Digital Music Notation Data Model and Prototype Delivery System – A DFG/NEH Bilateral Digital Humanities Program: Bilateral Symposia and Workshops Proposal

Description of the project and its significance

This proposal describes the initial steps required to create a music notation data model and prototype delivery system. This is an important and difficult problem: important because the lack of a universal musical data format limits the use of musical data in research, and difficult due to the nature of musical notation it hopes to digitally capture and the necessity of achieving community consensus. Crucial to this effort are the proposed workshops, which will be a bilateral effort bringing together scholars from both technological and musicological backgrounds.

For musicologists, digital scholars, cultural theorists, musicians, and music publishers, the reality of searching music online remains to be satisfactorily realized. First, the amount of printed music represented digitally in any way at all is miniscule. Second, these digital representations are most often simple digital images of the scores, which do not allow for searching or manipulation of the music itself. This situation resembles the history of the digital representation of texts. Once, searching of texts was limited to the simple metadata, such as author and title information, found in physical card catalogs. The advancement of scholarship in the humanities depended critically on the development of digital representation methods that surpassed the limitations of old ways of handling texts. So too does the advancement of scholarship in music depend on the development of a standardized, yet flexible and extensible format for representing musical notation and its associated data.

Technically, the encoding scheme must be standards-based and platform-independent, employ semantic markup (XML) and associated technology, and be designed for scholarly uses yet not exclude other potential users, including practicing musicians and music publishers. The scheme should provide for the common functions of traditional facsimile, critical and performance editions – all essential for the study and performance of music. And, since the study and subsequent performance of music requires the creation and study of scholarly editions that include information beyond that of the printed score, digital editions of music should allow for the encoding of presentation and meaning, especially of a composition’s textual variants and their origins. Particularly exciting is the potential to include both music notation and textual matter, such as the composer’s personal notes or the publisher's advertisements, which are very important in the historical and cultural study of a composition.

The significance of this project can be equated with that of the Text Encoding Initiative (TEI). Using a similar method of collaboration and collective development, this project will result in guidelines that can be widely used by libraries, museums, and individual scholars to present musical scores for online research, teaching and preservation. Such a project depends on a broadly-based effort that is international in scope. Not only must a vast array of technological skill sets (such as knowledge of existing music representations, schema design, optical music recognition and software development) be brought to bear on this effort, but also a broad array of musical specializations must be consulted to ensure that the challenges of notational styles from early music (pre-1750) to twenty-first century music can be incorporated into the model. This level of inclusiveness in the developmental stages will both set this encoding initiative apart from its more narrow or limited competitors and contribute to its quick adoption by a wide variety of musical practitioners.

In order to carry out the initial stage of this project, we are asking for support from the National Endowment for the Humanities ($44,164) and the Deutsche Forschungsgemeinschaft (31,279.00 €), totalling $88,048.44/63,617.65 €.

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Narrative

Topics and goals

Notated music forms the basic source material for musicology. It is the basis of most musical performance, especially in classical Western art music. It is also often used to record and describe performed music not based on a notated text. Notated music has been produced in the West for more than one thousand years. A vast quantity of notated scores, in both printed and manuscript forms, is stored in the world's libraries. However, only a small portion of this music is available in digital form, and usually as image files. An even smaller portion is available digitally in a machine-readable form that represents the structural and semantic information contained in written or printed scores and that would facilitate computer-assisted research.

A commonly accepted digital, symbolic representation of music is necessary in order to move musicology into the modern era; that is, to make it possible to carry out the same kinds of operations that are commonly performed on electronic textual sources, for example, compiling musical corpora, data interchange, and comparative analysis. Also, because music research routinely combines the study of manuscript sources, printed music editions and time-based media, an encoding mechanism that facilitates the creation and management of relationships between components of digital versions of these materials will lead to improvements in research efficiency.

The scholarly community devoted to the historical study of music needs a representation that meets the following requirements:

- represents the semantic and structural complexity of the entire diverse history of Western notation;
- represents the common expressive features of traditional facsimile, critical, and performance editions;
- is a public, open standard controlled by the scholarly community;
- is platform independent, which is to say, based on the XML family of standards;
- supports scholarly analysis and a variety of both digital and print rendering possibilities

Several scholars have defined requirements of a suitable representation. Byrd and Isaacson[1] have enumerated many of the requirements for CMN, while Loos et al.[2] and the Music Encoding Study Group[3] have approached the problem more generally. Also, conferences such as the annual International Symposium on Music Information Retrieval (ISMIR) conferences[4] and the conference on music editing held in Paderborn in 2007[5], indicate that interest in finding a solution to the challenges of representing music to support research is increasing. Despite these efforts, there are still many unresolved questions. For an indication of the problems, please see Appendix A.

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[1] Byrd and Isaacson.

[2] Loos, et al.

[3] Music Encoding Study Group.

[4] See http://www.ismir.net/ for proceedings of the ISMIR conferences.

[5] "Digitale Edition zwischen Experiment und Standardisierung / Digital Edition between Experiment and Standardization ".

Assuming the need for encoded musical data, the current problem is not that there is no method for encoding notated music's structural and semantic information, but rather that there are too many ways, at least for the common cases. There is no single, accepted, non-proprietary standard for electronically representing and sharing this important cultural data. Over the last 40 years, dozens of music encoding formats have been created. However, much of the work on other digital representations of symbolic music up to this point is unsuitable for the scholarly editing and analysis of music.

Most existing music representations are inadequate for scholarly purposes. Almost all narrowly focus on supporting one or two functional objectives; that is, printing or automated performance. Few encodings or representations exist that facilitate analysis. Most codes are limited in scope to Common Music Notation (CMN), the most commonly recognized form of music notation, in use principally between 1700 and 1935, or to a single repertoire or notational style. Many representations are useful as input codes, but they have limited use as complete representations[6]. Even the ubiquitous MIDI (Musical Instrument Digital Interface) files found in great quantities on the World Wide Web fit this paradigm. MIDI narrowly focuses on the storage and transmission of performed music. Therefore, it is completely unconcerned with score notation. MIDI does not allow the capture of the structural and semantic information necessary for applications in musicology, for example, for harmonic or structural analysis.

Rather than focusing too narrowly, other representations, such as the Standardized Music Description Language (SMDL), have attempted to represent music too broadly. SMDL was unable to attract a large user group in part because it was difficult for potential users and tool developers to see how SMDL might apply to their particular situation.

In addition to problems of scope, many existing encodings are dependent on particular hardware or software. The lack of acceptance of specialized hardware input devices for music, such as tablets and touch screens, outdated storage mechanisms, like punched cards and paper tape, and incompatible and obsolete file formats should stress the necessity of hardware and software independence. Frequently, data formats created for the typesetting and printing of music are binary codes, rendering them unreadable by a human without machine intervention and making them unsuitable for long-term use.

Many existing codes are also proprietary. After expending a great deal of effort to create them, their owners are reluctant to divulge their inner workings. Therefore, their use for information exchange is severely limited. In addition, commercial forces often function as stumbling blocks in the creation of new standards. For example, work on NIFF (Notation Interchange File Format) was abruptly halted when the commercial parties involved in its development lost interest in it.[7] Even the *de facto* MIDI standard is produced and controlled by the MIDI Manufacturers Association.

Furthermore, formats for music analysis generally do not deal with the graphical aspects of notation while those that work well for graphical applications do not have the semantic content necessary for other uses. Finally, few existing representations have even minimal support for the ambiguities and uncertainties encountered in manuscript sources.

While the advent of the eXtensible Markup Language (XML) in the last decade has led to the development of a new generation of XML-based music encoding formats, such as CapellaXML, MPEG SMR (formerly known as Wedelmusic), and MusicXML, each of them has disadvantages that make it unsuitable for academic purposes. CapellaXML was designed to store the data needed for a particular

[6] Selfridge-Field.

[7] Personal communication with Eleanor Selfridge-Field, 23 Sep 2008. Eleanor was a participant in the development of NIFF and SMDL.

notation software application. This format only stores information necessary for typesetting music; information beyond the visual shape is not intended to be stored. Because CapellaXML is closely bound to Capella, further development by the musicological community is unlikely. MPEG SMR on the other hand is designed to integrate with multimedia data. Although this format offers many possibilities for interaction with audio and video files, its ability to store unusual notation or notational variants is very limited. Due to its state as an ISO-standard, it would be a lengthy and difficult process to refine MPEG SMR so that it met the special needs of the musicological community.

Certainly, the best-known XML-based music encoding format is MusicXML. While it is based on Musedata and Humdrum **kern, two ASCII-based music encoding formats primarily built for analytical purposes, MusicXML is mainly intended as an interchange format. It is used by dozens of different applications such as score-writers and audio applications. Over the last few years, MusicXML has become the *de facto* standard of music notation interchange.

The success of MusicXML is based on its simplicity. It is simplicity, though, that makes MusicXML inadequate for scholarly applications. Since it is designed to map only CMN – and only the most common features of CMN needed for audio generation or score-writing – it is incomplete for scholarly editing purposes. In addition, MusicXML is not formally extensible by the user, provides few analytic features, and does not facilitate the capture of rich meta-data. While MusicXML has found a broad user base, its support of representing semantic and structural information necessary for complex musicological operations is insufficient for scholarly analysis. Further, MusicXML is proprietary. Recordare, LLC, is solely responsible for its development and maintenance. The scholarly community needs to be able to control the development and maintenance of any standard in order to ensure that its needs are met. Because MusicXML is primarily oriented toward the commercial sector, the success of academic applications is a not major concern for its developer or even its current users. Further development of MusicXML toward academic goals is unlikely given the interest of the current user group in maintaining interchange compatibility between existing and future MusicXML encodings.

The Music Encoding Initiative (MEI) data model attempts to address many of these issues and has been successful up to this point. Michael Kay, internationally-known for his work on Extensible Stylesheet Language Transformations (XSLT), an XML-based language used for the transformation of XML documents into other XML or "human-readable" documents, calls MEI a "serious contender."[8] MEI has also been covered by both the popular[9] and academic press[10]. Already capable of solving many of the problems associated with encoding music notation, MEI provides a promising starting point for future developments. The features of MEI are discussed in more detail in Appendix B.

MEI's main failing is that so far it has been a unilateral effort, not a community-driven one. The main objective of this grant is to remedy this situation. Unlike the development of music notation schemas heretofore, the process of development needs to be conducted in the open and the products of the process need to be the shared responsibility of a group of interested parties. This is the only way that a standard will reflect the functional needs of the community.

The next logical step is to bring key practitioners in the field together to collaboratively establish the design principles and the technological and representational requirements that will enable the discipline of musicology to take full advantage of the enhanced research made possible by advanced technologies.

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[8] Kay.

[9] Stewart.

[10] Williams and Webster.

The development of a standard digital representation of music by the scholarly community has the potential to transform musicology. Anyone who creates musical editions for publication or study, even ephemeral ones such as those for classroom use, will likely find the standard and tools based on it useful. Faculty teaching classes in the theory and history of music, students, and researchers conducting content-based analysis or historical research would all benefit enormously. Music publishers, universities and research institutes will be able to utilize the data model and associated tools to create and distribute music in print or on-line. Finally, since the schema developed in this project will be freely available, open, and extensible, other software developers can build open-source tools upon it. For example, applications may be developed for navigation within a score, for synchronized display of the score and a machine-generated or pre-recorded performance, for navigation among textual variants within the score, etc.

History, scope, and duration

History

Seeing the need for a comprehensive markup language in the music community, in 1999, Perry Roland of the University of Virginia set about creating an XML schema (DTD) for the representation of music notation. Eventually this DTD became known as MEI because it was influenced by the same principles that guided the creation of the Text Encoding Initiative (TEI). His interest in this task developed from his education and training as a musician (M.A., 1986, Music Composition, UVa) and librarian (M.L.S., 1995, UNCG). Mr. Roland presented his initial work at the first International Symposium on Music Information Retrieval in 2000. The following list of professional activities where Mr. Roland has made presentations demonstrates that since that time interest in MEI has been steadily growing.

- Musical Applications using XML (MAX) conference, Milan, 2002
- MusicNetwork Notation Workshop, Leeds, 2003
- ISMIR, Baltimore, 2003
- Online Chopin Variorum Edition (OCVE), Philadelphia, 2004
- Digital Humanities conference, Urbana-Champaign, 2007
- TEI Members' Meeting, College Park, 2007

These efforts were encouraged and supported by the University of Virginia Library. In 2005, Mr. Roland received support for a 2-year pilot project to demonstrate the capability of MEI to faithfully represent a sample of music scores found in Beyond MIDI, to investigate methods for transforming MusicXML-encoded data into the MEI format, and finally, to ensure that the semantic information encoded in MEI could be rendered as traditional music notation.

In the summer of 2007, Mr. Roland was approached by representatives of the German markup community, regarding the integration of text markup and music markup. This led to an invitation to make a presentation on MEI before the Arbeitsgruppe Musikcodierung in der Akademie der Wissenschaften und Literatur in Mainz, in July, 2007.

At this meeting, interest was generated in the further evaluation and development of MEI. Mr. Roland worked with Mr. Stefan Morent of the University of Tübingen to develop features within MEI for the representation of medieval notation. Mr. Morent and his students have since begun a project, using the works of Hildegard von Bingen, whose purpose is to visualize the structural and semantic information for medieval notation embodied in an MEI file. Mr. Roland also worked with Edirom staff, Johannes Kepper and Daniel Röwenstrunk, to refine MEI handling of score facsimiles and editorial intervention.

In addition, Mr. Kepper, with assistance from others, produced a document that served as a starting point for further discussion, outlining the scholarly needs for a music notation representation scheme and presenting several examples which a notation markup should be able to address. The principles and the examples embodied in this paper were taken up at the conference "Digitale Edition zwischen Experiment und Standardisierung", held in Paderborn, Germany in December, 2007. Mr. Roland demonstrated MEI functionality with regard to these needs and examples in a talk at the conference and in a written response that can be found in Appendix B.

The German Edirom (a contraction of "editorial CD-ROM") project was initiated in 2003 by Prof. Dr. Gerhard Allroggen and Prof. Dr. Joachim Veit. During a lecture on music editing they wondered if digitized editorial reports might be easier to understand than those in print format. After receiving assistance from the German Research Foundation (DFG), a prototype for digital music editions was created. In 2005, this prototype, containing Carl Maria von Weber's *Clarinet Quintet, op. 34*, was published at no charge as an addition to the printed edition of the Weber-Gesamtausgabe (Complete Works). This was the first complete computer-based edition of a piece of music from the Common Western Notation period. Due to its wide approval among musicologists and editors, the DFG granted funds for five more years, beginning in 2006.

In this on-going project, the lessons learned from development of the prototype are generalized and transferred to other composers and editorial problems. The Edirom project seeks to develop open source tools for the presentation and generation of digital music editions. Additionally, it designs and implements database solutions for relevant types of information (letters, documents, persons, etc.); seeks the adoption and improvement of underlying file formats like TEI and MEI; and advises other musicological and editorial projects with problems in the field of digital media. Edirom employs MEI in its prototype-successor software.

Scope

The main objective of the proposal is to assemble a representative group of scholars and technologists, who will survey the current state of music encoding. The group will determine scholars' requirements for a music notation representation, critically evaluate existing encoding schemes, and select an appropriate schema language for future development of a schema that meets the needs established by the group. In order to carry out this objective, we will establish a collaborative electronic working environment in which discussion and resource sharing is possible and conduct in-person meetings.

Duration

The complete project, i.e., the creation and documentation of an acceptable schema plus the implementation of a prototype delivery system, is expected to be a multi-year endeavor. However, funding is currently being sought only for the initial stage of the project. The duration of this stage of the project is 1 year, during which 2 meetings will be held.

Need for and value of trans-Atlantic collaboration

Collaboration has already been successfully employed in the development of other standards, such as, SGML, HTML, XML, TEI, and others, in widespread use at the present time. Therefore, this approach seems likely to be fruitful. However, this is the first XML standard for music notation for which collaborative development is envisioned.

A collaborative environment for the sharing of resources and for communication activities necessary for completion of the project will be established at the University of Virginia within *Collab*, the University's local implementation of *Sakai* (http://sakaiproject.org/). The working environment will include a Wiki for collaborative document development, a discussion list to support efficient communication among the participants, and posting of relevant secondary literature, among other features. In addition to providing asynchronous convenience, studies comparing computer-mediated communication and face-to-face communication in collaborative groups have shown that computer-mediated communication reduces participants' fear of rejection[11], especially among multi-lingual participants.[12]

However, in-person meetings are also invaluable for intensive collaborative discussions. Face-to-face communication "induces more conformity and opinion change" amongst group members[13], leads to higher levels of confidence in the decisions reached by the group[14], and is more emotionally satisfying to the participants.[15]

Using both of these communication channels, we intend to engage a select group of international scholars and technologists with a broad range of expertise in discussing the features and functions required in a scholarly XML music notation model, critically evaluate the existing data models, discuss optimum solutions for achieving the desired features, and plan for future implementation of the solutions.

The group must have members with knowledge of Medieval, Renaissance, and modern notation; existing music representations; schema design; optical music recognition; music editing and philology; and software development. It is important that all these disciplines be equally represented in any discussion of music representation.

It is particularly important to continue the momentum created by the prior cooperation between the MEI project at the University of Virginia, the developer of a significant music representation scheme, and the Edirom project at the University of Paderborn, a leading creator of digital music editions. Our collaboration so far has yielded a much-improved representation as well as software for creating critical editions. However, given the wide range of topics (both musical and technical) that a discussion of a broadly applicable music representation must encompass, it is crucial that other experts from both the U.S. and from Europe participate. Trans-Atlantic participation is essential in order to achieve the level of expertise necessary for the project and to broaden the range of demands and approaches that can be addressed.

Agenda

<u>Meeting 1 (Summer 2009)</u>

The primary objective of the first meeting is to develop specifications for the revision of the MEI schema. In pursuit of this goal the following activities are planned:

- tutorial on XML technologies;
- refinement of the consensus on functional requirements;
- evaluation and revision of the MEI schema.

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[11] Ho and McLeod.

[12] Freiermuth.

[13] Adrianson and Hjelmquist.

[14] Credé and Sniezek.

[15] Mallen, et al.

Meeting 2 (Spring 2010)

The primary objective of the review will be to address any major outstanding intellectual and technical challenges and to plan the work necessary to complete the schema and tag library. The following activities are planned to meet this goal:

- review the schema, examples, and tag library;
- develop a plan for publicizing and disseminating the schema and tag library;
- formulate a plan for developing training and workshop materials;
- create a strategy for developing applications for converting, analyzing, and rendering representations conforming to the MEI schema;
- design a strategy for funding training and application development.

Logistics

Two meetings will be held, each lasting three days. The first meeting will take place at the Institute for Advanced Technology in the Humanities at the University of Virginia in Charlottesville, Virginia, in June, 2009. In order to provide adequate travel time, the U.S. participants from outside Charlottesville will be housed in local hotels for four nights, while the European participants will be provided five nights of lodging. Refreshments, including a light morning snack, a mid-afternoon coffee, and a boxed lunch will be catered in the meeting room each day. The participants will be on their own for dinner, except for one evening event.

The second meeting will take place at the Musicological Institute Detmold/Paderborn in Detmold, Germany for 3 days in March of 2010, with arrangements similar to those offered in Charlottesville.

Work plan

January-April 2009 (pre-grant)

An Internet-accessible working environment to support the collaboration of the participants and achievement of the project goals will be created at the University of Virginia, using *Collab*. The working environment will include a Wiki for collaborative document development, a discussion list to support efficient communication among the participants, and posting of relevant secondary literature, among other features.

In addition, open-source version control software (*Subversion*) will be implemented to facilitate the collaborative development of the two principal products that comprise the project objectives: an XML schema for the encoding of representations of written music, and a schema tag library.

In collaboration with Kepper, Roland will post background readings, in particular, readings on 1) the XML suite of technologies with a particular emphasis on schema technologies; 2) other standards, in particular markup standards, that may be complementary to the music representation schema (e.g., METS, TEI, and SMIL), or that may serve as exemplars (e.g., TEI); and 3) relevant literature on the scholarly representation of written music.

In collaboration with Pitti, Roland will convert the existing MEI DTD into a RelaxNG (RNG) schema and will revise it to include prototype data typing of relevant elements. Roland will post the schema along with examples of encoded representations of written music. An evaluation of the MEI schema will serve to focus the discussion of the representation of written music.

<u>May-October 2009</u>

The project will be announced on relevant listservs in order that the scholarly communities that are most likely to benefit from the work of the project will be aware of it and will be invited to follow its progress on a project Web site available to the public.

Before meeting in late June, participants will focus on four activities:

1. ensuring that all participants have a sufficient understanding of XML technologies to be able to engage in informed discussion;
2. gathering examples of written music that represent a comprehensive set of notation types and transcriptional challenges;
3. ensuring that all participants have sufficient understanding of the MEI schema to be able to engage in an informed critique;
4. developing a rough consensus on the functional requirements for music representation.

The discussion of functional requirements will include consideration of the relation of the MEI schema to other schemas, the challenge of converting *de facto* (though non-scholarly) standard representations into the MEI schema, and analysis and rendering objectives.

The un-encoded musical examples contributed by the participants are expected to be useful outside the immediate context of the current grant, for example in other applications requiring a test corpus of representative musical examples.

The primary objective of the first meeting in June, 2009, is to develop specifications for the revision of the MEI schema. The initial focus of the meeting will be on providing a brief tutorial on XML technologies and on refining the consensus on the functional requirements. Based on the representative examples of music gathered and the functional requirements, the participants will evaluate the MEI schema and, based on the evaluation, will suggest revisions.

Immediately following the meeting, draft specifications will be written and posted for further discussion, and, if necessary, further refinement.

After the specifications are reasonably stable, the MEI schema and examples will be developed iteratively, with Roland revising the schema; and the other participants, with direction from Kepper, revising and encoding the representative examples and testing. Feedback from encoding and testing will inform additional revision.

At the end of the first six months, the MEI schema and examples will be reasonably stable, with only minor revisions necessary to complete the schema.

While the schema and examples are being revised, the participants will develop assignments for developing and writing the MEI schema tag library.

<u>November 2009-April 2010</u>

Using XSLT, Roland will derive an XML "outline" from the MEI schema that will list the unique elements and attributes. The outline will be in the form of a TEI document that will be further developed by the participants.

Working iteratively, the participants will develop the tag library, and refine the schema and encoded examples, with each activity providing feedback for each of the other activities.

In March of 2010, the participants will meet to review the schema, examples, and tag library, and to plan "next steps." The primary objective of the review will be to address any major outstanding intellectual and technical challenges and to plan the work necessary to complete the schema and tag library.

The discussion of next steps will cover the following:

1. plan for publicizing and disseminating the schema and tag library;
2. plan for developing training and workshop materials;
3. strategy for developing applications for converting, analyzing, and rendering representations conforming to the MEI schema;
4. strategy for funding training and application development.

Following the meeting, participants will complete revision of the schema, examples, and tag library. Roland will develop XSLT for rendering the tag library into HTML/CSS for dissemination on Web and for PDF. The MEI schema and tag library (with encoded examples for each element and attribute as well as complete examples) will be made Internet-accessible and announcements of their availability will be made on appropriate listservs and at professional conferences.

Results

The products of grant funding will be

- a RelaxNG (RNG) schema and tag library;
- a test collection of music notation examples that illustrate the functional requirements of a music schema;
- a plan of action for publicizing and disseminating the schema and tag library;
- plans for developing training and workshop materials;
- a strategy for developing applications for converting, analyzing, and rendering representations conforming to the MEI schema;
- a strategy for funding training and application development;
- a website making all products of the workshops available for download.

In order to introduce the new schema to a wider audience and solicit constructive criticism and/or further collaboration, presentations will be made at appropriate professional conferences, such as ISMIR and Digital Humanities, and at TEI Members' meetings. Plans for the music notation schema and the test collection will be made available for free download via the World Wide Web. The schema will be made available under the Educational Community License version 1.0.

The creation of a consortium of interested parties, similar to the TEI consortium, which will oversee future development, will also be investigated. In addition, opportunities for co-development of our music encoding and TEI will be pursued. Finally, additional grant funding for developing applications for converting, analyzing, and rendering representations conforming to the music notation schema will be sought.

Budget narrative

Summary Budget

[Not provided in this version.]

German Budget

[Not provided in this version.]

U.S. Budget

[Not provided in this version.]

List of invited participants

The following individuals are representative of the musicological and technical communities to whom the creation of a scholarly XML music notation model is addressed. The group has wide-ranging expertise, from historical and present-day notation to information system design, from software development to scholarly editing and philology. Often, these individuals have skills in more than one area. Where possible, multiple persons have been chosen with similar skills so that more than one point of view can be presented.

Erin Mayhood (Music Library, University of Virginia) is the Head of the Music Library at the University of Virginia. As evidenced by her recent receipt of a grant to provide access to the University's sheet music collection, Erin has expertise in music cataloging and meta-data issues.

Perry Roland (Alderman Library, University of Virginia) is a musician, librarian, and the creator of MEI. He has degrees in Music Education, Music Composition, and Library and Information Science.

Daniel Pitti (Institute for Advanced Technology in the Humanities, University of Virginia) is co-director of IATH. Given his expertise and experience in the creation of XML application vocabularies, Daniel will lead the project meetings and serve as a markup consultant.

Eleanor Selfridge-Field (Center for Computer-Assisted Research in the Humanities, Stanford University) has been involved in developing open-source repositories for symbolic musical data (with an emphasis on music of the 17th-19th centuries) for more than 20 years. CCARH conducts research in several areas, including music representation, data interchange, musical data-query methods, and musical data as intellectual property.

Donald Byrd (Indiana University) is Senior Scientist, Adjunct Associate Professor of Informatics, and Adjunct Associate Professor of Music at Indiana University. He was also principal designer and lead programmer for the commercial music-score editor Nightingale and Principal Investigator of the NSF-funded International Digital Libraries Initiative project for Online Music Retrieval and Searching (OMRAS). He is currently Principal Investigator of the NSF-funded project "Framework for a General Multimedia Workbench."

Laurent Pugin (McGill University, Montreal) is a post-doctoral research fellow at McGill University and is associated with the RISM project in Switzerland. His areas of expertise include early music editing, optical music recognition, and music philology. He is the principal designer and lead programmer of Aruspix, a software application for the optical recognition, superimposition and collation of early printed music.

Craig Sapp (Center for Computer-Assisted Research in the Humanities, Stanford University) currently works on musical data management and applications for music analysis. Previously he was a research fellow at the Centre for the History and Analysis of Recorded Music (CHARM) (Royal Holloway, University of London) performing alignment of musical scores with audio recordings for use in musical performance analysis. Craig has extensive experience using the Humdrum Toolkit, encoding musical scores and distributing them on the internet, on-demand conversion of musical data, and creating new harmonic analysis tools. His current work includes musical representations of traditional Japanese music tablatures for shamisen, shakuhachi and koto which employ MEI.

J. Stephen Downie (Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign) holds degrees in Music Theory and Composition and Library and Information Science. His research and teaching encompasses the areas of information system design and evaluation, multimedia information retrieval, info-metrics, information organization and access, and managing Internet information resources.

Joachim Veit (Carl-Maria-von-Weber-Gesamtausgabe, Academy of Music Detmold and University of Paderborn) is honorary professor at the Department of Musicology at the Academy for Music Detmold and the University of Paderborn. He holds degrees in Music Education and Musicology and is a specialist in 18th and early 19th century music. He is chief editor of the Carl Maria von Weber Complete Edition and since 2006 has directed the DFG-funded project "Development of tools for digital critical editions in music" (which is well-known under the name "Edirom"). He has presided over several conferences and meetings on problems of digital editing and is engaged in broadening the spectrum of digital projects in musicology.

Johannes Kepper (Edirom, Detmold) holds degrees in both Computer Science and Musicology. He is a research assistant with Edirom.

Daniel Röwenstrunk (Edirom, Detmold) has a graduate degree in Business Computing and as a research assistant he is responsible for the software development of the Edirom project. Based on his experience as a commercial Java developer and amateur musician, he personally developed most of the current Edirom tools.

Stefan Morent (Department of Musicology, University of Tübingen) holds degrees in Musicology and Computer Science and is currently an Associate Professor of Musicology. Medieval music and historical performance practices are his areas of expertise. Since 1998, he has directed the DFG-funded project, DiMusEd, an interdisciplinary research project focused on questions of digital editing of music.

Frans Wiering (Information and Computing Sciences Department, University of Utrecht) has been researching computer applications in musicology since the late 1980s. He is the founder of the *Thesaurus musicarum italicarum*, a corpus of online music treatises by Gioseffo Zarlino and his contemporaries. His present research is in digital scholarly publishing of music and music information retrieval. Frans is co-organizer of the Dagstuhl Seminar *Knowledge Representation for Intelligent Music Processing* and will be General Chair of the International Conference on Music Information Retrieval (ISMIR) in 2010 in Utrecht, Netherlands.

Fotis Jannidis (Technische Universität, Darmstadt) is Professor of German literature. His research interests include literary computing and textual criticism. Fotis is a partner of the TextGrid project, a modular platform for collaborative textual editing. He has extensive experience with the Text Encoding Initiative (TEI) where he once served on the Board.

Bernhard R. Appel (Beethoven-Archiv and the Verlag Beethoven-Haus, Bonn), founding editor of the complete edition of Robert Schumann's works (1986-2006) and chief-editor of the critical complete Edition of Beethoven's Works (since 2007). His expertise is in methods of critical editions, edition of sketches, and problems of historical notation.

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CVs

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Born in 1956, Joachim Veit studied music education in Saarbrücken and Detmold. In 1982, he completed the first state examination in music education and in 1984 received a Master of Arts in Musicology at Detmold/Paderborn. In 1988, he completed his doctoral thesis: "Studies on the early works of Carl Maria von Weber: Analyses of the influence of Abbé Vogler and Franz Danzi". Also in 1988, he became a research assistant in the DFG-funded project "Complete edition of Weber's letters". Veit became a member of the editorial staff of the Carl-Maria-von-Weber-complete edition in 1996 and since 2006 has served as its chief editor.

Veit organized several conferences and colloquia concerning editorial problems of the Weber edition. He gave the first public lecture on the problems of digital editing in musicology in 2002. Since that time he has published several articles and organized or taken part in conferences and presentations in Weimar, Prague, Mainz, Berlin and Paderborn. In 2005, the Weber-edition published the first digital critical edition with volume VI/3 of the critical edition. Veit began his directorship of the DFG-funded project "Edirom" in 1996 and was one of the leading forces in the formation the German TEI workgroups on music encoding and the encoding of letters and diaries. He is a member of the advisory board of the digital Mozart edition and, together with Peter Stadler, convener of the newly-founded Special Interest Group "Correspondence" within the TEI consortium.

Selected publications on editorial problems and digital media

- Die Weber-Briefausgabe als Teil der Weber-Gesamtausgabe und ihre spezifischen Editionsprobleme, in: Komponistenbriefe des 19. Jahrhunderts. Bericht des Kolloquiums Mainz 1994, hg. von Hanspeter Bennwitz, Gabriele Buschmeier und Albrecht Riethmüller (Abhandlungen der Geistes- und Sozialwissenschaftlichen Klasse / Akademie der Wissenschaften und der Literatur, Jg. 1997, Nr. 4), Mainz 1997, S. 136–168 [gemeinsam mit Gerhard Allroggen]
- Joachim Veit und Frank Ziegler, Webers Kopisten. Teil 1: Die Dresdner Notisten-Expedition zu Webers Zeit, in: Weber-Studien, Bd. 3, Mainz 1996, S. 149–161
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- Hase oder Igel? – Musikedition und neue Medien, in: „Alte“ Musik und „Neue“ Medien, hg. von Jürgen Arndt und Werner Keil (Diskordanzen, Bd. 14), Hildesheim 2003, S. 230–263
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und in neuen Medien, in: Mit Fassung. Fassungsprobleme in Musik- und Text-Philologie. Helga Lühning zum 60. Geburtstag, hg. von Reinmar Emans, Laaber 2007, S. 253–274 [zusammen mit Ralf Schnieders]
- Entwurf zur Auszeichnung von Briefen in der Carl-Maria-von-Weber-Gesamtausgabe nach TEI P5 (Fassung ohne Erweiterung der tags, Stand Anfang September 2007), 23 S., online unter: www.adwmainz.de/index.php?id=492
- XML-Briefcodierung mit TEI P5 im Kontext der Weber-Gesamtausgabe (gemeinsam mit Gabriele Buschmeier), Vortrag beim Workshop Digitale Editionen der Arbeitsgruppe Elektronisches Publizieren der Akademieunion in Zusammenarbeit mit der Berlin-Brandenburgischen Akademie der Wissenschaften, 15. bis 17. Oktober 2007 in Berlin, Kurzfassung online unter: http://www.telota.de/nachrichten/workshop-digitale-editionen

Presentations

- „Mediale Revolution? Perspektiven und Probleme neuer Formen der Musikedition“ (Vortrag in der Fachgruppe Freie Forschungsinstitute der Gesellschaft für Musikforschung am 27./28. September 2002 in Düsseldorf); online unter: http://www.edirom.de/das-forschungsprojekt/publikationen-und-vortraege.html
- „Digitale Edition von Musik als fachübergreifende Herausforderung“ (Vortrag beim Internationalen Kolloquium „Digitale Medien und Musikedition“, 16.-18. November 2006 in Mainz); online unter www.adwmainz.de/fileadmin/adwmainz/MuKo_Veranstaltungen/S2-Digitale_Medien/veit2006.pdf
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- „XML-Briefcodierung mit TEI P5 im Kontext der Weber-Gesamtausgabe“ (gemeinsam mit Gabriele Buschmeier), Vortrag beim Workshop Digitale Editionen der Arbeitsgruppe Elektronisches Publizieren der Akademieunion in Zusammenarbeit mit der Berlin-Brandenburgischen Akademie der Wissenschaften, 15. bis 17. Oktober 2007 in Berlin, Kurzfassung online unter: http://www.telota.de/nachrichten/workshop-digitale-editionen
- „Das Auge denkt mit – Editionsprobleme mit oder aufgrund von digitalen Medien?“, Vortrag bei der Tagung „Das Schaffen Antonín Dvoráks aus der Perspektive der heutigen Musikphilologie – Werk, Aufführung, Überlieferung“, Akademie der Wissenschaften und der Literatur, Mainz, 26.-28. Juni 2008

Conferences

- „Musical heritage in the digital age. Prospects and problems of new technical devices“, Symposion during the international congress at Weimar in September 2004
- „Digital editing between experiment and standardisation“, International conference at the Heinz-Nixdorf-Museumsform, Paderborn, Dezember 2007

Johannes Kepper (Project Co-Director, Germany)

Johannes Kepper, born 1980, studied Musicology at the Institute for Musicology at Detmold/Paderborn. In 2005 he completed his master thesis titled "Carl Maria von Weber's hymn: 'In seiner Ordnung schafft der Herr', Aspects of the Work and its Edition". In 2007 he obtained a degree in Computer Science in Media with a diploma thesis titled "File Formats for Music and its Edition". He is currently working on a doctoral thesis about aspects of digital music editions. Johannes began work at the Edirom project in 2003 as a student assistant. Currently, he is a research assistant, a post he has held since 2006, when the German Research Foundation began funding the project under the title of "Creating Tools for Digital Scholarly Music Editions".

Publications

Johannes Kepper und Daniel Röwenstrunk, "Das Edirom-Projekt. Werkzeuge für digitale Formen wissenschaftlich-kritischer Musikeditionen", in: Forum Musikbibliothek, Jg. 28 Heft 2007/1, S. 36–49

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Johannes Kepper, "The Edirom tools as an approach to digital editions of music from the Common Western Notation period", paper of a talk at the Digital Editions symposium at Copenhagen University, January 19th 2008 [http://digitaledition.musikvidenskab.ku.dk/files/proceedings.pdf, 8.4MB]

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Erin Mayhood is Head of the Music Library at the University of Virginia where she directs operations of the Music Library, develops the collections and access to information resources, provides reference serve and user education, maintains the website and serves on a variety of committees. She holds a Bachelor of Music from the University of Ottawa, a Masters of Music from Indiana University, Bloomington, and a Master of Science in Library and Information Science from the University of Illinois at Urbana-Champaign.

In addition to her musical background, Erin's professional focus is on usability and user centered design. As leader of the usability team at the University of Virginia, she has developed a new model for implementing user centered design at the University of Virginia Libraries.

Most recently Erin's work on the research habits of music and other humanities specialists and their functional requirements has led her to contribute to a specialized search interface for music. Though still limited to text searching, the BlackLight music interface indexes information that was previously unsearchable, such as instrumentation and composition era. Erin conducted "wants and needs" analyses to help guide development as well as usability testing to gauge user success using the interface. She also serves on the implementation team that will launch the beta version of BlackLight later this fall.

Erin received usability training from the Nielsen Norman Group where she studied the "thinking aloud" method, a method she uses extensively for product development at the University of Virginia. Currently nine usability study projects are under her direction including the NINES project (a federation of peer-reviewed resources, citation records, and innovative research tools, made freely available to students and scholars of 19th-century culture) and the University of Virginia web pages.

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Review of Henri Lazarof, *Invenzione Concertata for Brass Quintet* [1997]; Tansy Davies, *Keep On Keepin' On [for] Brass Quintet*; Bernard Rands, *Fanfare for Brass Quintet* [1997]; Robert Suderburg, *Entertainment-Sets (Chamber Music X) for Brass Quintet*; Jean Baily, *Hymn for Brass: pour quintette de cuivres (Ensembles de cuivres)*; and Shulamit Ran, *Fanfare for 2 Trumpets, 2 Horns, and Trombone*, arr. Cliff Colnot, in *NOTES: Quarterly Journal of the Music Library Association* 61 (March 2005): 870-4.

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Appendices

Appendix A: Requirements for a Music-editorial Data Format (revised 2008)

Introduction

The future of music-philology will be digital. Although the number of already well-established paper-based scholarly and practical editions will continue to grow over the next few years, no one can deny that they will be accompanied by an increasing number of their digital counterparts. Serious efforts to create digital scientific editions require the encoding of music, i.e., the transfer of the note text into a machine-readable and therefore into a searchable and operable form.

Although already a variety of concepts and data formats for the encoding of music exist, they appear mostly unsuitable for music-editorial demands. For example, a data format that was created for the typesetting of music often lacks support for music-editorial demands, while formats created for analysis generally do not incorporate the graphical aspects of notation. But having the possibility of describing uncertainties and ambiguities is certainly the highest demand on data formats made for editorial purposes. Handwritten notes especially often afford certain latitude for interpretation, which is the basis of any editorial work. Describing this leeway and documenting the corrections within one source and differences between multiple sources is the intention of scholarly music editions. This means that the ability to store this information is an indispensable requirement of a particular data format for this purpose.

This document attempts to specify these requirements by using typical examples. Hopefully, it will provide the foundation for a general discussion about the different concepts for storing editorial data. A comparison based on identical examples will unveil the advantages and disadvantages of different approaches and thus might allow well-informed decisions. Although a small discipline like musicology should always try to use as few different formats as possible and establish own standards, every editorial project needs the ability to choose the format that fits its own requirements best. Comparing the demands formulated in this document and the answers given to them during the Paderborn conference “Digital Editing between Experiment and Standardization” (December 6th – 8th, 2007) with the own project's requirements might facilitate a better-informed decision for or against a certain format. It is already clear that there is no format that satisfies all the different needs in the same way. Therefore, a separate analysis in the light of the own questions and requirements of each project will be essential.

Limits of a standard

Handwritten notes often make special demands on the reader. Generally, however, not all signs within a musical source are equally difficult to read and understand. Passages that are absolutely clear might alternate with completely ambiguous ones.

For an editorial standard, it is important to discuss this problem frankly, as this permits the definition of the format's limitations, not in an arbitrary, but instead in an objectively justified way. Therefore, it is helpful to split the aforementioned difficulties into three *cases*.

1. The *standard cases* consist of manuscripts and prints that are clearly beyond doubt and whose encoding entails no particular challenge. *Standard cases* can thus be handled by most file formats in a satisfactory manner.

2. The *rare cases*, however, are the real reason for a musicological employment. The music text is no longer a clearly interpretable one, but there are ambiguities and

uncertainties, which can only be resolved by an experienced editor and his in-depth knowledge of the object at hand.

3. In addition, there are *edge cases*, which cannot be treated with reasonable effort in printed editions either. Their problems are so unique that no standardized procedure exists. An editor here has to make decisions independently of any given editorial principles.

It is important to stress the point that it is not often that one can make this classification at the work level. More often, a single work contains standard, rare and edge case material.

An editorial data format has to treat the *rare cases* in a standardized manner, as this is the only method to guarantee a comparable and (inter)operable storing of information. The *edge cases* on the other hand are so unpredictable that a format cannot provide a pre-defined structure for them without getting a disproportionate degree of complexity at the same time. In these cases, however, it must be possible to extend the existing format in a standardized and self-documenting manner.

It is certainly not possible to find a clear differentiation between *rare cases* and *edge cases* (or even between *standard* and *rare cases*) and thus lay down clear standards as every rating of editorial problems depends on the repertoire handled with. The full potential of a format covering every *rare case* will hardly ever be needed for one single edition. Usually one will use a flexible chosen subset of the overall format. Nevertheless it should be provided in the standard, because otherwise the danger of different custom solutions for identical problems arises. This would significantly curtail the interoperability between the data of different projects and programs.

Especially in the field of *edge cases* there is often the question of the relationship of expense to benefit for a comprehensive encoding. Here it must be clarified which details should actually be encoded in a formalized and thus machine-readable way and under what circumstances a verbal description of the situation might be the better alternative. There are probably only a very few exceptional cases where it is actually necessary to formally encode the exact course of a slur that was corrected several times (cf. Example 4). Rather, it would be better here to have a substantive discussion of these corrections and their meaning, perhaps supplemented with a reasonable verbal description of the visible shape of the slur and possibly an indication of its location on a given facsimile. The claim of describing a sign as such in a fully formalized way would inevitably lead to a complete re-implementation of *PostScript* (or another graphics format), which makes no sense at all.

In order to compare data formats, it is very important to know to what degree a graphical description of the shape and position of individual signs is possible and how more complicated issues are treated. Also, the question of integration of pre-existing facsimiles arises. This includes the concepts of references to image files as well as the identification of certain areas within an image via percentage or pixel information. The examples presented below may help to specify a reasonable boundary between *rare cases* and *edge cases*. They can help to identify the different approaches for encoding (or giving facsimile-examples of) the corresponding problems.

Coding and interpretation

Reading music is already interpretation. Recognizing a thick point with a vertical line on one side as a note is interpretation based on the previous knowledge of the reader. This raises the question of how to deal with this subjectivity of reading in a necessarily structured and technically explicit data format.

The decoding of music manuscripts is already an editorial activity as it requires intimate knowledge of the handwriting and contemporary habits of the writer.

All passages that are incomprehensible for a third person, but due to his knowledge, absolutely clear to the editor, should be encoded without any signs of doubt or other possible interpretations. Even in a printed volume of a scholarly edition, the parts that are unambiguous from the editor's perspective are not discussed at all. However, once the (encoding) editor considers a passage as equivocal, he must have the opportunity to encode different interpretations and to rate their probabilities directly within the code. Also there must be the possibility to add further interpretations at a later date and thus to improve an edition in the course of time. Therefore it must always be clear who made which additions at which date.

An encoding should be gradually expandable. The first step in doing so is the transmission of the music's written symbols into a data format: "Our task is to encode the written sources, not the (sounding) 'music'."[1] So this step allows us to refrain from a further interpretation of the written notes. Even transposing instruments are encoded based on their typeface instead of the sound they stand for. The information about their sounding might be added in a second step by an editor with the appropriate knowledge.

For countering the depicted subjectivity (or "individual objectivity") on a technical level and ensuring an encoding as transparent as possible, data formats should offer the possibility to indicate responsibilities. This might be done directly within the corresponding file or by means of a standardized interface to an external version control system. In this case there should be a reference to the individual stages in the header part of the files.

Meta-data and comments

For an editorial encoding of music it is essential to store detailed meta-data. First, the *title*, *composer*, *poet*, *creation date,* and *place* for a work have to be stored in corresponding fields. It should always be possible to have more than one record for each field. Furthermore, it must be possible to specify the work within different *catalogue-systems*, which should be identified by name or even better through complete bibliographical reference, and to specify the *genre* of the work.

Additionally, every underlying source of an edition should be described in detail. This includes its *type* (autograph, copy, print etc.), *dimension*, *dating* and *condition* of the source as well as original *prelims*, information about *watermarks* (possibly with a reference to external databases and literature), *rastrology*, *writers* (as far as they are recognizable and identifiable) and information about the *provenances* of the source. For more detailed manuscript descriptions it should be possible to include information on the different pens used and to assign single signs to different writers.

Furthermore, every file has to contain information on the corresponding editorial project and a revision history with accountability, the date and at least a brief description of the changes made.

Within the musical text, it must be possible to group any number of signs (from individual notes over motifs and themes up to full movements) and to add comments on those sections. Whether this opportunity for storing single annotations of an editorial report will be used for publication or internal organization of the editor is irrelevant. In either case the editor needs the ability to

[1] David Halperin: *Guidelines for New Codes*, in: *Beyond MIDI*, ed. by Eleanor Selfridge-Field, Cambridge 1997, p. 574

assign individual tags to these sections. This would allow a classification of individual annotations for instance.

All of the meta-data or comments should be stored within specially designated fields that so they might be automatically selected by software and therefore be interpretable. More information on meta-data will be provided by the examples given below.

Examples

The following examples represent some typical editorial questions. They allow the examination of the different structures, concepts and approaches of the various formats. All information that has to be encoded is explicitly mentioned. Everything that goes beyond these demands might be abbreviated in pseudo-code for a more concise encoding.

It seems to be unlikely that one format can satisfy all requirements formulated in this document. Instead of presenting already working solutions it is more important to discuss different methods or solutions. Since each editorial project has its own individual prerequisites and demands, the examples given here surely illustrate the limits of editorial encoding. Every project has to decide which level of encoding makes sense and which information might be unnecessary. Particularly the fifth example is meant for demonstrating how well a particular standard might be adopted for music outside the *Common Western Music* period. Therefore, not every single problem has to be encoded in detail. Instead, a conceptual consideration and estimation of different possible solutions seems to be more important.

Example 1: Versions / Adaptations of BWV 655, *Herr Jesu Christ dich zu uns wend*, bars 1 - 4

This example of versions or adaptations of the chorale BWV 655 requires the encoding of two divergent sources. Discrepancies are found in both substantial note text and in the articulation. From a musical perspective, the encoding of the soprano clef in the middle voice will be the biggest challenge of this otherwise largely unproblematic example.

BWV 655, Version 1

The two sources differ in the upper voice by the slurs in the second bar and the articulation mark on the second eighth of bar 4. In the middle voice, however, pitches and rhythm vary in the second bar.

BWV 655, Version 2

The coding of this example primarily aims at the connection of two sources of one work. The code should allow one to discover in which source a certain variant can be found. Also, the potential for using nowadays unusual clefs gets reviewed by this example.

Example 2: Carl Maria von Weber, Clarinet Concerto in F minor, 2nd movement, bars 1 to 6

This example focuses primarily on the frequent uncertainty and openness of slurs, ties and the like. Furthermore, it requires the integration of facsimiles as well as the storing of typical meta-data about work and source. (The additionally necessary editorial decisions regarding an actual edition are not part of this example.)

For this example there are two different sources to encode, which should be described with the following information in a standardized manner.

Autograph I:

C. M. v. Weber: Autograph I

This source is located in the Berlin State Library (RISM: D-B) under the signature "Mus. ms. autogr. C. M. v. Weber WFN 11". The following description should be inserted in designated fields as much as possible.

Autograph (score) I with pencil inscriptions of Friedrich Wilhelm Jähns. The inscriptions follow the additions of Heinrich Baermann in Autograph II. 22 sheets with 43 inscribed pages, page 44 empty. Format: 24 x 34 cm paper with 12 staves. On pages 1-19 and 26-43 eleven staves are used, on page 20 and 25 only nine. The music notation is in ink. Autographic pagination with pencil counting pages 2-44. On top of the sheet, "No. 10"; has been written in red crayon by a foreigner. At the bottom of the sheet, F. W. Jähns added "op 73" with a pencil. At the end of the composition (p.43) is a note by Weber: “Vollendet d. 17. May 1811 in München”.

The title page of the source contains the following text (using "|" for line breaks): "Gran Concerto in Fa. b:- | per il | Clarinetto Principale | composto per uso | dell suo Amico, [deleted: il] Signore Baermann | di | Carlo Maria de Weber | Monaco il 17:t Majo 1811."

The source carries as a watermark the lettering "H. OSER". Until the year 1986 it was in the possession of the Weber family and was afterwards given to the Berlin State Library as a gift. However, it has been in the Library's possession since 1956.

Autograph II:

C. M. v. Weber: Autograph II

This source is located in the Library of Congress in Washington (RISM: US-Wc) under the signature "ML30.8b.W4t." It includes 43 sheets, and was examined by Friedrich Wilhelm Jähns.

The title page says: "Gran Concerto | per il | Clarinetto Principale. | composto per uso | [Rasuren] | di | Carlo Maria de Weber | Monaco. Majo 1811."

Regarding the provenance of the source, the following information should be captured:

- 1865, the autograph was owned by Carl Baermann, Munich
- Other stations without dates: Carl Wittgenstein, Hermione Wittgenstein, Wittgenstein family heritage
- 1948, acquired in favor of the Gertrude Clarke Whittall Foundation Collection of the Library of Congress

Musical aspects

The two sources are very similar regarding the music contained. Apart from a few minor differences (accent in bar 4 of the clarinet voice, dissenting names for the clarinet voice, different dynamics for violin 2), the musical substance of the two autographs is absolutely constant. Pitch, rhythm and notational abbreviation in both sources are absolutely identical.

The placing of slurs, however, is a challenge from an editorial perspective. One plausible explanation for the inconsistent inscriptions is that Weber only wanted to mark a *sempre legato* with indistinguishable bow strokes. The following information should be taken into account for a complete encoding.

- The exact position of the individual slurs in the respective sources. Uncertain endings and overlapping slurs should be traceable, for example at the second slur of violin 1 in A1. Here the curved line ends directly at the bar line, so that the slur might be associated with the last note of bar 4 as well as the first one of bar 5. For this problem it is sufficient to demonstrate the different possibilities and explain them with comments.

- The encoding should make clear that all slurs have to be understood as a *sempre legato* though this instruction is nowhere written in the source, but instead derived from the irregularities and variant of both sources.
- Regarding the uncertain shape of the slurs, the available facsimiles should be integrated into the encoding. Then the ambiguous signs could be referred to. This might ease a later assessment by the reader. Again, it is sufficient to discuss the problem only with a few points.

Therefore, this example also deals with the concepts of encoding variants. In this case they affect not the substantial parts of notations, but instead accidental entries. Not clearly defined starting and ending points of slurs and phrase marks are an everyday editorial problem, which therefore should be adequately treated by an editorial file format. At the same time it becomes clear that a completely formalized description of slurs only makes sense up to a certain degree. For this reason the usage of facsimiles shall be demonstrated by this example also. Another important aspect of the example is the treatment of graphical signs, which must not be interpreted in the literal sense, but instead have to be resolved to a general instruction. Due to its detailed meta-data, this example also shows the possibilities for a formalized storing of source descriptions, etc.

Example 3: Ludwig van Beethoven, Waldstein Sonata, Op 53, 1st movement, bars 1 - 4

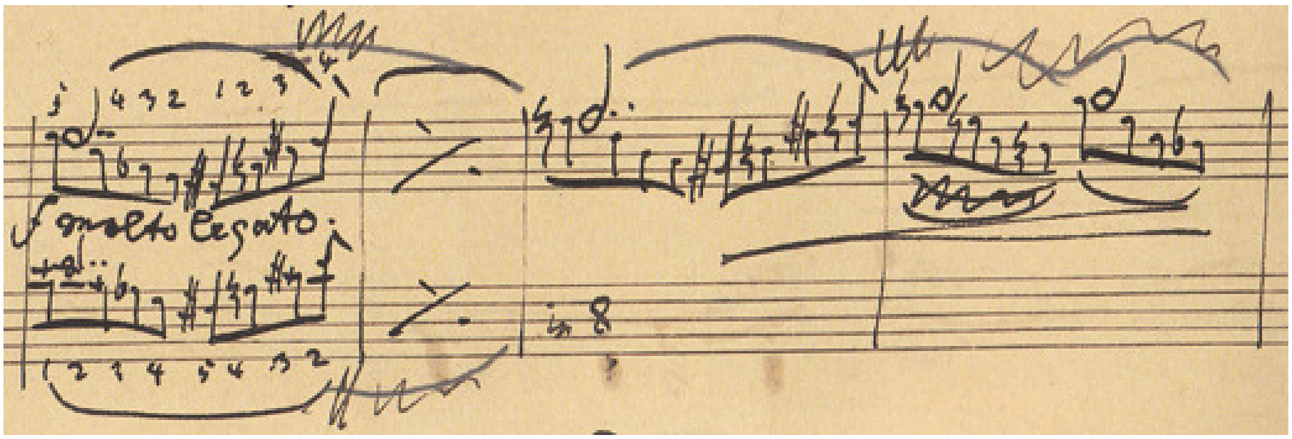
In addition to the problem of identifying voices this typical example of piano music shall demonstrate the difference between graphical sign and corresponding meaning. The encoding should aim to describe the signs found within the source as well as the intentions they stand for.

L.v.Beethoven: Waldstein Sonata, op.53

The code should include the following information: The exact spelling of the two *pianissimo*-directions with double underlining and a following colon, as well as their position in front of the corresponding notes. Furthermore, it should be clear that Beethoven wrote the first three bars of the right hand into the lower system and afterwards switched to the upper stave. The first three bars of the upper system should be marked as empty (not resting). The repetition strokes that start in the second half of the first bar should not only be encoded as a graphical addition. The code must contain the information that these strokes stand for repeated eighth notes. This might be done with an independent element with the appropriate meaning or a standardized hint to the corresponding sound of this shortcut. The encoding of the half-bar abbreviations starting at the second half of the third bar should also contain a graphical description as well as the actual notes they stand for. Furthermore, the *Allegro con brio* must be labeled as the title of the movement, whereas the *Sonata grande* has to be signified as the title of the work. *L. v. Beethoven* must be identified as the composer's name and finally the *Dämpfung | aufgehoben* should be qualified as verbal instruction on the right border of the page, visually rotated by 90° and containing a line break. There is no need to provide exact positions for these textual additions. Concerning the actual music encoding, especially the encoding of accidentals, slurs / ties, strokes and the grace note in the fourth bar are of interest.

Example 4: Johannes Brahms, Capriccio, op. 116, No. 3, bars 9-12

This example illustrates the specific difficulties of a genetic edition. This might give an answer to the question of how well these problems can be treated by the different formats.



J. Brahms: Capriccio, op.116

The substantial text (pitch and rhythm) of this example remains constant throughout the three distinguishable layers of the source. Problems that should be taken into account include the fingering in bar 9, which should be encoded as such (and not as mere numbers). Furthermore, bar 10 should be marked as repetition of the previous bar and in bars 11 and 12 the left hand must be labeled as "8" (ottava) in relation to the right hand. In this example the encoding of the graphical signs written in the source is dispensable, though the corresponding meaning is very important.

Also, the encoding should contain the three recognizable text layers in a differentiated way. Thus, the different stages should be traceable as far as possible.

1st layer: In this layer the actual notes are already written in their final shape. The right hand has three slurs in bars 9, 10 and 11, whereas the left hand has one slur in bar 9. All slurs are of one bars length.

2nd layer: The inscriptions of this stage are written with pencil (this information should be taken into the encoding). The first slur of the right hand was expanded to the next bar whereas the initial ending was canceled.

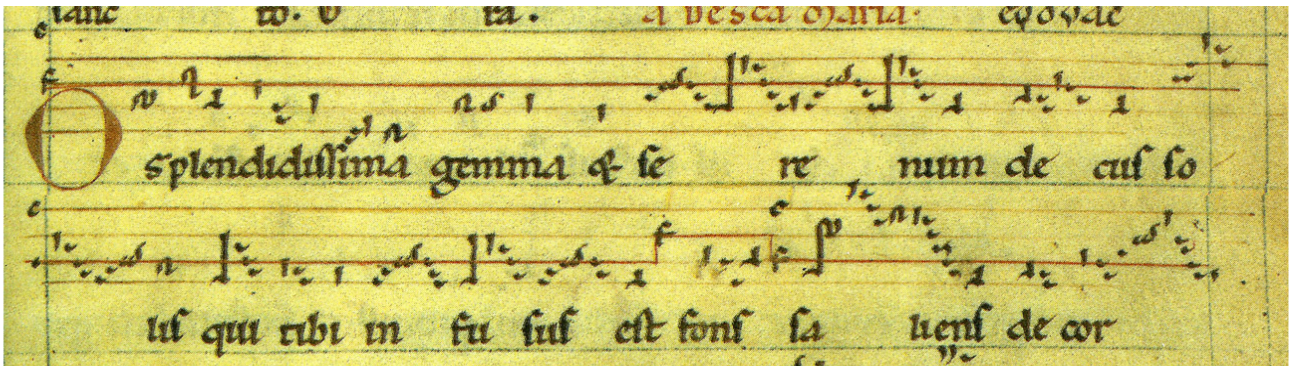
3rd layer: This layer was written again in (a marginally brighter) ink. The additional slurs of the second stage are crossed out except the one in bar 11. The original ending of the first slur of the right hand seems to be restored. Moreover, there are some other uncertainties, which should be taken into the encoding. The first slur in bar 12 (right hand) was crossed out and later rewritten. Here the

> encoding should leave open whether this first slur or its removal belong to stage 1 or 3. Equally unclear is to which layer the *crescendo*-sign belongs. This should be apparent from the encoding as well.

This example has certainly extreme requirements. This makes it suitable for revealing the limitations of a data format. Most interesting are especially the concept for dealing with ambiguities and genetic layers. These problems certainly raise the question of the adequacy of a fully formalized encoding. Perhaps the alternatives of a verbal description or the usage of a facsimile prove to be the more appropriate solution. Both kinds of problems have to be considered as typical editorial situations. Therefore they have to be taken into account as major issues of an editorial file format.

Example 5: Hildegard von Bingen, Antiphon "*O splendidissima gemma*" (incipit)

This example represents the special requirements of a digital edition of medieval music.



Codex Dendermonde (Abbey of Dendermonde, Belgium, Codex 9), f. 154, Lines 7-8: Antiphona O splendidissima gemma [De sancta Maria]

In this area, the difficulties already concern with the fundamental questions of encoding the particular notation system (mensural notation, modal notation, diastematic and adiastematic neumes), which is not compliant to the conventions established around 1600. Among those problems are old clefs, a changing numbers of lines within a stave, the lack of a concrete rhythm or meter, graphically connected groups of signs (neumes, groups within modal notation, ligatures in mensural notation) and their interpretation and notational signs without well-defined pitch (adiastematic neumes).

In addition, there are requirements to encode different interpretations based on varying combinations of signs. These possibilities have to be stored in a potential encoding as well as different readings based on multiple sources.

Although these forms of notation are very special cases, their integration into a data format is of fundamental importance, because on the one hand they represent a good test for the flexibility and expandability of the format, and on the other hand digital forms of publication offer new perspectives for the traditionally very expensive edition of older music.

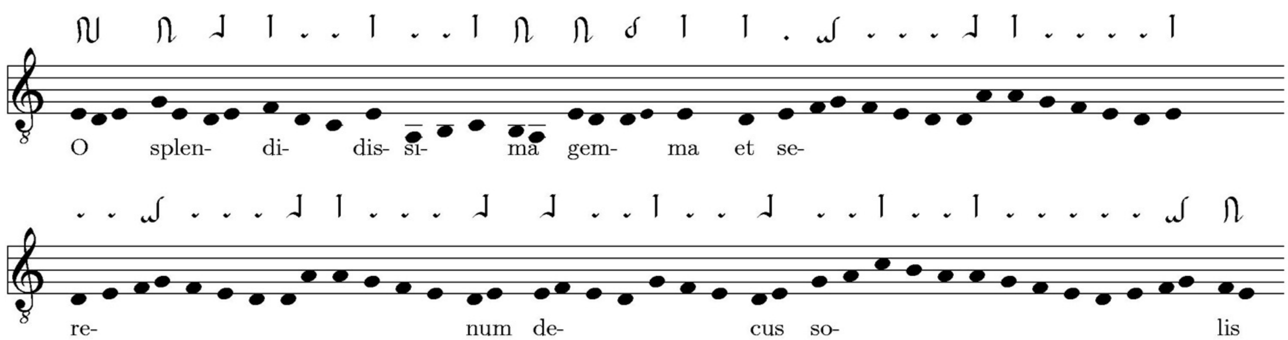
Codex R „Riesencodex“ (Hessian State Library Wiesbaden, Ms. 2), f. 466b, Lines 2-4: Antiphona O splendididissima gemma [De sancta Maria].

The two facsimiles show the beginning of the antiphon *O splendidissima gemma*. The first one is part of the Codex Dendermonde (D), the second belongs to the so called „Riesencodex“ (R). The beginning of the antiphon should be encoded up to "solis" (at the beginning of the second system in Codex D). The edition follows Codex D as main source.

Information on the source (provenance, siglum etc.) and on the antiphon (title, category, page number, number of lines on the page) shall be encoded. Regarding the text, the initial "O" and the abbreviations (e.g., "&" for "et") have to be encoded. The music part should contain the number of lines per system, the c- and f-clef including their positions (which incorporates the f-clef written as a dot at the beginning of the second stave) as well as the system break after "so". Besides the pitch information (represented here by neumes written on lines), the neume signs and their modifications (liquescences for example) have to be encoded. The transcription in so-called "Eierkohlennotation" might support the understanding and encoding of this example. The names of neumes are:

O	porrectus
splen-	clivis (2-tone) + pes (2-tone)
di-	climacus (3-tone)
dis-	virga
si-	scandicus
ma	clivis
gem-	clivis (2-tone) + liqueszenter pes (2-tone)
ma	virga
et	virga
se-	punctum (quadratic shape) + quilisma (2-tone) + punctum + punctum + punctum + pes (2-tone) +climacus (5-tone)+virga

re-	punctum + punctum + quilisma (2-tone) + punctum + punctum + punctum + pes + climacus (4-tone)
num	pes
de-	pes subbipunctis (4-tone) + climacus (3-tone)
cus	pes
so-	punctum + punctum + climacus (3-tone) + climacus (4-tone) + punctum + punctum + quilisma (2- tone)
lis	clivis



Example of a transcription into modern notation (so called „Eierkohlennotation“)

At the end of the syllable "so" it must be possible to read the sequence "a-g-f-e-d-e-f-g" either as Climacus (4-tone) + Punctum + Punctum + Quilisma (2-tone), or as Climacus (5-tone) + Punctum + Quilisma (2-tone). This range of interpretations has to be encoded. The additional punctum g, at the beginning of the syllable "so" in source R, has to be encoded as a variant reading.

More questions for a potential format

In addition to these content-oriented requirements the prevalence of the format must also be taken into account. Is it possible to easily import or convert data from other formats, such as *MIDI*, *Humdrum*, *Muse Data*, etc.? To what extent is the format supported by common notation applications, like *Finale*, *Sibelius*, *Capella*, and *Score*? Is the file format sufficiently described and documented? Is it based on a *DTD* or *XML Schema*? Is the DTD or Schema commented extensively? Does a comprehensive documentation with various examples exist for the format? Do validators exist, that not only check for formal, but possibly even for semantic correctness?

Furthermore, under what license the format will be published? Will license fees accrue from current or future use? Who is responsible for further development? Does an active community support further development? What are the primary concerns of the community members? Do they have mainly commercial interests? In what context do they tend to use the format – music printing, sound generation, analysis, or scholarly-critical editions?

These questions have to be taken into account when evaluating different file formats for a particular project. Due to the complexity of the subject, it is quite improbable that all questions raised in this document can be answered appropriately during the Paderborn conference 2007. Therefore, a conference volume shall be published that documents the current standardization efforts and allows for a more comprehensive discussion of the subject.

File formats are developed for specific purposes. None of the formats discussed[2] in this context is fundamentally better than the others – they always have to be evaluated in the light of the specific editorial problem at hand. But by discussing challenging music-editorial situations and their implications on encoding, a better understanding of the problems in historio-critical editions may be gained. Hopefully, this will lead to file formats that provide greater support for music-editorial issues.

Johannes Kepper, Hildegard von Bingen-Beispiel: Stefan Morent, 11. October 2007

[2] Among them are *MusicXML*, *MEI* and even *Humdrum*.

Appendix B: MEI as an Editorial Music Data Format

MEI as an Editorial Music Data Format

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Abstract

This paper provides an introduction to the design goals for MEI, presents its advantages as an editorial data format, describes the basic structure of an MEI markup instance, and provides examples of the use of MEI.

Introduction

The basic purpose of the Music Encoding Initiative (MEI, pronounced *"may"*) DTD is to provide a standardized, universal XML encoding format for music content (and its accompanying meta-data) and to facilitate interchange of the encoded data. MEI is not designed to be an input code per se, like the Plaine and Easie code; however, it is intended to be human-readable and easily understood and applied. MEI can support the encoding of the visual, gestural, and analytical domains of notation in a way that is flexible, yet formal and verifiable. MEI can also include relationships between elements, support navigation within the music structure as well as to external multimedia entities, allow definition of custom symbols, and support cooperative creation and editing of music markup.

With so many possibilities for music representation, one might well ask, "Why XML?" There are several reasons that XML was chosen for MEI. First, XML is a license-free standard and is not tied to any platform or application. XML provides a human or machine-readable syntax for encoding structured data in a way that allows it to be manipulated and displayed using simple and increasingly standardized and ubiquitous tools. As an XML solution, MEI is flexible, portable, and customizable, making it easy to exchange information regardless of platforms or systems. Second, there are many off-the-shelf parsers available for syntax validation. Creating and designing a representation for music notation is a large enough task. The additional burden of creating and maintaining specialized parsing software for the representation makes the job more difficult. Third, relatively simple tools, such as XSLT, may be used to verify the semantic correctness of the markup programmatically. Fourth, many XML vocabularies already exist for other applications. Expressing MEI in XML allows the possibility of integration of MEI with those other applications. For example, musical notation markup could be embedded in XML representing text, or markup for graphical objects might be contained by MEI. Finally, conversion to and from other formats is relatively easy using any programming language that can read and write plain text. This makes it possible for an XML application like MEI to serve as a "central hub" for any number of specialized representations, thereby decreasing the need for a large number of programs to accommodate all the transformations between the various individual representations and reducing the probability of error when moving data through a long chain of transformations.

One may also ask, "Why use a DTD?" The primary answer is that DTDs offer conceptual and syntactic simplicity. The number and complexity of constructs available in a DTD are somewhat limited compared with other schema-design languages. Therefore, DTD syntax is also limited. However, these limitations are actually advantageous. The relative simplicity of a DTD makes it easier to create, maintain, and interpret. In addition, the existence of parameters entities in a DTD make it possible to allow "revision" of the DTD by the instance document, a particular advantage during the schema design process and when a document may have a peculiar structure not accommodated in the final DTD.

Some Advantages of MEI

Unlike other proposed XML standards that define an entirely new terminology, MEI uses familiar names for elements and attributes; for example, the element for encoding a note is called `note` and the simultaneous sounding of multiple notes is called a `chord`, terms familiar to musicians. Using common music notation terminology has the benefit of making MEI files more human-readable, and makes clear the correspondence between MEI-encoded data and music notation. Similarly, attribute names and values are expressed in terms easily comprehended by musicians and non-musicians alike. For example, duration values may be expressed in measures and beats. In addition, element names, and to a lesser degree, attribute names, may be modified, for example, in order to better fit a particular repertoire, for coding efficiency, or to support a particular interface.

MEI is intended to be comprehensive. It meets or exceeds most of the technical requirements found in Byrd & Isaacson[1]. Simple codes that represent only the information necessary for a particular application seem efficient because they require less development effort and less complex processing software; however, a more comprehensive code is better able to capture the interdependency present in the elements within music. Due to its support for a multiplicity of functional and interchange possibilities, a comprehensive coding scheme is preferable.

MEI provides formal extension and restriction mechanisms. A music encoding solution cannot aim to eliminate all variation. Instead, it must remain flexible enough to accommodate variations in the source material. MEI does this by providing a large set of general-use elements and by allowing the user to choose from multiple methods of encoding based on his use for the data. Much of the encoding is optional so that the encoder is not required to mark up data that is not necessary for the problem at hand, something Huron calls "selective feature encoding".[2] Since no representation can anticipate all of its uses, extensibility is also required. MEI can be extended, via parameter entities, as needed to support the needs of the corpus being encoded. For example, the m.paracontent parameter entity

```
<!ENTITY % m.paracontent
'%n.blockquote;|%n.fig;|%n.list;|%n.table;|%m.textinline; %m.edit;'>
```

may be overwritten in order to eliminate block quotes from the content of paragraphs:

```
<!ENTITY % m.paracontent
'%n.fig;|%n.list;|%n.table;|%m.textinline; %m.edit;'>
```

MEI facilitates encoding of multiple versions of the music content in the same file. Using multiple files increases the amount of work to encode the file, because significant portions of the content in each version are often the same. It also creates a synchronization problem; that is, locating the same point, say the beginning of measure 3, in all the files. An `app` (apparatus) element contains `rdg` (reading) elements, each of which may be linked back to different `source` elements in the header. A reading may contain `app` sub-elements so that variants of variants may be described. This process may be used recursively to any depth necessary. Each reading may be assigned an order, such as for selection or rendering purposes, other than the encoded order. Readings may have different musical parameters, such as different keys or a different number of measures. Most importantly, `app` can even be used when readings do not synchronize with each other; such as, when the encoding of a sketch and the encoding of a published version have a differing number of measures.

Consideration and execution of these design goals have led to favorable comments from Michael Kay, editor of the W3C specification of the XSLT 2.0 language for performing XML transformations, and the developer of the Saxon XSLT and XQuery processing software. Kay draws attention to MEI as one of "two really serious contenders" for the representation of music in XML.[3]

Basic MEI file organization

Before showing specific examples of MEI usage, it is important to have a description of the general organization of an MEI instance.

An MEI file, like many other representations, has a "header + message" structure. This is a commonly-occurring structure because it effectively separates meta-data and data. In MEI these two parts of the file are called `meihead` and `work`. The `meihead` element contains meta-data about the encoded data found in the `work` element.

The header is modeled on the TEI `teiHeader` element and therefore has the same components as in TEI – `filedesc`, `encodingdesc`, `profiledesc`, and `revisiondesc` – plus an `meiid` element. The `filedesc` and `meiid` elements are required. `Filedesc` contains further sub-elements describing the electronic file itself and the sources from which it was drawn. The `encodingdesc` element documents the relationship between an electronic file and the source or sources from which it was derived. That is, it describes the purpose of the encoding and the methods used to create the file. A description of the non-bibliographic aspects of the creation of a work, that is, the languages and sub-languages used, the situation in which it was produced, e.g. the participants, setting, reception history, etc., is provided for by the `profiledesc` element and its children. The `revisiondesc` element provides a place to encode the revision history for the electronic file.

The `work` element of the MEI file contains the actual encoded content. MEI is agnostic regarding the definition of the term *work* – it is simply the thing being encoded. It can be a monophonic song or a complex symphony – the character of the work is encoded in the `work` element's components. The underlying assumption, however, is that the original work being encoded is or can be expressed in a *written* form. A musical work in MEI terms may be a collection of works, such as a printed collected edition or an electronic database of related works.

The `work` element allows `front`, `music`, and `back` components. Critical editions and collections of works often contain extensive text, such as a table of contents, an introduction, commentary, a biography, an index, etc. Accommodating this text within MEI gives control of the text as well as the notation markup to the encoder of the MEI instance and to the music markup community rather than the creators and maintainers of the text standard. In addition to front and back matter, MEI can also encode the introductory or explanatory text sometimes found between sections of a musical work.

The `music` element encodes the musical content of the work. It contains one or more discrete, linear segments, called `mdiv` ("musical division"). An `mdiv` is the highest-level indication of the structure of the composition. For example, a single `mdiv` indicates a single-movement work; however, when a musical work can be broken into several top-level segments, the `music` element may contain multiple `mdiv` elements. The `mdiv` element is a generic one which may be typed – a symphony, for example, usually consists of movements while operas are made up of acts. A part or score may be divided into linear segments or sections. `Section` elements often function as a scoping mechanism for clef signs, key and meter signatures, plus metronome, tempo, and expression markings. Their use also minimizes the need for backward scanning to establish context when the starting point for access is not at the beginning of the score. `Section` elements may also be used for other user-defined, i.e., analytical or editorial, purposes, and arbitrarily nested to any desired level. There is also an `ending` element, a specialized instance of `section` element that may not be recursively nested.

Also allowed within work is the `facsimile` element. `Facsimile` contains a representation of a written source in the form of a set of images rather than as transcribed or encoded text.

The `mdiv` element may contain one or both of two possible views. The `score` element contains a traditional, full open score while the `parts` element contains each performer's view of the work. Score and parts views are intended to accommodate different methods of organizing the markup – no particular presentation is implied, and software may render a collection of parts as a score or a score as a collection of parts. The explicit encoding of two views is necessary because it is not always possible to automatically derive one view from the other. In addition, separating scores and parts can eliminate a great deal of markup complexity.

A `part` element contains an individual performer's view of the score, effectively a mini-score requiring all the encoding features of a full score. The encoding of individual parts is practical when they do not share visual characteristics, such as typeface or page layout, with the full score. Part elements in MEI have little to do with voice leading, which can be encoded using the next attribute available on all event-type elements.

In both score and part views, the `scoredef` element and its sub-elements are used to describe logical characteristics of the encoded music, such as key signature, the "actual" key (as opposed to the notated key signature), meter, etc. and visual features, such as page size, staff groupings and labels, etc.

Within `section` elements several methods of organization are possible, depending upon the time period of the notation and the encoder's needs. For example, the default organization is measure-by-measure, with staff and layer sub-elements within measure. However, staff-by-staff organization is more appropriate for music without measures, e.g. mensural notation. Also, staff-by-staff organization might be preferable for reproduction of the visual layout of the music, while the measure-by-measure approach might be preferable for automated analysis.

Within the measure element, events, not symbols, are modeled. Events are the typical, time-based, discrete atoms of musical data, such as notes, chords, rests, etc. While events may have visual properties, modeling symbols places too much emphasis on presentational qualities and makes the markup less generally useful as a “music” markup standard. The list of elements comprising the event class and the attribute definitions they share are user-definable.

So-called "control events", such as dynamics, ties, phrase marks, pedal marks, etc., depend upon other events, such as notes or rests, for their existence. They often do not fit the principal hierarchy of sections, measures and staves. In addition, they cannot always be treated as properties of other events or forced to conform to the same markup hierarchy. Therefore, a second class of events exists in MEI for these musical elements. However, just as for the event class, the list of participants and the attributes they share are user-definable for control events. It should be noted that some event attributes are "propagated". That is, if not supplied, their values should be obtained from a previous event in the *same measure*. Other attributes are "implied"; that is, their values are contextual and may be supplied later, at the time of rendition, for example (See figure 3c).

An example of the basic structure of MEI files is included in the appendix. For more complete examples, the reader is encouraged to visit the Music Encoding Initiative website at http://www.lib.virginia.edu/digital/resndev/mei/.

Future Development of MEI

The next release of the MEI DTD is planned for the fall of 2008. Among other enhancements, this version will accommodate neume and mensural notations. It will also provide elements for marking scribal and editorial intervention, such as additions, deletions, and errors and their corrections. The DTD will be made available for download at the MEI website.

Despite the extensive comments in the DTD itself, there is a need, due to increasing awareness of MEI, to complete a user guide that will bring together as much as possible the information needed to use it effectively.

Discussion is already underway regarding the relationship of MEI and TEI, with which it shares many goals. MEI can benefit from the expertise of TEI's designers and users. Expressing MEI as something other than a DTD, as a W3C or RelaxNG schema, for instance, would facilitate integration of MEI with TEI and with other vocabularies, such as SVG.

Similar to the path that TEI has taken, a consortium ought to take over the long-term maintenance and promotion of MEI. The DTD is already freely available; however, creating a consortium will place control over MEI where it rightfully belongs – in the hands of the musicological community – thereby making it not only free but also non-proprietary.

Markup Examples

The following code examples are excerpts of complete markup examples presented during the Paderborn conference "Digital Editing between Experiment and Standardization" in response to Kepper and Morent.[4] Space does not permit reproduction and discussion of the complete examples; however, they will be made available at the MEI website with the next release of the DTD.

The examples here are only intended to address some of the functional targets of a representation; they do not represent all the encoding capabilities of MEI. The reader is encouraged to contact the author with questions regarding specific applications of MEI.

Example 1 - Bach, BWV 655, *Herr Jesu Christ dich zu uns wend*, bars 1-4

Primarily, this example demonstrates the musicological need to encode multiple, divergent sources. In order to satisfy this desire, the XML representation must accomplish two things: identify each source and record the differences between them.

The identification of the sources of the encoding takes place within the `sourcedesc` element, a component of the `filedesc` element. Description of the sources, as opposed to the identification of the sources, is optional. In figure 1a the sources have been identified but not described because no description, other than a label, was available to the encoder. More detailed description of sources is illustrated in Example 2.

Figure 1a.
```
<sourcedesc>
  <source id="fassung1"/>
  <source id="fassung2"/>
</sourcedesc>
```

The "note text" of the sources differs in the lower staff of the second measure. Figure 1b demonstrates how to encode this divergence in MEI. At the point that the sources diverge, the `app` element is used to signal variant readings. A `rdg` element is used for each variant. The source attribute on the `rdg` element provides a connection to the description of the source, while the `resp` attribute identifies the person responsible for asserting this reading. The `resp` attribute must point to one of the identifiers declared in the document header associated with a person asserted as responsible for some aspect of the text's creation, transcription, editing, or encoding.

The sources cited in this example also differ in that slurs exist in version 2 that are not present in version 1. A detailed discussion of the encoding of variants of this kind is addressed in the code accompanying Example 4.

Figure 1b.
```
<staff n="2">
  <app>
    <rdg source="fassung1" resp="pdr">
      <beam>
        <note pname="a" oct="4" dur="8"/>
        <note pname="f" tie="i"/>
      </beam>
      <beam>
        <note pname="f" tie="t"/>
        <note pname="e"/>
      </beam>
      <beam>
        <note pname="f"/>
        <note pname="d" oct="5" tie="i"/>
      </beam>
      <beam>
        <note tie="t"/>
        <note pname="c" tie="i"/>
      </beam>
    </rdg>
    <rdg source="fassung2" resp="pdr">
      <beam>
        <note pname="a" oct="4" dur="16"/>
        <note pname="f"/>
        <note pname="f" oct="5" dur="8" tie="i"/>
      </beam>
      <beam>
        <note pname="f" tie="t"/>
        <note pname="e"/>
      </beam>
      <beam>
        <note pname="f" dur="16"/>
        <note pname="e"/>
        <note pname="d" dur="8" tie="i"/>
      </beam>
      <beam>
        <note pname="d" tie="t"/>
        <note pname="c" tie="i"/>
      </beam>
    </rdg>
  </app>
</staff>
```

Figure 1c shows how clefs can be encoded using the `clef.line` and `clef.shape` attributes of an individual staff. It is important to note that it is the *semantics* of the clef that is being encoded, not its actual appearance. By default, MEI provides the possibility of encoding any combination of G, C, and F clefs situated on any line of the staff. The list of clefs may be extended or restricted as necessary.

This figure also illustrates how the `staffgrp` element's `barthru` attribute can be used to encode the fact that the bar lines cut across all the staves in the group.

Example 1c.

```
<staffgrp barthru="true">
  <staffdef n="1" clef.line="2" clef.shape="G"/>
  <staffdef n="2" clef.line="1" clef.shape="C"/>
</staffgrp>
```

Example 2 - Weber, Clarinet Concerto in F minor, 2nd mvt., bars 1-6

Example 2 calls for more complete source description and the recording of the placement of slurs, ties, and dynamic marks. The character strings used as dynamic marks and the use of facsimile images of the sources should also be addressed. The encoding of repetition signs mentioned by Kepper and Morent in this example is taken up in Example 3.

Figure 2a demonstrates a more detailed description of a source than was given in the figures for Example 1. Here the source is described in terms of its publication status, physical characteristics, physical location, and provenance. In addition, the scribal hands found in the source are included.

The publication status of any item is basically either "unpublished" or "published". The `unpub` element is used for the former, while the `pubstmt` element is used for the latter.

The `repository` element is used to contain information about the holding institution. The repository, functioning as a kind of substitute for a publisher in the case of an unpublished item, a "source for the source" if you will, is encoded, not with the physical description of the item, but one hierarchical layer above. Note that the repository element is recursive, allowing repository sub-elements to be used for describing sub-units of the organization. Sub-elements, such as `name` and `identifier`, may also be used within the `repository` element in order to give structure to its content.

Physical characteristics of the source, such as location within the repository, medium, dimensions, etc., are recorded in sub-elements of the `physdesc` element. The `physloc` element is used for data regarding the location within the repository, i.e. the shelf mark or call number. Since it is often used as a form of physical identifier, a diplomatic transcription of the title page may also be included in a `titlepage` element. Please note the use of `p`, `rend`, and `lb` elements used to capture layout and typographic details of the title page. Of note also is the `reg` attribute on the `date` element, used to supply a more machine-readable date than the one in the element's content. There are no specific elements for watermarks or rastrology, however, additional information may be placed within the generic `physmedium` element and a label used to identify its specific content.

Figure 2a also indicates how provenance of a source item may be encoded. Two versions of the provenance information have been provided. The first `provenance` element's content is in a narrative style, while the second has more structured content. The first option may be easier to create, but the second option may be more readily machine-processable – the choice belongs to the encoder. Note the use of `notbefore` and `notafter` attributes on the `date` element to indicate uncertainty of the element's content.

Finally, identification and description of the scribal hands associated with the source are captured in the `handlist` element and its `hand` sub-elements. Here the description is minimal, consisting of only a value for the `medium` attribute; however, the hand element may contain a more detailed description of the character of the hand. The `hand` element is not required to have an identifier, but this is the only mechanism by which it can be referred to later, so the use of the `id` attribute is recommended.

Figure 2a.

```
<source id="a1">
  <unpub/>
  <repository>
    <corpname>Berlin State Library</corpname>
    <identifier>RISM: D-B</identifier>
  </repository>
  <physdesc>
    <titlepage>
      <p>Gran Concerto in Fa. b:-<lb/>per il<lb/>Clarinetto Principale<lb/>
composto per uso<lb/>dell suo Amico, <rend rend="strike">il</rend> Signore
Baermann<lb/>di<lb/>Carlo Maria de Weber<lb/>Monaco il <date reg="1811-05-
17">17:t Majo 1811</date>.</p>
    </titlepage>
    <physloc>Mus. ms. autogr. C. M. v. Weber WFN 11</physloc>
    <physmedium>Autograph (score) with pencil inscriptions of Friedrich
Wilhelm J&auml;hns. The inscriptions follow the additions of Henrich Baermann
in Autograph II.</physmedium>
    <extent>22 sheets with 43 inscribed pages, page 44 empty;</extent>
    <dimensions>24 x 34 cm. paper with 12 staves.</dimensions>
    <physmedium>On pages 1-19 and 26-43 eleven staves are used, on page 20
and 25 only nine. Notation in ink. Autographic pagination with pencil
counting pages 2-44. On top of the sheet stands "No. 10"; written in red
chalk by a foreigner. At the bottom of the sheet F. W. J&auml;hns added "op
73" with a pencil. At the end of the composition (p. 43) is a note by Weber:
"Vollendet d. 17. May 1811 in M&uuml;nchen".</physmedium>
    <physmedium n="watermark">The source carries as a watermark the lettering
"H. OSER".</physmedium>
    <provenance>It was up to the year 1986 in the possession of the Weber
family and was afterwards given to the <repository>Berlin State
Library</repository> as a gift. It has been there since 1986.</provenance>
    <provenance>
      <list form="ordered">
        <item>Weber family <date notafter="1985">until 1986</date></item>
        <item>
          <repository>Berlin State Library</repository>
          <date notbefore="1986">1986-</date>
        </item>
      </list>
    </provenance>
  </physdesc>
  <handlist>
    <hand id="FWJ" medium="pencil"/>
    <hand id="CMW1" medium="ink"/>
```

```
    <hand id="CMW2" medium="pencil"/>
    <hand id="unknown" medium="red chalk"/>
  </handlist>
</source>
```

When the musical text is essentially the same across all sources, but so-called "control events", i.e., phrase marks, text directives, dynamics, etc., are different, the control events may be grouped, based on the source in which they occur, by using the `app` element. The differing phrase marks in measure 1 are shown in figure 2b. Their endpoints are indicated by the value of the `dur` attribute, which functions, not as a true duration, but rather as a time stamp for the endpoint. Comparing the values of the `dur` attribute for phrase `p1` (found in source `a1`) with that of phrase `p4` (found in source `a2`), it can be seen that both phrases extend over the bar line, a fact indicated by the string "1m+", but that `p1` ends on beat 2 of the next measure, while `p4` ends on the 2nd half of the 2nd beat.

If even more exact visual placement is needed, the `ho` attribute, used here on the `dynam` elements, but also available on `phrase`, can be employed. While not shown, the `phrase` element also has attributes that permit its description in terms of a Bezier curve.

Incidentally, the dynamic markings found in this and the following Beethoven example, i.e., *pp:, po:, pp:*, demonstrate that a simple enumeration of modern dynamic marks isn't sufficient for representing the variety of signs that is encountered in manuscript music.

Figure 2b.

```
<app>
  <rdg source="a1">
    <phrase id="p1" place="below" staff="2" tstamp="1" dur="1m+2"/>
    <phrase id="p2" place="below" staff="3" tstamp="1" dur="0m+2.5"/>
    <phrase id="p3" place="below" staff="4" tstamp="1" dur="0m+2.5"/>
    <dynam place="below" staff="2" tstamp="1" ho="-4">pp:</dynam>
    <dynam place="below" staff="3" tstamp="1" ho="-4">po:</dynam>
    <dynam place="below" staff="4" tstamp="1" ho="-4">po:</dynam>
  </rdg>
  <rdg source="a2">
    <phrase id="p4" place="above" staff="2" tstamp="1" dur="1m+2.5"/>
    <phrase id="p5" place="above" staff="3" tstamp="1" dur="1m+2.5"/>
    <phrase id="p6" place="below" staff="4" tstamp="1" dur="0m+2.5"/>
    <dynam place="below" staff="2" tstamp="1" ho="-4">pp.</dynam>
    <dynam place="below" staff="3" tstamp="1" ho="-4">pp.</dynam>
    <dynam place="below" staff="4" tstamp="1" ho="-4">pp.</dynam>
  </rdg>
</app>
```

The "sempre legato" indication for all slurs called for by this example is encoded in an `annot` (annotation) element. Structural and typographical elements, exemplified by `p` and `rend` here, are available within `annot` that allow for rendering its contents in sophisticated ways. Going beyond the simple encoding of the indication, using the `plist` (participant list) attribute it is possible to explicitly link the annotation with all the elements covered by it. The list may be explicit, that is, name every linked element, or it may be implicit, that is, contain a rule by which members of the collection may be discovered.

Figure 2c.
```
<annot
  plist="p1 p2 p3 p4 p5 p6 p7 p8 p9 p10 p11 p12 p13
  p14 p15 p16 p17 p18 p19 p20 p21 p22 p23">
  <p>All slurs must be understood as <rend fontstyle="ital">sempre
    legato</rend> even though this instruction is not written in the sources,
    but instead is derived from the irregularities and variants of both
    sources.
  </p>
</annot>
```

Finally, when all verbal description fails one can rely on a picture. This is why MEI provides a mechanism for including and referring to facsimile images. Not only may entire images be referenced, but also rectangular zones of those images are addressable. Figure 2d shows how annotations may be linked to zones of an image. The image and the zones of interest are first declared for source a2 in the `facsimile` element. Later, the `facs` attribute on `annot` may be used to "point to" the proper zone.

Figure 2d.
```
<facsimile source="a1">
  <graphic width="1446" height="416" href="Weber_A1.jpg"/>
</facsimile>
<facsimile source="a2">
  <surface>
    <graphic width="987" height="436" href="Weber_A2.jpg"/>
    <zone id="p10box" lrx="388" lry="115" ulx="91" uly="32"/>
  </surface>
</facsimile>
. . .
<annot plist="p10" facs="p10box">
  <p>Since this phrase mark ends at the barline, it could be associated with
  the last note of measure 3 as well as the first one of measure 4.</p>
</annot>
```

Example 3 - Beethoven, Waldstein Sonata, Op. 53, 1st mvt., bars 1-4

This example demands that non-musical text be addressed. It also calls for addressing the dichotomy between graphical signs and their meaning, as well as the interaction between the musical content and the staves on which it is written.

The `pghead1` element is provided for text that appears only on the first page and has a table-like layout. Text like this is often found in printed editions, but the text in this example is similarly structured; that is, it has a centered title, composer name at the right margin, and a performance indication at the left. In addition to the work title, the performance indication is also marked as a title. Note the use of the `del` element to indicate the deletion of the composer's name.

Figure 3a.
```
<pghead1>
  <fw>
    <fwr>
```

```
      <fwd><title>Allegro con Brio.</title></fwd>
      <fwd><title>Sonata grande</title></fwd>
      <fwd><name role="composer">
        <del rend="strike">L. v. Beethoven</del></name>
      </fwd>
    </fwr>
  </fw>
</pghead1>
```

The marginal annotation "Dämpfung aufgehoben" contains an explicit line break and is rotated 90 degrees clockwise. Marginalia can be coded with the `anchoredtext` element as in figure 3b. The `x` and `y` attributes are required, but their values can be empty if the exact coordinates of the text's starting point (upper left of the bounding box) are not known. Here the `rotation` attribute of the `rend` element is employed. Please note that `rend` elements may be nested as necessary, e.g., `<rend rend="bold"><rend rend="strike">` and so on, to achieve the desired rendition. Also note that since whitespace in Unicode is collapsible, the line break must be encoded explicitly, using the `lb` element, if it is to be preserved.

Figure 3b.

```
<anchoredtext n="directive" x="" y="">
  <rend rotation="90">D&auml;mpfung<lb/>augehoben</rend>
</anchoredtext>
```

The repetition signs in measure 4 of this example may cause one to ask, "What is being represented, the written symbols or their semantics?" In fact, it is possible to represent both. In figure 3c the `choice` element is used to indicate a divergence of editorial possibilities within a single source. Within `choice`, the `orig` (original) element contains the written form, while the regularized form follows.

In fact, there are two possible regularized forms, contained within another `choice` element, each represented by a `reg` element. The first regularization is intended for print use and resolves the repetition to the short-hand chord notation found in measure 3. The second regularized form is for a sounded rendition and therefore goes beyond the first and resolves the short-hand chord notation. This tree-like representation of decision points may be continued as deeply as necessary. Please note the use of `chord` elements without attributes or `note` sub-elements, to indicate an exact repetition of the preceding chord.

It should also be observed that the `orig` element represents the interpretation that Beethoven's slanted lines are in fact half measure repetition signs and that they should be rendered using the previously-declared alternative symbol `usersym1`.

Figure 3c.

```
<staff n="2">
  <choice>
    <orig>
      <halfmrpt altsym="usersym1"/>
      <halfmrpt altsym="usersym1"/>
    </orig>
    <choice>
```

```
      <reg n="print">
        <chord dur="2" stem.mod="1slash">
          <note pname="b" oct="2"/>
          <note pname="g" oct="3"/>
        </chord>
        <chord dur="2" stem.mod="1slash">
          <note pname="b" oct="2" dur="4"/>
          <note pname="g" oct="3" dur="2"/>
        </chord>
      </reg>
      <reg n="performance">
        <chord dur="8">
          <note pname="b" oct="2"/>
          <note pname="g" oct="3"/>
        </chord>
        <chord/>
        <chord/>
        <chord/>
        <chord dur="8">
          <note pname="b" oct="2"/>
          <note pname="g" oct="3"/>
        </chord>
        <chord/>
        <chord/>
        <chord/>
      </reg>
    </choice>
  </choice>
</staff>
```

As the right hand is temporarily written on the lower staff, the first 3 measures in the top staff should not contain rests. These measures are explicitly empty and in MEI contain `mspace` elements.

In addition, the change of staff between the third and fourth measures in the right hand is indicated in MEI by the use of the `next` attribute on the last rest in measure 3, its value being the `id` (identifier) of the first note in measure 4, e.g., `<rest dur="4" next="n1"/> . . . <note id="n1" grace="acc" pname="c" accid="s" oct="6" dur="16"/>`.

Finally, the double underlined dynamic marks and their positions can be represented using the `rend` element as a child of the `dynam` element and `vo` (vertical offset) and `ho` (horizontal offset) attributes, e.g. `<dynam place="above" staff="2" tstamp="1" vo="-5" ho="-7">`.

Example 4 - Brahms, Capriccio, Op. 116, no. 3, bars 9-12

In this example, the notation represents several stages of composition. An edition of a source like this is referred to as a "genetic" edition.

In figure 4 the `app` and `rdg` elements are being used again. However, in this case the readings do not represent separate sources, but rather different stages of composition of the same source. Therefore, the `hand` attribute is used on each `rdg` element instead of the `source` attribute in order to collect the phrase marks associated with each stage and connect them with the writing medium of each scribal hand. Annotations regarding each stage are included with the collection of phrase marks. Notice the use of the `plist` attribute to link the annotations with elements not described at this point in the markup. As previously demonstrated, phrases may also be linked to facsimile images in order to make their relationship to a particular compositional stage clear.

When it is unclear to which stage of composition some control events belong, they can be recorded without reference to any particular stage as has been done in figure 4 for fingerings. Alternatively, one may relate them to an "unknown" stage/hand. Note that there is no specific element for fingerings in MEI at the present time, these being handled as generic directives with an `n` (name/number) attribute.

This example, like the previous one, also contains short-hand notation, "in 8", which can be represented in its original or in its interpreted form using the same technique described above.

Figure 4.

```
<app>
  <rdg hand="stage1">
    <phrase id="ph1-1" place="above" staff="1" tstamp="1" dur="0m+4.5"/>
    <phrase id="ph1-2" place="below" staff="2" tstamp="1" dur="0m+4.5"/>
    <annot n="Stage1" plist="ph1-1 ph1-2 ph1-3 ph1-4 ph1-5">
      <p>The right hand has three slurs in bars 9, 10, and 11, whereas the
        left hand has one slur in bar 9. All slurs in this stage are of
        one bar's length.</p>
    </annot>
  </rdg>
  <rdg hand="stage2">
    <phrase id="ph2-1" place="above" staff="1" tstamp="1" dur="1m+5"/>
    <phrase id="ph2-2" place="below" staff="2" tstamp="1" dur="1m+5"/>
    <annot n="Stage2" plist="ph2-1 ph2-2 ph2-3 ph2-4">
      <p>The inscriptions of this stage are written in pencil. The first
        slur of the right hand is expanded to the next bar, whereas the
        initial ending is cancelled.</p>
    </annot>
  </rdg>
  <rdg hand="stage3">
    <phrase id="ph3-1" place="above" staff="1" tstamp="1" dur="0m+4.5"/>
    <annot n="Stage3" plist="ph3-1 ph3-2 ph3-3">
      <p>This layer returns to (a marginally brighter) ink. The slurs added
        in the second stage are crossed out except the one in bar 11. The
        original ending of the first slur of the right hand seems to be
        restored. It is unclear whether the first slur in bar 12 (r.h.) and
        its removal belong to Stage 1 or 3.</p>
    </annot>
  </rdg>
</app>
<dir n="finger" place="above" staff="1" tstamp="1" vo="2">5</dir>
<dir n="finger" place="above" staff="1" tstamp="1.5" vo="2">4</dir>
<dir n="finger" place="above" staff="1" tstamp="2" vo="2">3</dir>
<dir n="finger" place="above" staff="1" tstamp="2.5" vo="2">2</dir>
<dir n="finger" place="above" staff="1" tstamp="3" vo="2">1</dir>
<dir n="finger" place="above" staff="1" tstamp="3.5" vo="2">2</dir>
<dir n="finger" place="above" staff="1" tstamp="4" vo="2">3</dir>
```

```
<dir n="finger" place="above" staff="1" tstamp="4.5" vo="2">4</dir>
```

Example 5 - Hildegard von Bingen, Antiphon *O splendissima gemma* (incipit)

The final example illustrates the special requirements necessary for the representation of medieval music. Unlike modern notation in which the text is often thought of as secondary to the notes, medieval notation is more like a "neumed text". That is, the musical notation was believed to be something added to an existing text.

By default MEI takes the modern approach; however, it can also accommodate the structure of medieval notation. After "switching on" this kind of behavior, the `staff` element no longer has modern notation event children. Instead, the principal event is now the `syllable`. The `syl` element holds the textual content of the syllable.

Despite these structure changes, elements are still available for marking rendition and scribal/editorial intervention. In figure 5 the `add` element indicates that the initial character has been added, while the `rend` element records its decoration. Similarly, textual abbreviation, while not illustrated here, can be recorded using the `abbr` element. Other elements might be used here to indicate correction, deletion, restoration after a deletion, text supplied by the editor, etc.

Figure 5a also shows neumes associated with the text. Neume shape varies according to time, place, musical style, and even musical context but there is a common set of names that can be used to identify a neume. This name is placed in the `name` attribute, the values of which may be restricted or extended as necessary. Since a single neume may represent multiple performed pitches, modern `note` elements are available to facilitate sound rendition.

Figure 5a.
```
<staff n="1">
  <syllable>
    <syl n="initial">
      <add>
        <rend color="red">O</rend>
      </add>
    </syl>
    <uneume name="porrectus">
      <note pname="e" oct="3" accid="f"/>
      <note pname="d" oct="3"/>
      <note pname="e" oct="3"/>
    </uneume>
  </syllable>
```

Figure 5b illustrates the basic varieties of neumes in MEI. Uninterrupted neumes consist of a single written gesture, while interrupted neumes are composed of a collection of other interrupted or uninterrupted signs. However, what is considered an uninterrupted sign in one repertoire may be thought of as interrupted in another. Therefore, the value lists for the `ineume` and `uneume` elements' name attribute may be modified independently of each other, allowing any neume to be part of either category.

Figure 5b.

```
<ineume name="scandicus">
  <uneume name="punctum"/>
  <uneume name="punctum"/>
  <uneume name="virga"/>
</ineume>
```

Figure 5c shows how the `altsym` attribute may be used, just as it was in the Beethoven example, to connect the semantic markup of an element with a description of its appearance. Alternatively, one might employ the `facs` attribute described above to link the clef to an area of a facsimile image. The choice of technique depends on whether the connection is intended for rendition (here's how the clef ought to be drawn) or for information (this is what the written gesture looks like).

The number of staff lines may be indicated using the `lines` attribute. If the number of staff lines changes during the course of the notation, the `staffdef` element may be used to re-declare the number of lines.

This figure also demonstrates that with the change in MEI's basic structure for neumatic notation described previously, other changes are effected. For instance, multiple simultaneous clefs may be encoded by using clef sub-elements instead of `clef.line` and `clef.shape` attributes on the `staffdef` element.

In modern notation the meter may be indicated by `meter.count`, `meter.unit`, and `meter.sym` attributes on either the `scoredef` or `staffdef` elements. The indeterminate meter of medieval notation may be accommodated simply by not providing this information.

Figure 5c.

```
<scoredef>
  <staffdef n="1" lines="5">
    <clef line="4" shape="C"/>
    <clef line="2" shape="F" altsym="dotclef"/>
  </staffdef>
  . . .
  <staffdef n="1" lines="4"/>
```

While not required, this example also provides the opportunity to show how language usage and classification information can be included in MEI. Both of these are important for searching collections of files. In figure 5d the `language` element is used to provide both a textual and coded label for the language of the work. In addition, both controlled and uncontrolled keyword terms may be supplied as a search aid. Here the first 2 terms are approved Library of Congress subject headings while the third term is uncontrolled.

Figure 5d.

```
<profiledesc>
  <langusage>
    <language id="lat">latin</language>
  </langusage>
  <musicclass>
```

```
  <keywords>
    <term analog="lcsh">Gregorian chants</term>
    <term analog="lcsh">Manuscripts, Latin (Medieval and modern)
      -- Germany</term>
    <term>Marian antiphon</term>
  </keywords>
  </musicclass>
</profiledesc>
```

Conclusion

No document such as this can answer all the questions surrounding a data format for musicological use. Sometimes the questions are literally unanswerable – the best answer often being, "It depends". MEI is therefore designed to strike a reasonable balance between standardization and extensibility. The capabilities of MEI as demonstrated here are not exhaustive, but are meant to show how we might begin asking the proper questions about music encoding, if not provide immediate answers.

References

[1] Byrd, Donald and Isaacson, Eric. "A Music Representation Requirement Specification for Academia." *Computer Music Journal*, vol. 27, no. 4 (Dec. 2003), pp. 43-57.

[2] Huron, David. "Humdrum and Kern: Selective Feature Encoding." Beyond MIDI: The Handbook of Musical Codes. Ed. Eleanor Selfridge-Field. Cambridge, MA: MIT Press, 1997. 375-401.

[3] Kay, Michael. XSLT 2.0 Programmer's Reference. 3rd edition. Indianapolis, IN: Wiley, 2004.

[4] Kepper, Johannes and Morent, Stefan. Requirements for a Music-editorial Data Format. Typescript. Oct., 2007. Available from: http://www.edirom.de/fileadmin/downloads/Requirements_for_Music_Encoding.pdf

Appendix

```
<mei version="1.8b">
  <meihead>

    <!-- The meiid element is required; however, it may be empty. -->
    <meiid/>

    <!-- Filedesc contains a description of the electronic file. -->
    <filedesc>
      <titlestmt>
        <title/>
      </titlestmt>
      <pubstmt/>
    </filedesc>
```

```
  <encodingdesc>
    <!-- Projectdesc is for describing the aim or purpose for which
    the electronic file was encoded, funding agencies, etc. together with
    any other relevant information concerning the process by which it was
    assembled or collected. Use <revisiondesc> to describe changes
    subsequent to the initial creation of the file. -->
    <projectdesc>
      <p/>
    </projectdesc>

    <!-- Samplingdecl contains a prose description of the rationale and
    methods used in sampling texts in the creation of a corpus or
    collection. -->
    <samplingdecl>
      <p/>
    </samplingdecl>

    <!-- Editorialdecl should be used to provide details of editorial
    principles and practices applied during the encoding of musical text.
    -->
    <editorialdecl>
      <p/>
    </editorialdecl>
  </encodingdesc>

  <!-- Profiledesc contains non-bibliographic details regarding the
  creation of the work, the language(s) used, and classification info. -->
  <profiledesc/>
</meihead>

<!-- The work element is the container for everything else in the document
besides the header, i.e., the musical text and front and back matter. -->
<work>

  <!-- The musical "text" is contained within the music element. -->
  <music>

    <!-- The mdiv element represents the top-level musical division, e.g.
    movement, act, etc. Each mdiv may contain a score or a collection of
    individual parts.-->
    <mdiv>

      <score>

        <!-- Score features/attributes are encoded in attributes. -->
        <scoredef key.sig="1f" meter.count="4" meter.unit="4"
          key.mode="major" meter.sym="common">

          <!-- Attributes of the staffgrp element record features of the
          group of staves, e.g., whether bar lines are drawn through the
          staves or not, the group's label ("Violins"), its abbreviated
          label ("Vlns."), etc. -->
          <staffgrp>

            <!-- Individual staff features -->
            <staffdef n="1" clef.line="2" clef.shape="G" key.sig="1f"/>
            <staffdef n="2" clef.line="4" clef.shape="F" key.sig="1f"/>
```

```
  </staffgrp>
</scoredef>

<!-- A section is a continuous segment of music. -->
<section>

  <!-- Default organization of section is measure-by-measure. -->
  <measure n="1">

    <!-- Default organization within measure is staff-by-staff. -->
    <staff n="1">

      <!-- The staff element contains layers. Layer ≠ voice! -->
      <layer n="1">

        <!-- Events, e.g., notes, chords, rests, etc., typically
        have a collection of features/attributes. -->
        <note id="d1e113" pname="f" oct="4" dur="16" stem.dir="up"
          stem.len="7"/>

        <!-- Some attributes, such as pitch name, oct(ave) and
        dur(ation), may be "propagated"; that is, they are assumed
        to have the same value as the preceding element with the
        same name. This allows the encoding to be compact, thereby
        facilitating hand-coding, but it also makes the markup less
        explicit. The choice is left to the encoder.

        Other attributes, such as stem length and direction may be
        "implied"; that is, determined at a later stage of
        processing (usually by a rendering engine). -->
        <note pname="g"/>

        <chord id="d737e1" dur="8" dur.ges="2" stem.dir="up">

          <!-- The note children of chord elements may inherit some
          attributes, such as tstamp, dur, etc. from the parent
          chord element.-->
          <note id="d1e1002" pname="e" oct="4"/>
          <note id="d1e1018" pname="g" oct="4"/>
          <note id="d1e1035" pname="c" oct="5"/>
        </chord>
      </layer>
    </staff>

    <!-- "Control events", i.e., those that rely on other events
    for their existence, are placed outside the stream of events.
    -->
    <dir tstamp="0" place="above" staff="1">
      <rend fontsize="11.8" fontweight="bold">Not fast.</rend>
    </dir>

  </measure>

  <!-- Page break, system break, scoredef, and staffdef function as
  'milestones'; that is, their attribute values remain in effect
  until new values are encountered. These elements may occur
  between measures; they may or may not signal the start of a new
```

```
            section.-->
            <sb/>
            <scoredef spacing.system="110"/>
            <staffdef n="2" spacing="66"/>
          </section>
        </score>
      </mdiv>
    </music>
  </work>
</mei>
```

Appendix C: Letters of Support

Dr. Eleanor Selfridge-Field

CENTER FOR COMPUTER ASSISTED RESEARCH IN THE HUMANITIES

BRAUN MUSIC CENTER #129, STANFORD UNIVERSITY STANFORD, CA 94305-3076

ELEANOR SELFRIDGE-FIELD, CONSULTING PROFESSOR (MUSIC AND SYMBOLIC SYSTEMS) Fax: (650) 725-9290
Tel: (650) 725-9242 esfield@stanford.edu

23 September 2008

Perry Roland
Alderman Library
University of Virginia
P.O. Box 400155
Charlottesville, VA 22904

To Whom It May Concern:

As someone who has worked with the development of digital tools for music applications for more than two decades, I am very pleased to recommend the project proposed by Perry Roland and others entitled "Digital Music Notation Data Model and Prototype Delivery System." At the present time those wishing to develop digital projects involving musical scores can choose for their archival representation of musical works between relatively stable schemes developed by academic users but poorly supported by software that is easily accessible and easily mastered, or by easily available, somewhat costly commercial software which is not extensible and is not stable from year to year.

The project proposed is ill served by either of these alternatives, since it focuses on repertories which a wide range of special notational needs and on a level of detail in comparative and philological studies (en route to the making of critical editions) which demands extensibility and user control. These requirements cannot be met adequately by the recent but prevalent MusicXML scheme, which is a commercial product focused on the needs of end-users of commercial notation programs, not on those concerned with the unusual notations through which a large part of the repertory studied in university classrooms and performed by professional groups is preserved in physical media.

To bring such repertories into the digital arena without compromising standards of editorial attention to the interpretation of early printed and manuscript music, some kind of new approach must be developed. Roland's efforts on behalf of the Music Encoding Initiative extend back several years. They synthesize sensitivity to the special requirements of musical materials and editorial procedures with the bedrock of the Text Encoding Initiative. They also liberate music scholars from dependence of commercial tools, which are prone to require re-adjustment with every new product announcement and operating system upgrade. Scholars simply cannot survive in the turbulent world of change promoted by commercial vendors.

The test-bed for the development of the Music Encoding Initiative is provided by the German applicants, who have been developing since 2003 or earlier a digital apparatus for graphical comparison of multiple sources of a single musical work. Their collaboration, based at the University of Detmold, involves editors currently engaged in the preparation of critical editions in a wide range of musical periods and locales. The examples on which the application focuses are representative of the diverse problems that can occur in digitizing notated musical sources. No doubt in the interest of practicality, they are far from being exhaustive. It will take substantial amount of time to accommodate a workable number of notational variants and corner cases.

The value of a successful project in this area would be to provide a framework on which scholars and editors of historical repertories of music could stand for a generation or more. That goal seems very worthwhile to me. I do very much hope that both agencies will see fit to enable its pursuit.

Yours sincerely,

Eleanor Selfridge-Field

Digitally signed by Eleanor Selfridge-Field
DN: cn=Eleanor Selfridge-Field, c=US, o=Stanford University, ou=CCARH, email=esfield@stanford.edu
Reason: I am the author of this document.
Date: 2008.09.26 16:37:46 -07'00'

Eleanor Selfridge-Field

Dr. Frans Wiering

Utrecht University

Padualaan 14, 3584 CH Utrecht

(Dept. ICS P.O.Box 80089, 3508 TB Utrecht, The Netherlands)

Faculty of Science

Department of Information and Computing Sciences

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Date
26 September, 2008

Subject
Proposal Digital Music Notation

Page
Page 1 of 3

Dear Mr. Roland,

With this letter I would like to express my great interest in and strong support of your proposed project *Digital Music Notation Data Model and Prototype Delivery System*. This is an excellent and much-needed project, which will constitute an important advance in computational musicology by providing an infrastructure for a wide range of scholarly digital editions. Thank you for the invitation to serve as a member of the advisory board, and I accept this invitation with the greatest pleasure.

As you know, I am one of the organisers of the Dagstuhl Seminar *Knowledge representation for intelligent music processing* (January 25-30, 2009). Music representation for digital critical editions of music will be an important theme of this seminar. Therefore I do hope you will be able to attend this event. Several researchers that are listed in your proposal have already confirmed their presence. It will be a pleasure and an honour for me to offer you the facilities to do preliminary work on this important project during the Seminar.

Sincerely,

Dr. Frans Wiering
Assistant Professor

Dr. Laurent Pugin

CENTER FOR COMPUTER ASSISTED RESEARCH
IN THE HUMANITIES
BRAUN MUSIC CENTER, #129
STANFORD UNIVERSITY
STANFORD, CA 94305-3076, USA

September 25, 2008

To Whom it May Concern:

I write to confirm my special interest and my enthusiatic support for the project ‘Digital Music Notation Data Model and Prototype Delivery System – A DFG/NEH Joint Digitization Program Proposal’.

As a music philologist, computer scientist and expert in the field of optical music recognition for Renaissance music, I can attest the timeliness and the importance of the project. The high quality digital music notation data model that will be developed in this project will be of tremendous benefit not only for music digitization projects, but also for several related fields, such as music philology and music information retrieval. Whereas various initiatives have already covered specific areas of the topic, this project takes an original approach by bringing together a broad range of international experts with a strong interdisciplinary background that will enable a global approach of the problem to be taken. As a member of the working group of the project, I will contribute with my experience in Renaissance music encoding and in computer music notation.

I am pleased to participate in this very important international project. Please do not hesitate to contact me with any questions you may have.

Yours faithfully,

Dr. Laurent Pugin
Visiting Research Fellow
lxpugin@gmail.com

Dr. Stephen Downie

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

J. Stephen Downie, Ph.D.
Associate Professor, and
Director, International Music Information Retrieval
Systems Evaluation Laboratory (IMIRSEL)

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October 13, 2008

Perry Roland
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Dear Perry:

Thank you very much for allowing me to review your “Digital Music Notation Data Model and Prototype Delivery System – A DFG/NEH Bilateral Digital Humanities Program Bilateral Symposia and Workshops Proposal.” The project’s research goals — and the strategies employed to reach those goals — have the very real potential to radically improve access to our collective musical heritage. Furthermore, the strengths brought to the project by its leaders and its proposed participants represent the perfect blend of professional skills and knowledge that will be required to make the project and its outcomes a successful reality.

On a more personal note, I want to thank you for inviting me to serve on the project’s Advisory Board. I accept your invitation with relish. As you know, my IMIRSEL team was recently awarded $1.2 Million from the Andrew W. Mellon Foundation for its “Networked Environment for Music Analysis” project[1]. I am overjoyed at the prospect that our two projects will be able to work collaboratively to meet their mutually supportive goals. I have already begun sketching out some planning ideas on how we might maximize the synergies between our two projects and I will be sending these along to you later in the term. I am especially eager to garner your team’s expertise in helping the NEMA team to design and implement new notation-based NEMA services and tools to help us overcome the embarrassing paucity of high quality digitally encoded symbolic datasets!

Congratulations to you and your team on putting together a first-rate proposal. If there is anything I can do to further enhance the relationship and interactivity between my IMIRSEL/NEMA team and your international team, please do not hesitate to ask.

Sincerely,

J. Stephen Downie

[1] Feel free to share access to the NEMA proposal: http://www.music-ir.org/nema/nema_main_proposal.pdf .