OH 43210.



Screen configuration of the figure palette, one of twelve menus available with *LabanWriter*.



A few measures of Anna Sokolow's *Lyric Suite* produced with *LabanWriter*.

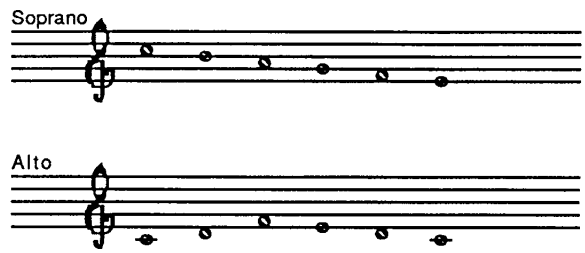
A directional symbol is being placed by the cursor on the staff. The main palette in the upper left corner includes the main directional symbols plus eleven buttons which bring up the other palettes as well as a line drawing tool, a text tool, and a selection box.

Software for Theory and Analysis

Classroom Software—Music Theory

Counterpoint

Palestrina introduces students to two-part counterpoint in first, second, and fourth species. It runs on the Macintosh. The program identifies modes, detects errors, and stores rules. Screen size limits the length of examples, and the choice of only whole and half notes limits the complexity of what can be created. *Palestrina* was developed at Dartmouth College (Hanover, NH 03755) by David E. Jones and John R. Meier and is distributed in the US by Kinko's.



Two-part counterpoint in first species created with *Palestrina*.

Ear Training

Practica Musica is an interactive drill-and-review ear-training and music-theory program for the Macintosh. Dictation exercises use selections from the entire history of music (in contrast to the computer-generated melodies used by some other ear-training programs). New material can be created by the user from a MIDI keyboard or an onscreen picture of a keyboard. *Practica Musica* is a commercial program from Ars Nova Software, PO Box 637, Kirkland, WA 98083; telephone (800) 445-4866.

Harmony

Harmony Coach by John William Schaffer (School of Music, 455 N. Park St., University of Wisconsin, Madison, WI 53706) allows students to classify harmonies into general chord classes and to structure "lower levels of information specific to distinctive

chord groups." It is written in Prolog for PC's and forms part of an *Intelligent Tutoring System* reflecting approaches currently popular in artificial intelligence research.

MacVoice helps music theory students write four-voice chorales according to practices of the seventeenth and eighteenth centuries. It was developed at Carnegie Mellon University by Marilyn Taft Thomas (Department of Music, Carnegie Mellon University, Pittsburgh, PA 15213) and others. It is distributed in the US by Kinko's Copy Shops.

Theory

Guido, developed by Fred Hofstetter on the PLATO system at the University of Delaware, includes lessons on intervals, melodies, chords, and rhythms. All are oriented towards use in ear training.

MacGamut by Ann Blombach teaches scales and other elements of music theory and analysis on the Macintosh. The program was originally designed to work with Ohio State University's Musicode 2. There is no synthesizer output. *MacGamut* is available from Mayfield Publishing Co., 1240 Villa St., Mountain View, CA 94041.

At Florida State University a broad range of music theory courseware is under development on Atari 1040 ST's. The intention is to use computer-based instructional materials, running on low-cost workstations, in all basic musicianship classes.

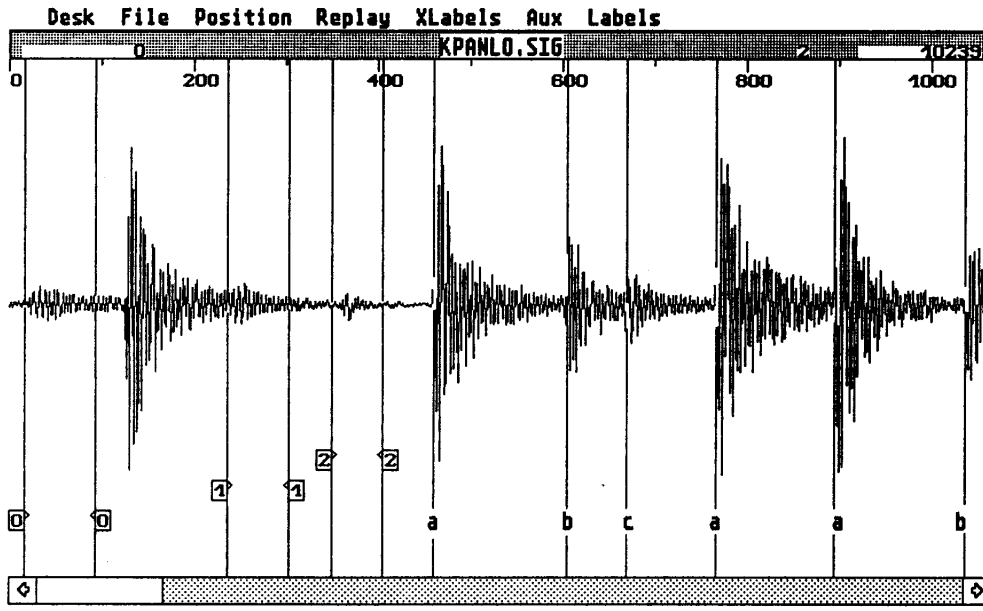
Sound Control and Analysis Software

CASE Sound Tools

Barry Eaglestone and others at the University of Bradford have been extending Computer Aided Software Engineering (CASE) tools to provide support for sound manipulation and synthetic musical instrument development (Computer Aided Sound Engineering). Their work is based on a Sun workstation running under UNIX. The INGRES relational database is used.

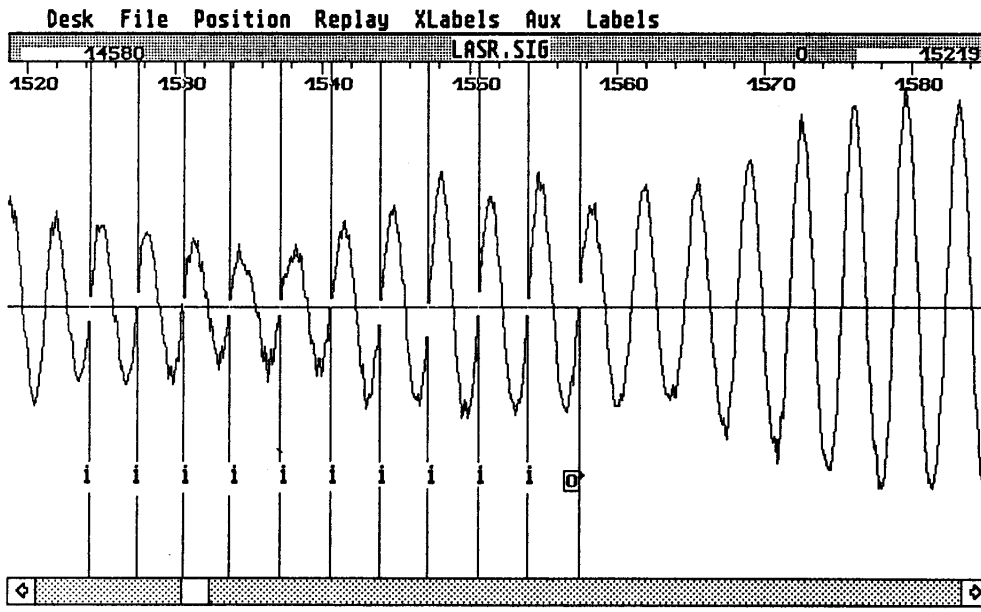
Sound Analysis

Johannes E. Philipp has developed an Interactive Signal Inspection System (ISIS) for the Atari ST. ISIS, which has been used in some ethnomusicological research, is designed to accommodated both music and speech. It provides segment labeling for pitch and duration measurement as well as rhythmic and phonetic transcription. It also provides an oscillogram display and digital-to-analog replay. Automatic pitch determination is intended. Illustrations are shown on the following page. The contact address is Beuzlen 6, D-7140 Ludwigsburg 11, Germany.



***ISIS:* Comparison of membranophone and ideophone played simultaneously.**

The left side of the window shows cursor pairs (0, 1, 2) defining segments for comparison. Here they reveal that the beats within the first two segments originate from the membranophone, while the one within the third segment is a soft ideophone beat. The right side of the window shows labels (a, b, c) providing the basis for calculations of duration from one tone onset to the next.



***ISIS:* Oscillogram for pitch determination.**

This oscillogram is zoomed to 1280 samples per window. It facilitates the labeling of period duration for pitch determination.

Bol Processor

Version 2 of the *Bol Processor* by Bernard Bel and Jim Kippen deals with "sound objects" that may be assigned metric and topological properties. These objects are defined from prototypes, *i.e.*, musical gestures captured by an instrument and represented as sequences of MIDI messages. It runs on the Macintosh under HyperCard, permitting users to adapt the interface to their own needs. An enhanced version of the algorithmic part of BP1 is written in C. *Bols* are quasi-onomatopoeic syllables used in Indian tabla drumming. The original version of the software enabled Kippen to study improvisatory techniques in this art form and ran on the Apple IIc.

Tunings and Temperaments

Tunings and Temperaments by Igor Popovic allows users to simulate historical tunings and temperaments on an IBM PC PS/2. Eight-channel sound is output. The developer is in the Department of Music, Yale University, 143 Elm St., New Haven, CT 06510 (POPIGOA@YALEVM).

Automatic Arrangement Software

Stephen Wu's thesis research at the University of Hong Kong [see p. 18] is oriented toward the automatic arrangement of popular song melodies. In its current phase, he is developing a deterministic algorithm for rhythmic segmentation of melodies. Wu defines the rhythmic pattern as a series of pulses of sounds and silences. The best fit of a rhythm to a melody is the pattern having the minimum distance with the melody. The distance is defined after writing out both the melody and the rhythmic pattern on a time axis: for every time unit, if there is an attack point at the melody but there is none at the rhythm, or if there is no attack point at the melody but there is one at the rhythm, the distance is increased by 1. When the whole melody has been processed, the distance would have been fully accumulated. Finding the rhythm that minimizes this distance is a major challenge.

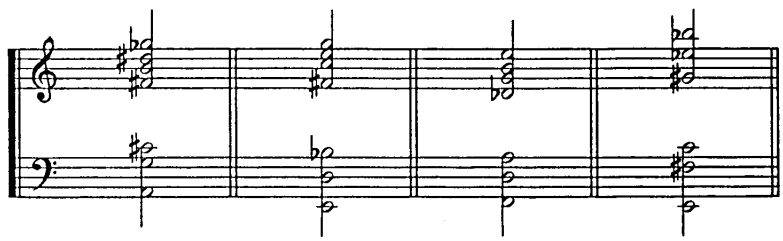
The melody is broken into two segments, to which different rhythms are assigned. These segments are checked to see if the break point is optimal and what the effect is on the overall distance. If the total distance is not optimal, this procedure becomes recursive until it is. The final rhythmic pattern is considered the best fit to the given melody.

After completing this project, Wu hopes to identify other problems of music arrangement that can be solved in a similar way.

Analysis Software

Chord Comparison

Larry J. Solomon's *Music Analysis System* software has an ever-growing range of capabilities oriented mainly towards music of the past century. The musical description is alphanumeric. The program identifies chords in the chromatic scale and tags them with set names and common chord names (when applicable). An example of its chord comparison capabilities, which include intervallic similarities, interval vector contents, and subset relations, is shown below. *MAS* also analyzes melodic series and tone rows. Input is by note name (C#, Db, etc.). A facility for MIDI input is under development.



Chord analysis by Solomon's *Music Analysis System.*

(1) Scriabin's "Prometheus" hexachord, or 6-34.
(2) Harmonic hexachord, or augmented eleventh (6-34B).
(3) Harmonic heptachord, or augmented thirteenth (7-34).

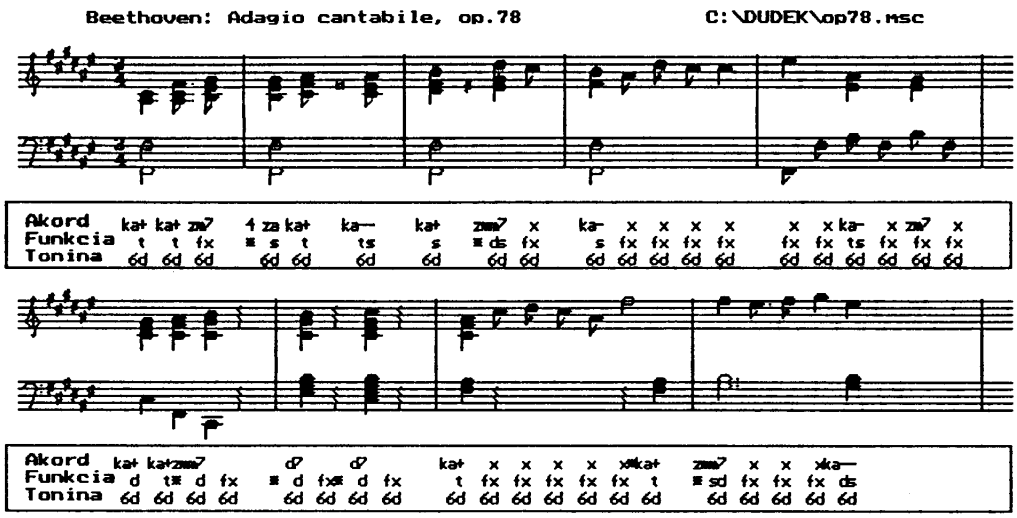
MAS can determine that (3) is a mirror-chord, that (4) is identical to (1) enharmonically, by transposition, that (1) and (2) are inversely related and are complements, and that (1), (2), and (4) are contained within (3).

An algorithm to implement Schenkerian analysis of voice-leading layers is now under development. Results can be printed with *MusicPrinter*. *MAS* is distributed by Soft Stuff Computer Co., 5122 North Tortolita Road, Tucson, AZ 85745.

Chordal/Tonal Analysis

The work of Eva Ferkova at the Czech Academy of Sciences goes well beyond chordal identification and analysis to probe such questions as how to determine starting and ending points of temporary modulation, how to discriminate between major and minor keys associated with the same key signature, and how to ascertain the contextual tonal function of a given chord. The main program considers harmonic activity on three levels—chordal, tonal, and functional. To identify temporary changes in tonality, local accidentals are tracked. The key signature can be changed by joining local accidentals to it. In evaluating chordal function in modulatory passages, the root of the current chord is compared with the root of the chord that follows.

The developers hope to extend the project to accept input from various devices and to facilitate conversion of their data format to ANSI standards. Recent programming in the project, in Turbo Pascal, has been contributed by Marian Dudek (Faculty of Mathematics and Physics, Comenius University, Bratislava). Ferkova's address is Ustav Hudobnej vedy SAV, Fajorovo nabrezie 7, 813 64 Bratislava, Czechoslovakia.



Chordal analysis of the opening movement of Beethoven's Piano Sonata Op. 78 from the project in Bratislava headed by Eva Ferkova.

Line 1 contains chord names. KA = triad; + = major; — = minor. D = dominant. Configurations are also indicated. Zm7 = 3-3-3. Zmm7 = 3-4-3. x = an ornamental tone. Line 2 contains names of tonal functions. Line 3 contains the name of the tonality. d = dur [major], m = mol [minor].

Melodic Comparison—Bevil

J. Marshall Bevil's *MelAnaly* software was originally developed in connection with a Ph.D. dissertation (North Texas State University, 1984) on British and American folk tunes. The core of the package is a menu-driven program, running on the Apple IIgs, that compares the arrays of two numerically encoded melodies in order to determine the kinship of the tunes to each other. Each melody is represented by two arrays. The first contains the codes for pitch, duration, and stress of the three-note motifs that open and close the coarse and fine strains of the melody. The second array contains pitch encoding of the complete melodic contour at three levels of details—elemental, broadly detailed, and specifically detailed. Analytical results can be displayed both graphically and

statistically. An example of graphic comparison was shown in the 1988 *Directory*, pp. 119. The contact address is 4614 W. 43rd Street, Houston, TX 77092.

Melodic Comparison—Burroughs

Alexander Brinkman's binomial representation system provides the foundation for Michael Burroughs' effort at Indiana University to devise a mathematical algorithm for melodic comparison. It is a depth-first search technique that matches principal tones while ignoring inconsequential ones. Inversions and transpositions of a designated melody may be identified through linear algebraic operations.

Set-Theoretic Analysis Software

CCARH receives many reports of set-theoretic analysis programs. At this writing we are aware of approximately two dozen of them. Although we have reported on these in previous years [see the *Cumulative Index* in last year's issue], we are reluctant to list new programs unless it can be demonstrated that they contain unique capabilities and that they work with encoded music, rather than purely numeric pitch descriptions.

Software for Modelling of Music Theory

Cognitive Theories of Harmony

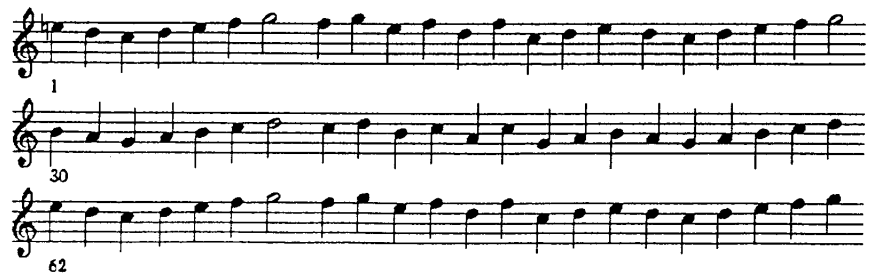
"New Cognitive Theories of Harmony Applied to Direct Manipulation Tools for Novices" by Simon Holland is available from the Open University as CITE Report No. 17 (1987) [address on p. 16].

Connectionist Models of Music Listening

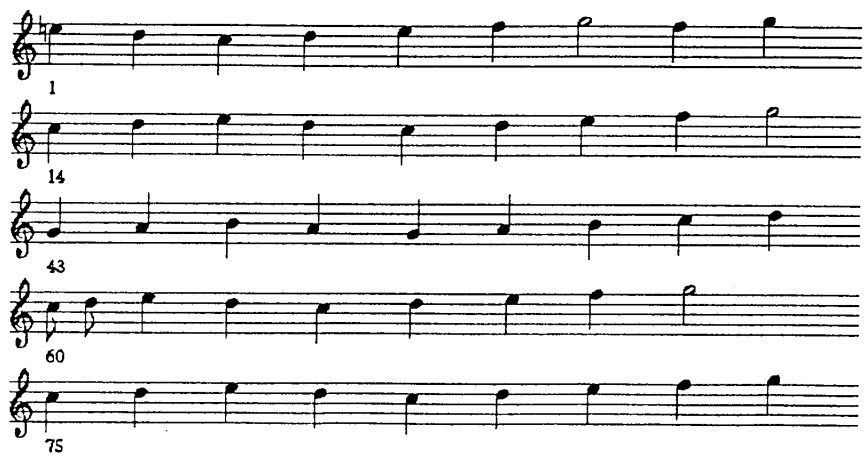
The research of Mauri Kaipainen is directed toward an overall view of the possibilities of modelling the cognitive perceptual skills of music listening within the connectionist framework. In its first stage, it is concerned with how cognition makes use of the repetitive structures of music, with how perceptual constancies are abstracted from the acoustic continuum, how the perceptual competence can be implemented, and what the nature of the learning processes along prolonged time-intervals is. The aim of the second stage is to build a self-organizing model that extracts significant features from digitized natural sound. Kaipainen is in the Department of Musicology, University of Helsinki, Vironkatu 1, 00170 Helsinki, Finland (kaipainen@FINUH.BITNET or in% Skaipainen@cc.helsinki.fiS).

Distributed Analysis

A program for distributed analysis of musical pieces, as proposed by Nicolas Ruwet, is under development at the Florence Conservatory by David Bencini, Michele Ignelzi, and Lelio Camilleri. This kind of analysis aims to define the formal or signifying unit (the longest unit used at least twice in a work) and its sub-units. These units acquire significance within a network of structural relationships. The user may define the parts of the signifying unit with which the analysis may be performed. The program can supply output in *SCORE* code.



The signifying unit and its repetitions in Schumann's *Canzone*.



Distributed analysis based on second half of signifying unit.

Evaluation of Predictive Theories

Darrell Conklin and Ian H. Witten are involved in an ongoing series of experiments to evaluate predictive theories of music. Initial attention is restricted to melody; testing is performed on a corpus of 100 Bach chorale melodies. Theories are evaluated by a data compression measure, which is believed to be a strong indicator of their predictive power. The entropy of the chorales is estimated by averaging the amount of compression given to a test set using a theory learned from a training set.

To date they have defined approximately 20 viewpoints, which make predictions based on duration, pitch, interval, contour, phrasing, and so forth. A distinction is made between theories that adapt to a class of sequences and those pertaining to a particular work. The authors may be contacted at the Department of Computer Science, University of Calgary, Calgary T2N 1N4, Canada.

Explication

Michael Kassler continues his research on explications of the theories of tonality proposed by A. F. C. Kollmann (1756-1828) and Heinrich Schenker. Programming is in APL on a Canon microcomputer, with output of notation files in Canon's printing system language, CaPSL [see the *1987 Directory*, p. 108]. Kassler reports that "the research differs from other projects in that it involves in-depth explication of historically important music theories rather than oversimplifications."

Fractals

In his research on modelling of compositional processes, Ioannis Zannos, who is now working at the University of Tokyo, is trying to bring a new, non-Western aesthetic perspective to the understanding of near-Eastern traditional music. In particular, he is examining the concepts of (1) fractals in relation to improvisation and (2) cellular automata in relation to the composition of polyphonic and polyrhythmic structures.

Grouping Structure

The first complete part of a Florence Conservatory expert system for music analysis is a program to implement the rules of musical grouping structures laid down by Lerdahl and Jackendoff. Current work carried out by Lelio Camilleri, Francesco Giomi, and Francesco Carreras is concerned with the development of an expert system for analytical discoveries of tonal harmonic analysis. It is based on segmentation into structurally significant time-spans at well-defined hierarchical levels. This phase of the work is being carried out in an MS DOS environment with the expert system shell *Intelligent Compiler*.

At the Open University's Institute of Educational Technology in the UK, M. Baker completed a study on "An Artificial Intelligence Approach to Musical Grouping Structure," which is available as CITE Report No. 34 [address given on p. 16].

Improvised Counterpoint

At the Massachusetts Institute of Technology Lincoln Laboratory, Timothy C. Aarset has developed, in C, a simulator of Renaissance instructions on modal counterpoint as they might have been applied in extemporaneous practice. The user may vary the rules, the order in which the rules are acquired, and the precedence of rules in cases of conflict. The musicological goal of the simulation is to demonstrate that Renaissance manuals on counterpoint contain a method for training musicians to improvise advanced florid counterpoint using the elements of hexachordal solmisation as encapsulated in the Guidonian hand. The simulation environment is based on "discrete event simulation of dynamic systems" rather than a rule-based expert system. The benefit outside Renaissance studies lies in showing how this approach can be applied generally to studies of musical processes.

Musical Intuition and Thinking

The recent work of Jeanne Bamberger in the Department of Music at the Massachusetts Institute of Technology has been especially concerned with student perception of musical structure in works from the standard repertory. Under the aegis of MIT's *Project Athena*, Bamberger developed a special language called MusicLogo, which is related to LISP. Because MIDI-compatible music primitives are incorporated, students have simultaneous access to as many as four voices, a wide selection of timbral "instrument" settings, and extensive procedural control of material. The students are given design constraints within which to work. The hardware environment, which includes four IBM PC AT's and ten Macintoshes, is complemented by a *Sourcebook* and an *Athena Music Workbook* written by Bamberger.

One way of working with this system is to listen to a piece of music, describe it procedurally, and then attempt to create a new piece of music conforming to the procedure. Overwhelmingly, students have found that there is a large gap between perceived procedure and a complete description and that even intellectually simple procedural descriptions can generate perceptually complex music.

In relation to the discovery that Vivaldi's music cannot be reduced to procedural generalization, Bamberger writes that the research "gives pause to notions of what the computer is and is not good for: Rather than a medium that can substitute for thinking, listening, and playing music on real musical instruments, or even make such activities easier, the computer becomes a medium through which to interrogate and challenge one's everyday knowledge so as to build on it. In this way the Lab serves not as a source of answers, but rather as an environment for moving towards a better understanding of how learning happens."

Style Simulation

Experiments in Musical Intelligence (EMI) is an ongoing research project conducted by David Cope at the University of California at Santa Cruz to simulate well defined musical styles of classical composers, twentieth-century styles, and certain ethnic repertories. The experiments are based on classical pattern-matching techniques used in artificial intelligence. Its working metaphor is linguistic: a rule-base structures the voicing constraints and new works are composed top-down. *EMI*'s working library includes simulated Bach two-part inventions, Mozart keyboard sonatas (one movement), Bartok *Mikrokosmos*, and Palestrina four-voice compositions.

Some of the factors considered in creating a stylistic profile are the maximum number of pitches allowed in a motive, the overall time length of a motive, constraints on melodic shape, level of dissonance, key shifts, and variation by augmentation, diminution, inversion, and ornamentation.

When a second work is analyzed and a subsequent image is overlaid on the first, those motives which significantly increase in number are considered to be the essence of the style of the composer. The locations of these motives, which are now called *signatures*, are noted for the framework of future compositions. Those that increase somewhat are considered *coercing agents*. The remaining material is considered local to each work and is discarded from the profile. Cope is currently writing a book on *Computers and Musical Style* for the A-R Digital Audio Series.

Theories of Musical Information

Number-Line Representations of Pitch

Walter B. Hewlett, the director of CCARH, will present a description of his system for representing the letter name, octave number, and accidental applied to a note as a single parameter, for use in the analysis of tonal music at the conference on Computers in Music Research in 1991.

An Object-Oriented Approach to Musical Information

Alan Marsden (The Queen's University, Belfast) probes the applicability of object-oriented data definitions to music-analytic applications in a forthcoming publication. In object-oriented programming, data types which are conceptually similar but technically different may be available for linked or hierarchically prioritized operations.

A Data Structure for Score Representation

John William Schaffer (University of Wisconsin) advocates the use of a data structure for score representation and analysis that takes advantage of Prolog's support for predicates and list structures in a talk scheduled for presentation to the Society of Music Theory in Oakland in November 1990.

Composition and Music Systems Software

APL for Music

APL for Music (an extension of the IBM mainframe language called A Programming Language) is a multifaceted computer music system under development by Stanley Jordan. It provides support for algorithmic composition, computer-assisted music instruction, granular synthesis, MIDI score editing, and music theory and analysis. A description of the system is included in the Association of Computing Machinery's *APL89 Conference Proceedings*, which is available from Jordan at 163 Third Ave., Ste. 143, New York, NY 10003, and as #554890 from the ACM Order Department, Waverly Press, PO Box 64145, Baltimore, MD 21264.

"Musical Syntactic and Semantic Structures in APL2" is the title of a paper by Jordan and Erik S. Friis scheduled to appeared in the ACM *APL90 Conference Proceedings*. The authors describe their system for using general arrays to represent syntactic information in the form of MIDI data streams and illustrate a semantic structure by defining a diatonic scale. Chords are created within the scale using the "each" operator. Copies may be requested from Friis, IBM Corp., Route 100, Somers, NY 10589.

The Composers' Desktop Project

The Composers' Desktop Project is an independent, non-profit limited company which is distinct from but closely in touch with York University. Enquiries may be addressed to Martin Atkins, Composers' Desktop Project Ltd., Unit 7, 35 Hospital Fields Rd., Fulford Industrial Estate, York YO1 4DZ, UK (44-904-613299) [see p. 128].

Keynote

Keynote is a UNIX-based programming language for manipulating and generating music with MIDI-compatible equipment. It was designed as an application-specific language and interactive shell by Tim Thompson at AT&T Bell Labs. Although support for algorithmic composition was a central goal, *Keynote* also serves as a utility for non-realtime and realtime data manipulation. Nested pop-up menus and operations of a graphical music editor have been implemented. The AT&T UNIX Toolchest contains source code for *Keynote*; binaries for the Macintosh and Amiga are also available. Modest licensing fees are charged for both the Toolchest and *Keynote*. A reference manual is

available from Thompson, AT&T Bell Labs, Room 3C-231, Crawford's Corner Road, Holmdel, NJ 07733 (tjt@twitch.att.com). A user group has recently been organized by Jon W. Backstrom, Applied Digital Arts, PO Box 176, Bloomington, IN 47401-0176 (media@silver.ucs.indiana.edu). A quarterly newsletter is available by subscription.

Music4C

Music4C is a sound synthesis and signal processing program in C for the Macintosh. It includes source code in THINK C and is available from Graeme Gerrard, Faculty of Music, University of Melbourne, Royal Parade, Parkville 3052, Australia.

Ravel

Ravel is an interpreted music programming language resembling C. It runs on the IBM PC/MPU-401. Data can be imported from MIDI files and from *Cakewalk*, a popular sequencer program. *Ravel* is in the public domain. Details of a jazz improvisation program written in the language are available from James Binkley, 5814 S. W. Taylor, Portland, OR 97221.

Symbolic Composer

Symbolic Composer, written in LISP, uses symbol and vector patterns to describe the elements of composition. The software makes it possible to use any information structure (for example, from astronomy or organic chemistry) as a seed to produce music. The basic idea of the software is total freedom of conversion between symbolic and numeric information.

Melodies, harmonies, velocities, lengths and "humanizing parameters" are described separately for each instrument. They may be constructed manually or with generators. Symbol generators are based on recursive association structures. There is also a Fibonacci string generator. The software runs on the Atari ST. It can also control three-dimensional objects and S-geometry animations on a Symbolics workstation. Resulting MIDI files can be used with *Masterscore*. A manual in English is currently in preparation. Further information and demonstration cassettes may be requested from Pekka Tolonen, Frederikinkatu 26 D 40, SF-00120 Helsinki, Finland.

Workstations and Integrated Projects

Berkeley: CNMAT

At the Center for New Music and Audio Technologies, a part of the University of California at Berkeley, Adrian Freed directs the program in New Media Resources for Music Scholarship and Education. One of the project's goals is to develop with readily available and affordable components workstations that serve music scholars. Conceived in a hypermedia environment, such systems would provide rapid access to suitably indexed audio materials, representations of notated music, text materials, and images.

In related work, Ben Brinner is developing an *Ethnomusicologist's Workbench* to aid in the exploration and characterization of recorded materials. This environment consists of tools for selecting, playing, viewing, editing, and transcribing segments of recorded performance. These tools are complemented by a signal processing library with procedures for pitch extraction, temporal segmentation, and separation of simultaneous sound sources.

Other avenues of research at CNMAT include projects in computer architectures for sound synthesis and research on music perception and cognition, especially in relation to traditional approaches to music theory and composition. In the first case, significant design work, under the direction of John Wawrzynek, has taken place for a Memory Intensive Music Integrated Circuit (MIMIC). David Wessel heads the effort in cognition and perception and is research director of the Center. Richard Felciano is the general director of CNMAT. Enquiries may be addressed to any of the above at 1750 Arch St., Berkeley, CA 94720.

Boston University

Otto Laske proposes that a musicological workstation linking an interactive music environment, an automated composition module, and tools for modelling musical knowledge acquisition should be developed. Ideally it would provide hypermedia facilities for using notated scores in modelling knowledge and would permit musical sounds to become part of the material for modelling by using video disk. He encourage readers interested in such a project to contact him at 926 Greendale Avenue, Needham, MA 02191 (laske@bu-cs.bu.edu or 617-449-0781).

Florence Conservatory

The Teletau system of musical encoding, processing, and playback developed in the 1970's and early 80's on mainframe computers at C.N.U.C.E. in Pisa is currently being adapted to the MS DOS environment under the direction of Lelio Camilleri at the Florence Conservatory in cooperation with I.R.O.E., another institute of the Centro Nazionale di Ricerca in Pisa.

The aim of this project is to provide a musical workstation with all the flexible features of the original Teletau system in combination with conversion routines to commercially available software for microcomputers. Micro-Teletau will provide programs for encoding, processing, and playback (eight-voice polyphony), a library of encoded pieces, and transcoding support for the creation of *SCORE* print files. Because of the absence of a graphical interface, support for blind and visually limited users is intended. The software development work is being carried out by Camilleri, Francesco Giomi, Paolo Graziani, and Lucia Taggi, with a view towards completion by the end of 1990.

Milan: LIM

The research coordinated by Goffredo Haus on the development of an *Intelligent Music Workstation* is carried out at the Laboratorio di Informatica Musicale at the University of Milan. Including collaborators from the artificial intelligence and music labs at the Universities of Genoa (D.I.S.T.) and Padua (C.S.C.), there are now ten researchers and 20 graduate students working on various aspects of the project. The goal of the project is to design and develop a musical software and hardware environment in which commercially available products can be integrated with prototypical modules built within the context of musical informatics research. Funding has been provided by the Italian National Research Council through the end of 1992.

The *Intelligent Music Workstation* is an open environment, so that musicians can add their own applications. Most modules run on the Macintosh family of computers. All software modules are able to import and export standard MIDI files in three available formats. Sound files are compatible with the Digidesign Sound Designer format. A HyperText interface is provided.

Modules currently in preparation provide such capabilities as the following:

- Editing and synthesis of sound samples
- Hybrid environments for knowledge representations based on Petri nets
- HyperText retrieval of sampled sounds in a 7000-item data base
- An expert system for piano-bar-like improvisation
- Musical object segmentation routines for fugue and sonata form
- Audiovisual performance combining MIDI processes with automatic generation of Escher-like tessellations

No coding format for the symbolic level of information has been adopted yet, but serious attention is being given to ANSI *SMDL* [see *Technical Standards*].

Most of the modules will be available free of charge, for academic use only, at the end of 1992. Those interested may contact the director at L.I.M., Dipartimento di Scienze dell'Informazione, Università degli Studi, via Moretto da Brescia 9, I-20133 Milan, Italy (MUSIC@IMISIAM.BITNET).

University of Amsterdam

In the Center for Experimental Music at the University of Amsterdam a broad range of applications is being supported with a diverse array of commercial hardware and software. Macintosh computers are being used for MIDI applications; printing applications are carried out with *Finale*. Atari Mega ST's are being used for more elaborate projects, sometimes involving the Composers' Desktop system [see p. 123], to run *CSound*, *CMusic*, and the *Phase Vocoder*. For general musicological applications the *Note Processor* is being used on IBM PC's.

Three dissertations in the department relate to experimental music. One, recently completed by Christiane ten Hoopen, concerns form and structure in electroacoustic music. One on voice synthesis will include a survey of current systems and potential applications in this area. Another concerns simulation of formalized systems, including those of Xenakis, and interactive improvisation. Leigh Landy directs the Center, which is located at Spuistraat 134, 1012 VB Amsterdam, The Netherlands (LSNDY@ALF.LET.UVA.NL). Leo Plenckers supervises applications in historical and ethnomusicology.

University of Wisconsin

The *Composer's Studio* project at the University of Wisconsin involves the integration of a variety of software to provide a flexible working environment for a composer on a NeXT workstation. The facilities available will include notation and audio synthesis as well as a framework for the representation of manipulation of compositional information at a variety of hierarchical and theoretical levels. Currently a model for the representation of musical knowledge is under development; a note-list approach has been deemed inadequate. Stephen Dembski (School of Music, University of Wisconsin, 455 N. Park St., Madison, WI 53706) directs the project. Edith Epstein, a doctoral student in Computer Science, is his assistant.