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# Electronic Information and Applications in Musicology and Music Theory

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## ABSTRACT

IN THE FIELD OF MUSIC, the impact of electronic information goes beyond research on music and writings about music to the processes of creating, notating, printing, performing, and recording music. The overview of electronic publications and information resources selectively covers: (1) bibliographic citations of books, articles, scores, and sound recordings; (2) electronic network resources; (3) databases, some with music incipits or complete scores in image or sound or both; (4) music laboratory environments; and (5) commercial multimedia products.

## INTRODUCTION

Both the scholarly study of already existing music and the creation and performance of new music are being transformed by the proliferation of electronic music information hardware and software. The nature of the music curriculum and the music library that supports that curriculum undergo continuing revision as the boundaries of both what is studied and how such study is accomplished are redefined. The latest manifestations of that revision are accompanied by electronic resources that suggest a fundamental reexamination of the relationship of the student, scholar, music department, and library. A diminished relative importance of local resources comes with easy, efficient, and inexpensive access to equally important outside resources. To the roles of librarians as collectors, catalogers, and servers of information comes a new role of provider

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LIBRARY TRENDS, Vol. 40, No. 4, Spring 1992, pp. 756-80

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of hardware and software interfaces that link users to outside information and allow them to process it, and a new key role of educating users themselves to access invisible resources. The relationship of the library to what is outside of it—in laboratories of the music department; laboratories of other departments; centralized campus installations; or regional, state, national, and international networks—has begun to transform former concepts of what the library is for, what librarians do and what they should and can do (Dougherty & Hughes, 1990, pp. 10-18; Woodsworth, 1991). Scholars and students of music who have grown up with the computer go to the libraries and networks with great expectations of access to the world of scholarship and with the knowledge of the ability of that world to accommodate research results and pedagogical tools that use the full range of resources available. Fulfillment of such expectations has been the goal of music libraries in the past and this full utilization of resources in and outside the library will continue in the future.

Today's scholars in musicology and music theory require a variety of information formats. There are those who find materials for research on their own shelves and manage to exchange information orally with those in the world whose ideas are important to them. At the opposite end are those who find or create their research materials on the computer and constantly use electronic communication to seek those in the world who can stimulate their thinking. In between are the mass who wish to exploit all kinds of information—oral, printed, and digital. None is content with what is in the local library; scholars never have been. Electronic information processing promises to serve these users by abbreviating those years of productive life spent in the search for, and study of, music and writings about music.

Even greater change is taking place as the computer affects the processes of creating, notating, printing, performing, and recording music. In a recent article on computers and music, David Crawford (1991) pointed out that the artistic, educational, and social issues surrounding computerized performance and composition are especially controversial, though they are nevertheless the issues which grip the campus, the training of children, and the music around us (p. 35). As computer workstations acquire the capability of displaying notation, analyzing it, printing it, playing it, and interfacing with electronic musical instruments, they provide composers, performers, and researchers with an attractive and relatively inexpensive tool for such activities as composing and storing music. Educators use workstations to follow the individual performance of a room of electronic instrument novices; train students in melodic memory, pitch, and rhythm; teach paleography by inputting transcriptions, listening

to the resulting polyphony, and printing in a variety of notations. Listening and composition laboratories become interactive multimedia experiences as scores and structure are displayed on the monitor, high quality speakers produce sound, and computer keyboards are used by students to control activities and learning levels. Instructors, students, departments, libraries, and campuses have purchased hardware and software individually or through committees. No matter where computers for music are located, careful decisions on operating platforms, software, and output to systems and printers will take into consideration issues of electronic music information that go beyond the local laboratory. It is likely that the hardware and software used for music research, teaching, composition, and performance is the same that will be needed in the future to serve electronic music information to users on networks and in libraries.

The overview of electronic information and applications in music that follows surveys selected publications and information resources in several categories and summarizes major issues in providing that information. It begins with bibliographic citations of books, articles, scores, and sound recordings, an area of astounding growth in recent years that has transformed all levels of research from that of the beginning high school student to that of the most advanced researcher in need of up-to-date citations. Next, consideration is given to the resources of Bitnet and the Internet for professional communication via electronic mail, LISTSERVs, and networked databases. Even more selective is the introduction to music databases, some with text, some with incipits or complete music scores in digital searchable form or in images, some with sound incipits or complete works. A brief section reviews computer music laboratory environments and the variety of alternatives being utilized on campuses today. A final section looks at electronic multimedia commercial products, probable precursors of normal scholarly publications of the future. Major issues that arise in providing that information involve the role of the music and general libraries and librarians and their relationship to: (1) the computer laboratory and computer networks in providing music information; (2) accessibility; (3) the nature of service to electronic end-users; (4) the future of music printing and publishing; and (5) the position of music in relation to the developing importance of multimedia art forms and interdisciplinary research strategies, a position that already makes an isolated chapter on music an impossible challenge.

#### BIBLIOGRAPHIC CITATIONS

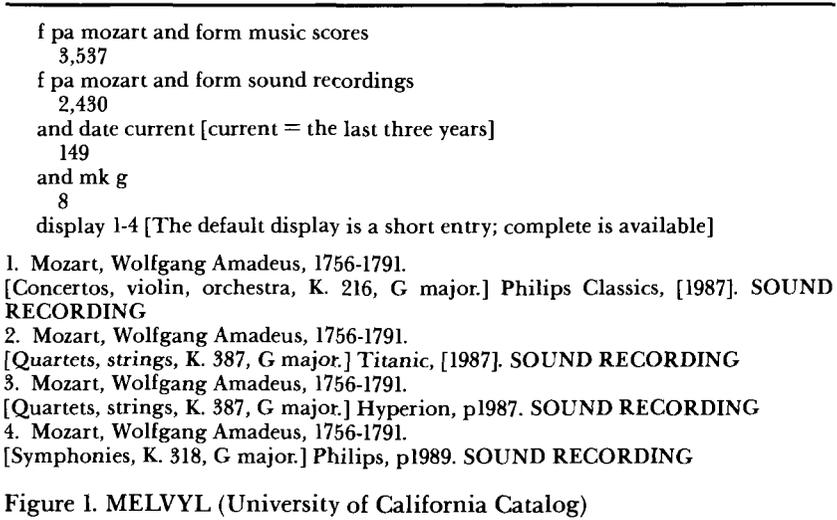
A pervasive and transformational electronic tool in music, as in other research areas, is the online library catalog of records in a standard MARC format, grown over the years to include large

numbers of music scores and sound recordings deliverable to the personal workstation. It epitomizes the positive aspects of electronic information since it is prepared by professionals in standard format, constantly updated, accessible in sophisticated interfaces for the novice, and provided through networks at no cost to users. A good online catalog provides access to high quality and detailed information through fields never searchable in drawers of cards (for example, by date or language) and allows Boolean combinations of fields that narrow results to a precise goal. Despite the amalgamation into centralized catalogs of music scores and sound recordings formerly housed in separate drawers in the music library, music materials can again be isolated by the use of appropriate command language (search by "form music scores" or "form sound recordings" as well as the newer electronic formats, "form databases" or "form CD-ROM"). By providing special search capabilities unique to music—key, music publisher, thematic catalog numbers such as Köchel numbers for Mozart, personal name for performers, corporate name for performing groups, highly refined subject access—online catalogs have become the best available bibliographies of many composers, performers, genres, and so on. For example, begun in 1977, MELVYL is the catalog of the books, periodicals, scores, sound recordings, and other materials of the nine University of California campuses plus periodical holdings at California State University, California State Library, Stanford, University of Southern California, The Getty Center for the History of Art and the Humanities, and the Center for Research Libraries (as of October 1990, 6 million book titles and 800,000 periodical titles). A sample search of music materials uses form commands to isolate the field and the special index of key (mk); others available include music publisher (mp) and thematic catalog number (thematic K. 318).

With the assistance of federal funding, retrospective conversion of card catalogs has made it possible for some music collections to put their entire holdings into catalogs. Cables that network campus buildings allow individual users in offices or dormitories to have instant access to catalogs through their personal computer. Modem and a password provides access to general users; in addition, international access is provided free to the academic community through Internet. MELVYL was found to be the most used library catalog on Internet, a compliment to the designers of the friendly user interface.

Several national projects have issued electronic music information on CD-ROM. For access to musical scores, the British Library published its printed music catalog up to 1980 in paper, but the supplement to 1990 has appeared on CD-ROM (*CPM Plus*,

Bowker/Saur, 1991) where it can be searched by composer, title, keyword, publisher, place and date of publication, publisher or plate number, and series title. It can be updated by *CPM Plus* (see later discussion). Other CD-ROM products for coverage of British holdings include printed books in the *British Library Catalogue of Printed Books to 1975*, and *BNB on CD-ROM* (British National Bibliography from 1950 to present on two disks, over 1,200,000 records). A search of music truncated ("music#") in the *BNB on CD-ROM* to October 1991 retrieved 10,163 titles. The British Library CD-ROM can be updated by online access by subscription to Blaise (a search of "1977-", retrieves 22,000 records on "music"). The same software is used for the CD-ROM catalogs of the Bibliothèque Nationale of France and the Deutsche Bibliothek of Germany. The *Music Catalogue of the Netherlands* (MCN MUSICROM) contains cataloging for 200,000 printed scores in libraries of that country.



While it may seem trivial to have begun an article on electronic information for music with online bibliographic catalogs, it is the genre which offers the most in the immediate future as the goals of international bibliographic coverage are realized. Though it is often easier for librarians to use the larger bibliographic utilities to which they, as professionals, have access as a privilege of their position, they can as well become skilled users of Internet resources in order to instruct users in resources that are free to workstation users, make current directories of the library catalogs available, and

describe the relevance of holdings for music researchers. Over 250 library catalogs, including some forty academic and research library catalogs of the United Kingdom, available through a gateway to JANET (Joint Academic Network), the centrally funded academic network in the United Kingdom, are available to users of Internet (Farley, 1991). The MARC records of the catalog of the Library of Congress are now accessible to specified libraries in the United States. With initial funding in place for NREN (National Research and Education Network), a broadband national network that will allow rapid transmission of full text, image, and sound files, national network services promise to grow. Similar developments are taking place across the globe (Dierickx, 1990, pp. 97-103) that will affect access to electronic information in all categories.

Very large files of music records are held by the bibliographic utilities OCLC and RLIN (Research Libraries Information Network). Developed as tools for catalogers, the databases are usually accessed by librarians at special workstations by contract with the utilities, although it is now possible for any user to acquire a password and, for a fee, search OCLC or RLIN through Internet (see Figure 2).

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OCLC 24 million records, 606,156 scores, 719,020 sound recordings (1992)  
 EPIC, with public access interface; First Search  
 CAT-CD450, entire database on CD-ROM (annual subscription), including two  
 CDs of music scores and sound recordings (1,000,000 items)  
*Music Library*, CD-ROM (now published by Silver Platter, annual subscription)  
 containing more than 408,000 records for musical sound recordings  
 RLIN 12,000,000 books, 1,200,000 serials, 430,000 scores, 200,000 sound recordings  
 (1990)

Figure 2. Databases available on OCLC and RLIN

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Both utilities have been the beneficiaries of large bodies of music records from retrospective conversion projects (jazz recordings, librettos, sheet music, etc.). Music was a participant in the development of the RLG (Research Libraries Group) conspectus to describe, through the LC classification system, the level of comprehensiveness at which an institution collects materials in a given subject area. The widespread application of the conspectus to record conversion within the research library community brought much music into RLIN and OCLC, though not always with the comprehensiveness intended (Hewitt & Shipman, 1987; Farrell & Reed-Scott, 1989). As regional and national databases and networks increase access to freely shared information resources, the role of the utilities as national suppliers of bibliographic information is undergoing revision.

While indexes of periodical and newspaper articles have not traditionally formed a significant part of American library catalogs, online catalog vendors have begun to offer users integrated access to their own indexes (CARL [Colorado Alliance of Research Libraries]) or to other commercial databases (*Current Contents*, *ERIC*, *InfoTrac*, *Academic Index* including six months of the *New York Times*, the H. W. Wilson indexes including *Humanities Index* [reviewed with music examples in Tseng & Dixon, 1990, pp. 94-115]), ISI's citation indexes including *Arts and Humanities Search*, and *Newspaper Index*, covering a wide body of music titles. In 1991, the two following music indexes moved to a CD-ROM format to offer electronic access on music library PCs to a focused music user group, on many campuses putting themselves in competition with coverage that had been contracted for on the campus network.

The *Music Index on CD-ROM* (Chadwyck-Healey, annual subscription) covers material from 1981 to 1988 gathered from about 350 journals, primarily English language. Citations include illustrations, biographies, portraits, etc., although indexing is limited to words in four fields: subject (index heading), subject subdivision (index subhead), title/author, periodical title. Since titles and authors are entered in the same field, it is not currently possible to search a "surname, first name." Boolean searching is possible, but a search of "J? Nelson" in the title/author field would retrieve any word beginning with J and Nelson. One can search a surname and browse an index of all words in the title/author field which includes surnames with first names (Nelson, J.; Nelson, Judy; Nelson, Judith). Searches are discarded after use; a search strategy may be saved in a named file. Records may be output as word processing files (for example, WordStar, ASCII) or as database files (for example, dBASEIII[+], Lotus).

The CD-ROM *MUSE* (MUSIC SEARCH, NISC, annual subscription) contains the complete RILM Abstracts of Music Literature, over 100,000 records from 1970-1984, covering books, journals, newsletters, conference proceedings, catalogs, dissertations, and reports of government and international bodies. Indexing by an international thesaurus of terms is available in print in seventeen languages. A publication developed from the start for online access but the least used of DIALOG's humanities databases, RILM on CD-ROM could at last bring electronic access to music scholars. The publication is trying to make coverage more current, a constant struggle with the international corps of volunteers who collect citations and write the abstracts.

Because of RILM's lack of currency, electronic means are useful as a way of supplementing its coverage. *Syntagma Musicum* is an

electronic file of recently published musicological articles based in Turin, Italy, that permits users to type in messages to other users and input information of their own (*CiM*, 1990, p. 136). Coverage so current that it may beat the actual issues to library shelves is found in *Current Contents* and *Arts and Humanities Search* (ISI, available online on some campuses or from DIALOG and BRS) for seventy-seven of RILM's periodical titles (listed in Duggan, 1990, pp. 5-6) though only with keyword access and without abstracts. Many libraries now subscribe to an electronic periodical index that covers some music journals (*Academic Index*, Information Access, eighteen titles; *Humanities Index*, H. W. Wilson, fifteen music titles). Music dissertations with abstracts are included in the more current *Dissertation Abstracts* (UMI, online or CD-ROM). Current coverage of new books and conference proceedings can be found on CD-ROM through the following commercial in-print literature:

*Books In Print* (Bowker), or *Books In Print Plus*, with reviews. 840,000 books plus 40,000 from the BIP supplement and 85,000 from Forthcoming Books. Updated bimonthly with 10,000 titles. Lists 9,980 titles under the keyword "Music" (1990).

*British National Bibliography*. Over 1 million books published in Britain since 1950.

*Deutsche Bibliographie-CD-ROM* (Buchhändler-Vereinigung GmbH). Over 450,000 books published in Germany since 1986.

*Alice-CD* (Alcor). Over 240,000 books published in Italy.

*Bibliographie Nationale Française depuis 1975 sur CD-ROM*. Over 380,000 books published in France since 1975.

While not yet electronic in publication format, *The MPA Printed Music Catalogue on Microfiche* has been prepared by the Music Publishers' Association with the capacity and currency of the computer. Already up to 240,000 entries on title and composer fiches, the catalog contains entries for printed music currently available for sale through United Kingdom publishers and distributors. Updated twice a year, the catalog will retain titles which are no longer available, adding the reference O/P.

Representation of sound recordings in the bibliographic universe has been greatly increased by online library catalog coverage as evidenced by the OCLC *Music Library* CD-ROM (Silver Platter, 408,000 recordings). A 1991 entry in the field is the *Billboard/Phonolog Music Reference Library* (BPI Communications, Inc., annual subscription with quarterly updates), a CD-ROM containing entries for over 1 million songs and over 80,000 record albums of "classical, country, pop, rock, jazz or any form of music in-between." Long popular in libraries as the Phonolog looseleaf service, the

electronic format allows searching of ten fields plus Boolean and keyword searching. Future issues promise *Billboard* chart data and reviews. Another CD-ROM, *CD Guide* (Audio Compact-Discs, annual subscription, updated quarterly), contains entries for over 40,000 recordings, 5,000 of which include reviews from the journal of the same name. Audio samples of a few titles seem to be all that are possible due to copyright restrictions and the constraints of the optical medium. Directed at marketing, each entry includes title, artist(s), number of disks, ADD/DDD etc., ref., running time and track information, year of recording, and release and performance quality ratings by professional reviewers. The obvious advantage to users of sound samples in sound recordings citations was recognized by Bowker in their CD-ROM *Music Directory Plus* announced for 1990 but was postponed as negotiations with ASCAP (The American Society of Composers, Authors, and Publishers) and its British counterpart continued. In a paper given at the IAML (International Association of Music Libraries) conference in Boulogne, 8-13 July 1990, this author demonstrated one hardware and software package for the creation of a local sound catalog of CDs (Duggan, 1991, pp. 74-75), a logical extension of the digital information of the current CD catalogs. With better compression techniques for storage, broad band networks for transmission, and standards for multimedia, distribution of MARC records with images and sound should become common (see multimedia discussed later).

## NETWORK RESOURCES

For many campus scholars, the freely distributed network resources on Bitnet and Internet are changing the way they communicate (Kalin, 1991; Arms, 1990). Informal and uncontrolled at some levels, filtered in both content and participants at others, such resources include person-to-person electronic mail, free-wheeling bulletin boards, electronic discussion lists (LISTSERVs) for particular subject areas with monitored messages, edited electronic newsletters and journals, and full-text complete files. Music users can join interdisciplinary discussion groups such as HUMANIST, HISTORY, or Women's Studies, or join thriving music lists such as MLA-L (Music Library Association) and NOTMUS-L (Notis Music Library List). *EthnoForum* is another well archived and indexed discussion digest on work in ethnomusicology (EthnoForum, ongoing). The Society for Music Theory Network (1991) began a discussion group in spring 1991 and the International Musicological Society's Study Group on Musical Data and Computer Applications is currently seeking to establish a group based at the University of Oslo (Vollsnes, ongoing). An early music discussion group provides news on records, books, musical events, etc. (*EARLYM-L*, ongoing).

Electronic journals for music have also begun to appear. An early entry was *Musicus: Computer Applications in Music Education* (*Musicus*, 1989 and ongoing), which was reviewed in MRD, February 3, 1991. MRD (*Music Research Digest*) provides current access to music software information (MRD, ongoing). HUMBUL, the Humanities Bulletin serving United Kingdom universities on JANET, posts announcements on symposia, grants, publications, and positions (HUMBUL, ongoing). Major problems of access and communications standards have kept many from taking advantage of these resources, but changes under way promise to simplify use and enlarge capability.

Internet is a group of connected networks that share a common network protocol (TCP/IP) and, in the United States, communicate over a high-speed network called NSFNET that in 1989 connected 346 separate computer networks. Legislation for NREN (National Research and Education Network), passed by both the U.S. House and Senate, would move scholarly communication to a broadband network capable of carrying immense files including images and sounds, making possible the electronic equivalent of a "virtual" library that could offer full score and sound files to music users (Cline, 1990, p. 30). Since Internet is not governed by a central agency, no one body has responsibility for providing directories of users' numbers or lists of resources. Access to its information has relied on the efforts of dedicated individuals, and it is difficult to know who is available on Internet, what is available, and how to use it. Provision of directories and indexes must deal with the three standards relating to finding or accessing information on a network. First is the ANSI/ISO Z39.2 standard which is used by most automated library systems for the exchange of US MARC records. Another is the information retrieval protocol Z39.50 standard, developed during the Linked Systems Project for communication between the Library of Congress and the major bibliographic utilities, "which enabled a requesting computer to 1) request that the responding computer search a specified database and identify records which meet the specified criteria, and 2) request transmission of, and receive some or all of the identified records..." (McGill, 1989, p. 29). The third standard, X.500, developed in Europe by the International Telegraph and Telephone Consultative Committee, provides a mechanism for describing objects associated with a network such as people, organizations, distribution lists, applications, and network hardware. Both Z39.50 and X.500 conform to the standards of Open System Interconnect (OSI) now being developed by the International Standards Organization for intersystem and internetwork communication. Efforts to use these standards to create tools for access on Internet include the use of MARC data elements for describing resources (Dalton, 1991, Figure 1)

and X.500 standards for user directory information (Dalton, 1991, Figure 2). A prototype project of the University of California uses existing standards and provides access within institutional library catalogs. Alternatively, a front end Z39.50 application (Brewster Kahle of Thinking Machines Corporation) puts the software on Internet but allows code to be downloaded so that searches are processed on a personal workstation rather than burdening Internet.

Some have refused to wait for the creation of optimal access tools. The New York State Education and Research Network (NYSERNet) has already implemented an X.500 directory of system users as has Merit, a network linking eight state-supported Michigan universities. The *Internet-Accessible Library and Database Catalog* lists accessible online public access catalogs and information on how to reach them (St. George & Larsen, 1990- ). Since there is little online assistance to novice users, a committee of librarians has developed a useful guide to these resources (Farley, 1991). An Association of Research Libraries publication brings Strangelove's *Directory of Electronic Journals and Newsletters* and Kovacs's *Directories of Academic E-Mail Conferences* into a directory of United States and Canadian sources (*Directory*, 1991). Items related to music are listed under the broad discipline "Social Sciences and Humanities" and also listed alphabetically by title in the index. Meckler promises a directory of directories on Internet (Metz, 1992).

In addition to the standards for access to text on networks, work is going forward to allow network access to music notation and sound encoded digitally. Currently several systems of encoding are in use, some of which can be used with software for music analysis. All systems can produce printed output, and some can produce sound (for a discussion of available systems and software, see recent issues of *CiM*). In 1987, the Standard MIDI (Musical Instrument Digital Interface) File format (ANSI X3VI.8M/88-6) was adopted to enable communications between electronic instruments and microcomputers (*CiM*, 1990, pp. 51-53). Computer workstations are now equipped for MIDI output or can be upgraded with boards for doing so. In addition, standardization of communication between the proliferation of encoding systems for music notation and other software is moving forward. The American National Standards Institute Committee on Musical Information Processing (MIPS) hoped to issue a first draft of a proposed national Standard Music Description Language (SMDL) in 1991 (Newcomb, 1991, pp. 76-79). OMR (Optical Music Recognition) (Carter & Bacon, 1991), using the standard SMDL, could facilitate large-scale transfer of music scores to digital form for musical data interchange on the network, emulating the full-text files that are emerging for other fields in music (see *Thesaurus Musicarum*

*Latinarum* discussed later) and the other humanities (Price-Wilkin, 1991; Tibbo, 1991). With the establishment of a North American Center for Machine-Readable Texts at Rutgers University and the appointment of Susan Hockey in October 1991 as the first director, a mechanism is now in place to ensure access to digitized texts and avoid duplication of effort in digitization of material. The commercial push to multimedia products is also providing an impetus for movement toward international standards for music and images.

Network participants move from novice to expert through a series of levels. The usual strategy of beginning users of electronic network resources is to enroll and get a password, become familiar with a telecommunications protocol and the UNIX commands of an Internet account, and learn to function as an online participant in electronic mail and conferences. As users tire of irrelevant mail messages, they become interested in starting a Bitnet LISTSERV or Internet conference aimed directly at a small group who share interests (opera, jazz, early music). There is no doubt that a local resource person is essential for success at the beginning and a music librarian fluent in network use and information service is accessible and logical for that role. Likewise it is essential for the success of electronic music on the network, such resources as those described in the following sections, that there be a sufficient body of skilled users and librarians. From the formulation of research projects and analytical techniques, to bibliographic searching, to the presentation of research to peers, network resources have transformed music research.

## ELECTRONIC MUSIC APPLICATIONS

Thanks to some recent publications, readers can find current printed discussion and bibliographies of computer music applications to supplement the brief descriptions provided here. Thus an important part of this section is the review of published sources that can provide depth of coverage of books, periodicals, conference proceedings, electronic digests, followed by a brief look at selected projects of different types—bibliographical, full text, full score, analytical, tutorial, studio, and multimedia.

A current discussion of computer applications is the issue on music of *Advances in Computing in the Humanities* (Goffredo Haus, guest editor) that covers tutorials, music processing, and music studio reports (Haus, 1991). Haus is also the editor of the anthology *Music Processing* to be published by A-R Editions in 1992 (Haus, in press). Articles on applications in musicology and composition were collected by Helmut Schaffrath in *Computer in der Musik: Über den Einsatz in Wissenschaft, Komposition, und Pädagogik* (Schaffrath, 1990). An annual review of electronic music activities

appears in *Computing in Musicology*, edited by Walter Hewlett and Eleanor Selfridge-Field at the Center For Computer Assisted Research in the Humanities. In addition to summaries of new projects in music history, theory, composition, and performance, *CiM* includes sections on such topics as software for music printing, representation and analysis software, and OMR, as well as a current chronicle and address list of contributors. As the volume of contributions has grown, annual issues have become more selective and Deta Davis's (1989, 1991) bibliography of computer applications up until 1989 is a welcome auxiliary publication. Hewlett and Selfridge-Field (1991) provide an overview of the electronic music applications they have reviewed in an article "Computing in Musicology, 1966-1991."

To keep abreast of current activities, the electronic journals listed earlier and several of the print journals that follow offer a variety of approaches:

*Array*. Quarterly. Computer Music Association.

*Computer Music Journal*. (1980- ).

*Computers in Music Research*. Annual. Madison, WI: University of Wisconsin, Wisconsin Center for Music Technology, School of Music.

*Computing in Musicology*.

*Electronic Musician*.

*Leonardo Music Journal*. (1991- ). Annual. Berkeley, CA. Combines visual and sound arts.

*Musician's Music Software Catalog*. Annual. Mahopac, NY: Digital Arts and Technologies, Inc.

*Perspectives in New Music*. Quarterly.

In addition, published proceedings of conferences on computers and music provide detailed articles on specific projects. The following are some examples (for annotations, see the "News" sections of *CiM*):

*Computer Representations and Models in Music*. First International Conference on Computers in Music Research, Lancaster, England, 1988. Edited by Alan Marsden and Anthony Pople. London, England: Academic Press, to appear in 1992.

*Proceedings of the First International Conference on Music Perception and Cognition*, 17-19 October 1989, Kyoto. Available: Manuel Gonzales, Society for Music Perception and Cognition, Department of Psychology, University of California at San Diego, La Jolla, CA 92093.

*Proceedings of the 1989 International Computer Music Conference, San Francisco*. Available: Computer Music Association, P.O. Box 1634, San Francisco, CA 94101-1634.

*Proceedings of the 1990 International Computer Music Conference, Glasgow*. Available: Computer Music Association, P.O. Box 1634, San Francisco, CA 94101-1634.

*Fifth Workshop on Artificial Intelligence and Music*, 7 August 1990, Stockholm. Proceedings. Available: Antonio Camurri <music@dist.dist.unige.it>.

Since currency is so important as technology changes and research possibilities expand and because publications on paper often take years to appear, electronic discussion groups and bulletin boards are essential for news of conferences and proceedings.

Many current computer projects in music are bibliographical in nature, from informal localized efforts to well-funded large-scale published databases. RILM and *Syntagma Musicum*, mentioned earlier, are quite different approaches to the bibliography of scholarly music writings. RILM is comprehensive with abstracts and *Syntagma* is current with citations partly dependent on contributors. Nearly 12,000 librettos predating 1800 in the Albert Schatz collection of the Library of Congress were cataloged under Marita P. McClymonds and Diane Parr Walker (1986) (e-mail: <dpw@virginia.bitnet>) at the U.S. RISM Libretto Project, University of Virginia (currently searchable on RLIN in conjunction with a comprehensive guide and 244 reels of microfilms of texts). An Italian project (ACOM, Archivio Computerizzato Musicale veneto) is now cataloging about 50,000 librettos as well as hundreds of thousands of other items on the seventeenth- and eighteenth-century Venetian theater. Norman L. Wick's *Music Theory Index*, built with FoxBASE+Mac, covers books and articles published in English that pertain to music theory (some 15,000). It will be published by Pendragon Press about 1994 and a CD-ROM format is under consideration. RELICS (Renaissance Liturgical Imprints: A Census) built by David Crawford (1991, pp. 39-42) provides descriptions of about 5,000 liturgical books with multiple fields for Boolean searching, including a note on the presence of music (i.e., mostly, some, no music). Access is now limited to printed output at the library or searching the mainframe at the University of Michigan. Pending funding for data conversion, it may be loaded on RLIN.

A comprehensive bibliography of French music and dance of the seventeenth and eighteenth centuries by the Atelier d'Etudes of the Centre de Musique Baroque de Versailles is scheduled for public access in 1992 (*CiM*, 1991, p. 33). The project consists of five databases: (1) WORKS—citations of writings after 1800 (8,000 entries); (2) MUSIC—information about printed and manuscript sources for musical works and source concordances; (3) WRITINGS—pre-1800 documents; (4) NAMES—a list of researchers, librarians, booksellers, and musicians currently involved; and (5) POETRY—literary sources of texts set to music.

A more ambitious bibliographical project is the database of music in manuscripts dating from 1600 to 1800 sponsored by the Répertoire International des Sources Musicales (RISM). More than 100,000 musical and text incipits and associated bibliographical data for manuscripts with call numbers from libraries all over the world can be retrieved from a relational database mounted on a personal computer at the headquarters in Frankfurt. Music notation for incipits was encoded in the Plaine and Easie Code developed in the 1960s which, despite its name, is not at all easy for the novice to use. The ability to search the actual music melodies moves music bibliography into a new realm that need not depend on words but can use melody, rhythm, and other notational clues as well as keyword, tempo, and instrumentation (*INFO RISM*, 1990). Other RISM projects have been printed on paper or microfiche, but CD-ROM may prove a viable alternative. By means of a contract with RISM headquarters, national RISM groups may acquire the software and RISM data transmission program to accelerate communication of entries.

As a byproduct of the RISM project, an online index of names of composers and their works has been created that, as of 1991, contained 7,000 entries and 90,000 titles. A composer file includes references to variant names, pseudonyms, and initials, as well as birth and death dates and is an invaluable biographical dictionary, especially for lesser-known composers (*INFO RISM*, 1991, pp. 7-17).

A new project is the *International Inventory of Villancico Texts* for printed and manuscript villancicos of the sixteenth to nineteenth centuries. Three files provide access to: (1) bibliographic information (library and call number, institution, feast, year, composer, printer); (2) music incipits of the printed villancicos; and (3) textual incipits of the manuscript villancicos. David Martinez and Paul Laird (e-mail: <plaird@ducair.bitnet> or <plaird@athena.cair.du.edu>) at the University of Denver used SAS on a VAX for data processing for analysis (*CiM*, 1991, p. 45).

Another bibliographical project now underway that promises to include musical incipits is the new edition of Heyer's *Music in Monuments, Sets, and Series* being prepared under George Hill as a multifaceted database. A paper publication is scheduled to appear in 1992 (Fallen Leaf Press, Berkeley, California) that will vastly improve the entries and indexes of the previous edition. An optical edition to follow will provide the sophistication of computer searching and extend music indexing into the realm of melody and rhythm.

A full-text project already available on Internet is the *Thesaurus Musicarum Latinarum* (TML), an evolving database of more than half a million words that will eventually contain the entire corpus

of Latin music theory written between the sixth and mid-sixteenth centuries, both published and unpublished. Searching can be done on every occurrence of a particular term, phrase, or passage, or group of terms in close proximity. TML is centered at Indiana University-Bloomington under Thomas J. Mathiesen, Department of Musicology (e-mail: <Mathiese@iubacs> or <Mathiese@ucs.Indiana.edu>) and is available free of charge (e-mail: <listserv@iubvm> or <listsrv@iubvm.ucs.Indiana.edu>). Access to full-text periodicals includes a proposed CD-ROM of Tom Griffin's edition of music material in the *Gazetta di Napoli* (Fallen Leaf Press, Berkeley, California). The *Register of Musical Data in London Newspapers (1600-1800)* by Rosamund McGuinness (Royal Holloway and Bedford New College, University of London (e-mail: <uhwm001@vax.rhbc.ac.uk>) is limited to citations for material in the main newspapers of the time (*CiM*, 1991, p. 49).

Full-score projects include:

Walter Hewlett's Bach project at the Center for Computer Assisted Research in the Humanities (e-mail: <XB.L36@stanford.bitnet>); digital music files are available for display, sound, searching, analysis, and printing.

Essen University's monophonic songs of German-speaking lands. More than 13,000 songs encoded in ESAC (Essen Associative Code) appear in one field of an AskSam relational database for display, sound, searching, analysis, and printing (*CiM*, 1991, pp. 30-32). The files, software, and documentation are available free by license to scholars from Helmut Schaffrath (e-mail: <jmpl00adeohrzia.bitnet>).

The European Repertoire Information Service (EURIS) plans to distribute to public libraries scanned images of score pages together with MARC cataloging, graded level of difficulty, and information on where to order the scores. The first repertoire chosen is brass band music, the entire corpus of which is estimated to fit on one CD-ROM (*CiM*, 1991, pp. 34-35).

Several current projects are notable for their additions to existing software programming to allow analysis of various characteristics of music. One such project is *NeurSwing* of Denis L. Baggi is a "a system of connectionist models, or neural nets, to investigate swing in Afro-American jazz by simulating the operation of a jazz rhythm section" (*CiM*, 1991, p. 85). Hilde M. Binford-Walsh (Stanford University) encoded Aquitanian tropes in SCORE and applied a code to each neume that provided data for statistical analysis and comparison through Turbo Pascal programs and SAS (Statistical Analysis System) (*CiM*, 1991, pp. 41-42). John Walter Hill (University

of Illinois) entered melodic (pitch) incipits and full poetic texts of Vivaldi arias to find clues to reused arias in the absence of surviving scores (*CiM*, 1991, p. 47). Hill is also creating a full-text database of manuscripts of Italian monody to c.1630 with melodic incipits (*CiM*, 1991, p. 46).

### TUTORIAL AND LABORATORY PROJECTS

The proliferation of tutorial music applications is reviewed in the annual *MTNA Guide to Music Instruction Software* (Music Teachers National Association), the British electronic journal *Musicus: Computer Applications in Music Education* (1989- ), *ERIC* (U.S. Dept. of Education), and in Schaffrath's recent *Computer in der Musik: Ein Einsatz in Wissenschaft, Komposition und Pädagogik* (1991). Both commercial and music studio software creation is highly dependent on specific hardware platforms. Early electronic music applications were on mainframes because of the very large demands of music sound and notation, both for storage and for processing, and are found today in research universities where mainframes are available (Mathews & Pierce, 1989). When the Macintosh appeared with a MIDI interface for keyboard input and HyperCard for the manipulation of sound and image segments, local and commercial applications exploded. Digital sound input and editing were easily accomplished through an inexpensive piece of hardware called the MacRecorder, though only at 22 kHz (Duggan, 1991, pp. 71-75). The NeXt computer builds in the sound digitizer (44 kHz) as well as the MIDI interface and software for editing and manipulation and adds fast processing in a UNIX environment with optical storage for large sound files. More recently, hypermedia software has become available for the DOS platform. Because of that sequence of development, it is not uncommon for music computer laboratories, music tutorial facilities, and music libraries to use several hardware platforms for creation, training, and information services. Despite the difficulty for staff in maintaining a current knowledge of several platforms and current software for each, the library will need to support various platforms if it is to remain in touch with the variety of electronic applications.

University music and performing arts laboratories (Flurry, 1988, 1989; Gregory, 1988; *CiM*, 1990, pp. 125-28; Craner, 1991) are developing multimedia workstations linking an interactive music environment, a composition module, and tools for modeling such processes as musical knowledge acquisition, synthesis of the singing voice and other music performance, or a new computer musical language not dependent on the normal limitations of pitches based on the octave and rhythm based on divisions of a beat. Often they

use a few powerful and current UNIX machines together with several Macintoshes all linked to a campus mainframe and networks. An anthology of articles from the *Computer Music Journal*, 1980-1989, called *The Well-Tempered Object* (Pope, 1991) describes activities in such laboratories, focusing on the object-oriented software of the NeXt and Mac. Workstations take on a role in the curriculum much as tape decks did forty years ago. For example, assignments in paleography can be done at the digital keyboard of the workstation, viewed on the screen, and played back. Learning the rules of counterpoint can proceed interactively with a computerized "Gradus ad Parnassum" (Schottstaedt, 1989). A thoughtful review of computers for music composition by Gareth Loy (1989) describes the way music composition programs and programming language for music help and affect the writing of music. When Loy wrote his article, he noted that musical computing was in a league with research in vision and particle physics in the sheer volume of computational demand it placed on the computer. With the move away from the mainframe to the multipurpose individual workstation in the last three years, music computing hardware and software is moving back into the central focus of the music department and, in some cases, to the music or performing arts or multimedia computer laboratory in the library.

Computers with analytical programs may be reservoirs of score and sound material. The project *Humdrum Database* brings whole libraries of scores with software for analysis to the hands of students at the workstation.

The *Humdrum Database* includes about 2,300 scores ranging from the twelfth-century Notre Dame School to twentieth-century works out of copyright, 90 percent of which are polyphonic. The project is notable for the Humdrum system of music tools for UNIX, including a tool kit of some fifty interrelated software tools written in *awk* and/or C, designed to work in conjunction with standard UNIX software tools (Hewlett & Selfridge-Field, 1991, pp. 32, 66-67). Further information is available from David Huron, Conrad Grebel College, University of Waterloo (e-mail: <dhuron@watservl.uwaterloo.edu>).

Case Western Reserve University's *Musical Scores Project*, developed in cooperation with music instructional staff and the Library Collection Services Project, puts together on a DOS platform: (1) digital music scores; (2) a searchable database/index about the works; (3) links to commercial or university recordings; (4) graphics and text tools to allow the on-screen analysis of musical works either as a "clear" overlay on the score image or as a separate document (Duggan, 1992, p. 99).

Where does the library fit in? Information delivery—of citations, full text, full score, music, image, or all of the above—can be electronic through cables in addition to or instead of print, tape, CD, interlibrary loan, or photocopy. Local information development of files of scores, sound, and instructional material can be facilitated by the cooperation among library, instructional, and computing services staff and can be coordinated with regional, state, and national digitized music information and delivery systems. Information hardware and software sites can be located in supervised service areas of the library with professional staff for consultation. The indispensable link between such library service and the user is a librarian or information specialist deeply interested and well trained in computerized information service. Invisible electronic information, software, and communication among different kinds of music activities on campus can become more visible through the librarian. The same multiple hardware platforms used for tutorials and creative activity can serve information in the library. In fact, the activities of electronic tutoring and creative work can be placed in the library as well. As more and more of the work of the library moves to interactive multimedia workstations, the library becomes a laboratory and the laboratory becomes a library.

### INTERACTIVE MULTIMEDIA PUBLICATIONS

At the risk of creating a category of information that is not really separate from work going on in the laboratories described earlier, this final section is devoted primarily to CD-ROM and CDTV titles now appearing in the marketplace. Despite the risk of commitment to a transitory hardware platform, the great potential of emerging platforms for a new kind of music information service demands the attention of those collecting publications for music readers or users. The high quality of the CD is not matched by the standard computer monitor or television screen technology, but improvements in both areas are promising. Similarly, the software for handling very large files of sound and images is not yet capable of the compression and decompression techniques and storage capabilities necessary for easy delivery, but progress in the last two years has been phenomenal and will likely continue. Powerful scanners with high resolution are becoming available on campuses as is the hardware to capture short audio events from CDs and video events from videotape (for example, Voyager's CD AudioStack and VideoStack). Authors can plan on incorporating sound and images into their "manuscripts," and libraries must plan on delivering multimedia electronic publications.

A current music project that stretches the limits of multimedia is the Edvard Grieg Project to create a multimedia catalog of the

manuscript music, notes, sketches, letters with transcriptions, and early sound recordings of this composer on deposit in the Public Library in Bergen, Norway. Scanned images of music scores and other manuscripts, digitized sound input through a MIDI keyboard to produce encoded music files, and textual transcriptions of alphabetic materials are projected to become available on CD-ROM at UNIX workstations for simultaneous presentation of image, text, and music files in windows and speakers (Duggan, 1992, Figures 1-3). The printed volumes and recording archives of complete works that take up so much space in music libraries today could be replaced by CDs through such visionary projects. MusikFUNN, a music information network using the fourteen FUNN centers in Norway, is preparing the database (contact person, Bård Uri Jensen, Western Norway Research Centre, Sogndal, Norway) (*CiM*, 1990, pp. 151-52).

Commercial CD-ROMs are taking advantage of computer workstation software in multimedia publications directed at the mass music market by authors interested in entertaining as much as learning. Warner New Media's Audio Notes is a series of CD-ROMs that uses HyperCard on a Macintosh to present interactive performances and commentary on well-known music. The first publication, Mozart's "Magic Flute" on three CD-ROMs based on a 1988 German CD release, can be synchronized with a video disk of the Ingmar Bergman production, a necessity since quality of monitor images is so poor. Supertitles in German or English (with other languages promised); musical analysis at two levels, high school and college; and plot synopses can be changed at a touch of the mouse through an attractive icon interface (Duggan, 1991, Figure 2). The music is full stereo quality of 44 kHz but the black and white images at 72 dots per inch on the small HyperCard screen barely allow more than two lines of music to be displayed on the screen at a time. Brahms's "German Requiem" and Beethoven's String Quartet No. 14 (edited by Cynthia Woll) are the latest releases of the series that promises Stravinsky's "Sacre du Printemps," Berlioz's "Symphonie Fantastique," Beethoven's Seventh Symphony, Britten's "Young Person's Guide to the Orchestra," and Schoenberg's "Pierrot Lunaire," the last written by Schoenberg Institute head Leonard Stein, as well as jazz and popular titles.

Voyager has issued Beethoven's Ninth Symphony and Stravinsky's "Sacre du Printemps" as CDs with HyperCard stacks on diskettes to explain musical instruments, structure, themes, and translation of lyrics. Music notation with corresponding sound are coupled. Authored by music historian Robert Winter, the electronic tool communicates what he has to say and is a powerful learning instrument. Future titles promise the first three Brandenburg

concertos and histories of early jazz and mid-1950s rock, as well as a five-camera shoot of Mozart's Quartet K. 465, for the first time adding video to Voyager's options.

With the introduction in 1990 and 1991 of better quality images through CDTV, a hardware concept by Commodore that links the television monitor with CD-ROM or CD and a small controller or full computer keyboard and mouse with a computer, the stage is set for inexpensive and high quality multimedia publishing. The CD-ROM encyclopedias, atlases, and other reference tools provided to purchasers of the hardware include quality sound and color moving images.

### THE MUSIC PUBLISHING FUTURE

The movement of music scores and sound to a digital format is a revolution being accomplished by companies, institutions, and individuals, each of which challenges the traditional concept of the music publisher. To avoid the issue of copyright contracts, major multimedia publishers have been purchasing rights to archives of images and sound (Time Warner purchased MGM/UA; Bill Gates of Microsoft has purchased the rights to entire holdings of certain museums). As major repositories of information that scholars would like to see become available in digital form, research libraries may also wish to become publishing partners in an effort to continue to provide information service to their users in the most democratic and inexpensive manner possible (Ostrow & Zich, 1990). Examples mentioned earlier include the Bach repertoire by the Center for Computer Assisted Research in the Humanities, the Edvard Grieg archives in a Norwegian public library, and the Case Western Reserve Library Project that includes university music performance tapes and scores. Fair use under copyright and publication in new formats of material under copyright are issues with new ramifications in an electronic age.

As software for printing music has developed in recent years, *CiM* has reviewed processes and has printed examples of pages with copy chosen for its difficult passages. A glance at those pages proves how far the software and laser printers have come. Some of the packages that do very well on such passages are not easy to use and professional music printers are investing large sums developing their own solutions. A-R Editions for example has developed a system on a UNIX platform that is known for its flexibility and aesthetic solutions to printing problems. Such professional software may be the "MusicPerfect" of the future. In the meantime, libraries that must function as desktop publishers for internal software can choose from a number of capable products. Until a standard is developed

that will allow movement from one system to another, moving from music notation to print will be software dependent. When such a standard appears, network transmission of full-text full-score files for delivery in library environments may make the library into a large-scale printing establishment.

One bottleneck for music has been the development of a system for the entry of large amounts of notated music into a database by optical scanning which would permit fast error-free encoding of a large number of sources or an extensive repertoire and then provide for the analysis and output of the data according to the requirements of a particular study. That has been solved for text by OCR (Optical Character Recognition), a system now routinely used for standard fonts and rapidly developing for use with the most demanding text. Optical Music Recognition (OMR), the automatic recognition of printed music by scanners, is still in its infancy. Recent work by Nicholas Carter at the University of Surrey takes significant steps toward a solution by a staff line-finding process that recognizes staff lines, removes them from characters, defines characters in relation to these defined stavelines, and then is able to draw the lines and position the characters. "Further work needs to be done in order to cover a larger vocabulary of symbols, but the foundations of a robust, omnifont and size-independent system which has significant tolerance of noise and rotation, are in place" (Carter & Bacon, in press). A related technique of scanning for staff lines and eliminating them to recognize pitches is used by McGee and Markley (1991) to scan medieval music; once the repertoire is scanned they are able to collate music and textual variants and compare modal and liturgical assignments (pp. 47-53).

Projects are now underway to scan brass band music, medieval music, nineteenth-century sheet music (Library of Congress "American Memory" project), and numbers of others. It is time for the North American Center for Machine-Readable Texts in the Humanities to take note of music scores as they tumble onto the networks. Publishers and printers are also taking note. Already, computer shops are promising electronic books printed on demand (SoftServ Electronic Book Publishing, advertisement in *Computer Music Journal*). The *Note-Station* is an electronic library of some 12,000 music items on CD-ROM. A user selects a title, views the music on the screen, listens to a segment, instructs the machine to transpose it (if desired), and selects parts to be printed with automatic billing and royalty accounting (available in both laser-printed copies and MIDI sequences) (*CiM*, 1991, p. 15).

In 1990, on the Music Library Association's LIST-SERV, Andrew Potter of Oxford University Press published a questionnaire

concerning the publication of music in electronic form, prior to the press's initiation of a series of music publications in machine-readable form. He prefaced the questionnaire by asking for help "in ascertaining the type of repertoire, the form it should take, and the way it might be used in order to be of most use to scholars and others in the musical community." When asked if readers would find it beneficial to buy multivolume works in machine-readable form, such as complete editions or editions of musical genres which could be accessed by proprietary software, nineteen of the forty respondents said yes, four said no, and seventeen had no comment. When scholars who are creating giant research projects are doing so in digital form complete with software for analysis and statistical processing, they are unlikely to submit that scholarship to a rigid printed format which is no longer susceptible to the same type of use.

But, for many, printed or electronic notation is no longer necessary. In a recent book on artificial intelligence, Raymond Kurzweil (1990) predicted that:

intelligent software incorporating extensive knowledge of musical theory and styles would be extensively used by professional musicians in creating musical compositions and preparing performances, by amateur musicians who can jam with their computerized instruments, and by students learning how to play. The advent of musically knowledgeable software-based accompanists will provide children with exciting musical experiences at early stages of their knowledge and skill acquisition. (p. 444)

The so-called intelligent software referred to by Kurzweil presents theories of chords, progressions, rhythm, and structure without music notation; software replaces music printing in such teaching tools and moves directly to sound. Kurzweil speaks of a new type of musician, one who specializes in sound design, and speaks of an age when one could not imagine a book about music that had no sound. For that book the electronic music keyboard may be more important to music library computers than the normal computer keyboard.

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