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Going digital: Finding the right path for critical music editions

The development of computer music editing

Music representation is a multi-faceted problem since music can be represented at different levels of abstraction. At the most concrete level, there is the sound itself; that is, how music sounds when played by a musician and, to some extent, how it is conceived in the head of a composer.[1] In a compositional process, the sound is abstracted into the notated score, a highly symbolic representation of the music. In between the sounded music and the notated score there exist a wide range of representations, including iconic or graphical notations that mimetically depict the inflections of the sound, imperative notations, or others, or a mix of these.[2] The multi-faceted property of music representation in the analogical world is naturally reflected in the digital domain. While the most concrete representation of music, sound, can very well be represented digitally, so too can more abstract representations, ranging from uncompressed audio to score formats, with MIDI, a widely-used instrument control representation, in the middle.[3]

1 The Babbitt representation of music makes the distinction between three different domains. We consider here only the ‹acoustic› domain, the sound, and the ‹graphemic› domain, the score, but left out the ‹auditory› domain since it is not directly relevant to our topic. Babbitt, Milton, «The Use of Computers in Musicological Research» in *Perspectives of New Music*, vol. 3, no. 2 (Spring – Summer, 1965), pp. 74-83.

2 A good example of a mixed notation is the tablature that uses symbolic notation for the durations mixed with imperative components that represent how fingers have to be placed on the fingerboard for the pitches.

3 It is also interesting to point out that conversion to the left is considerably easier than conversion to the right. For example, converting a sound recording into symbolic representation remains a challenge for polyphonic music depending on the complexity of the polyphony and the instrument being played.

Each of these representations uses different units: sound samples for audio recording, numeric event codes for MIDI, or music symbols for score representation.

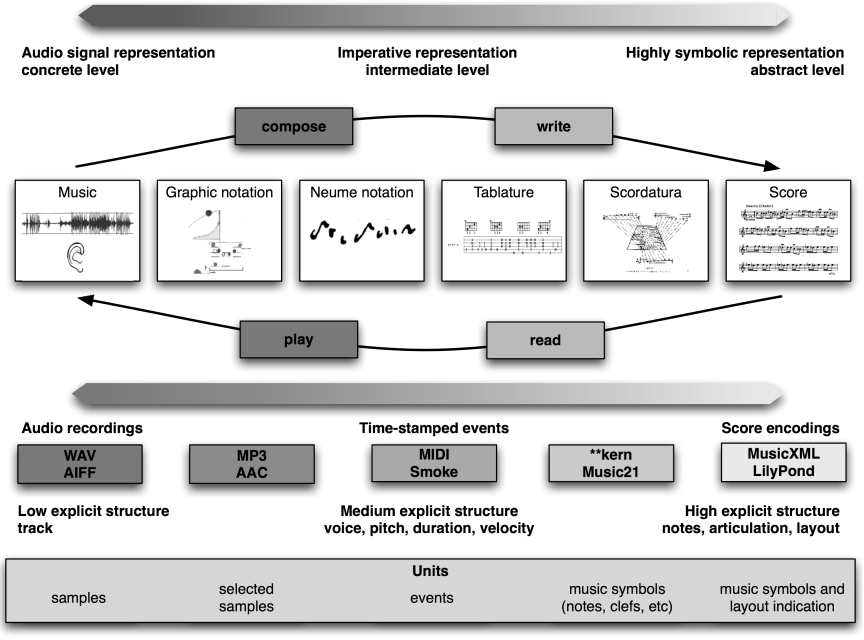

Figure 1. Music representation levels and some corresponding digital formats. Uncompressed audio files have a very low explicit structure that is limited to the track. Encoded notated scores, on the other hand, have a detailed explicit structure that includes musical symbols and layout information.

A notated score, the representation that interests us most when dealing with critical editions, is in several aspects very similar to a literary text. This is confirmed by the fact that historically, media used for notating and transmitting text such as handwritten manuscripts, typographic prints or engraved prints, have all been used or adapted for music, albeit not necessarily immediately. It required a few decades for the newly-invented typographic printing technique introduced by Gutenberg to be applied to music. Petrucci invented a several impression technique for printing music about thirty years later, and it was only twenty years after Petrucci that Attaingnant was able to find a more sustainable solution with a single impression technique. In a similar way, while notating and printing text by computer

became possible fairly rapidly when computers were invented, notating and printing music notation by computer has remained a challenge for decades. The pioneers of music notation by computer started to work on mainframe computers prior to 1980, but it was really the invention of the personal computers in the mid-Eighties that stimulated research.[4] Notating and printing music by computer became a field of research and development in itself, but it took years to develop acceptable and useable solutions. As an example, just for the data input, which for text can be done very intuitively with a computer keyboard, it was necessary to find specific solutions for music using artifacts such as combinations of codes, because both the pitch and the duration (at the very least) need to be given. The emergence of MIDI, the *de facto* standard for instrument control, opened up new ways of inputting data even if data quantization or enharmonic transcription of MIDI data remain problematic. Researchers were for a very long time heavily constrained by the restricted amount of memory available on the computers of the time and by the limited speed of their processors, and the computer resources required for achieving the goal attest to the difficulty of the task. Interestingly, the efforts to notate and print music by computer not only highlighted the complexity and the multifaceted property of music notation, but also brought to light all the skills and knowledge involved in music edition preparation, and in particular for creating the layout of music on the pages of an edition and for distributing appropriately the music on the staves. For example, it quickly appeared that aligning the notes according only to their respective duration would produce correct and understandable scores that would, however, undoubtedly be aesthetically unsatisfactory. For the result to be acceptable, the polyphonic context has to be taken into account.[5] In a certain way, it meant that the engraving rules normally applied by the original music engravers had to be formalized and implemented, and layout capa-

4 For a detailed description of the systems being developed at that time, see Hewlett, Walter B. and Selfridge-Field, Eleanor (eds.), *Computing in Musicology,* vol. 2 (1986).

5 Layout of text is of course not a straightforward task, but the two-dimensional property of music notation certainly makes it more difficult. See Blostein, Dorothea and Hakken, Lippold, «Justification of Printed Music» in *Communications of the ACM*, vol. 34, no. 3 (March 91), pp. 88-99; Hakken, Lippold and Blostein, Dorothea, «A New Algorithm for Horizontal Spacing of Printed Music» in *Proceedings of the 1995 International Computer Music Conference,* Banff, Canada, 1995, pp. 118-119.

bilities of music notation software applications have always been pivotal features for evaluating their strength.[6]

The primary focus of developments in music notation by computer has been the creation of tools for the production of printed music editions, be they low-cost music editions or scholarly critical music editions. Due to the limitation in digital data storage that was available early on, data files developed for music notation software applications were mostly binary files; that is, files that are not human-readable and that are machine-readable only with full specifications in hand. This situation was reinforced by the fact that most music notation software applications are commercial products for which companies do not necessarily want to share their internal data structure, and usually quite the reverse. This has meant that dozens of ways of encoding music notation have been developed without any specification made available, or with only scarce documentation, and without making them compatible between each other. Even the musical codes that were made open (DARMS or SCORE for example) proliferated only because the goals pursued covered a wide range of computer applications that are not necessarily limited to music notation.[7] In this context, a few initiatives have tried to bridge the tools, among which we can mention the Notation Interchange File Format, or NIFF, started in 1994. The aim of NIFF was to become a standard file format for exchanging music notation data between editing and publishing software applications as well as from scanning software applications. Even though it has been used by a certain number of tools, it failed to become a reference standard and is no longer maintained. The most successful initiative is undoubtedly MusicXML, created by Michael Good.[8] The format uses XML[9] and was heavily inspired by the MuseData format developed by

6 Pountain, Dick, «Following in Wolfgang's Footsteps» in *Bytes* (March 1992), p. 921S-20.

7 See Selfrige-Field, Eleanor (ed.), *Beyond MIDI: The Handbook of Musical Codes*, Cambridge MA, The MIT Press, 1997.

8 Good, Michael, «MusicXML in Commercial Applications» in Hewlett, Watler B. and Selfridge-Field, Eleanor (eds.), *Music Analysis East and West* (Computing in Musicology vol. 14), Cambridge MA, MIT Press, 2006, pp. 9-20.

9 XML, which stands for «Extensible Markup Language,» is a widely used markup language that offers the advantage of being both machine-readable and, to some extend, human-readable. It is a subset of SGML and presents similarities with HTML in the sense that is uses <tags> to structure the data and to delimit content.

Walter B. Hewlett at the Center for Computer Assisted Research in the Humanities at Stanford University. It succeeded in becoming a standard path for exchanging data between music notation software applications, even though it never became an official standard. In 2011, MusicXML was acquired by MakeMusic, the publisher of the Finale music notation software application.

The experience of text studies

Already from the early Eighties, scholars working with digital tools for representing texts began to face the problem of seeing a wide range of different tools being developed using incompatible data formats. Everybody had their own opinion on how text data should be represented, developing very specific solutions suitable most of the time only for a particular project. Fairly quickly, scholars became aware that this was by far not ideal and that it was even a dangerous path. The digital data generated were mutually incompatible and each approach required a dedicated tool to be developed; worse still, if the tools were no longer maintained, data could rapidly become unreadable, and hence unusable because in most cases binary formats were used due to computer memory limitations. Considering this precarious situation, a group of scholars established in 1987 the Text Encoding Initiative, known as TEI, with the aim of providing scholars with guidelines, or recommendations, on how text should be represented for projects in the digital humanities; that is, how to encode machine-readable texts. Three sponsoring organizations undertook the work of developing the guidelines: the Association for Computers in the Humanities, the Association for Literary and Linguistic Computing, and the Association for Computational Linguistics.[10] In 2000, the project was established as a Consortium, and guidelines have been updated regularly. 2002 saw the release of the P4 version of the recommendations, the first one to use XML, and the current version named P5 was released in 2007.

10 For more information about TEI, see <http://www.tei-c.org> [All links referred to in this text were accessible in March 2012].

TEI has been widely adopted and is clearly recognized as the reference standard for encoding texts, even if strictly speaking it is not a standard but only a set of recommendations. TEI now plays a fundamental role not only in text digital data sharing, but also in long-term preservation. This has been made possible thanks to a clear separation of data and tools, which is a key requirement for large-scale and long-term projects. Technology evolves extremely quickly, and data have to remain readable and usable even when the tools used to generate, manipulate or visualize them become obsolete. Making a clear distinction between data and tools and keeping them as independent as possible is a very wise approach and certainly a major contribution of TEI in text studies.

TEI is organized into several modules, each of them focusing on specific aspects of text encoding. While the first modules are related to general document structure, some more advanced modules are dedicated to specific topics, such as verse encoding, dictionaries, or encoding of name or dates. One of the modules is dedicated to critical editing: the module 12 Critical Apparatus in the P5 version. The module contains a whole range of tags that enable variants and readings to be encoded in a very detailed way. In TEI, variants and reading are conceptually absolutely identical to the notes we would expect to see listed in a printed critical apparatus. The main difference is that they are placed directly within the text. Wherever a critical note needs to be inserted in the text, an <app> tag representing an apparatus entry occurs, with all the content of the note (e. g., with all the variant readings of the text). The formatting of the notes, and possibly their grouping into a list of critical notes, is left to the rendering tool, respecting the clear separation between data and tools that we underlined earlier. The Critical Apparatus module is very often used in conjunction with the modules dedicated to source description and to facsimile, a combination that makes TEI a perfect structure for creating digital critical editions of text.

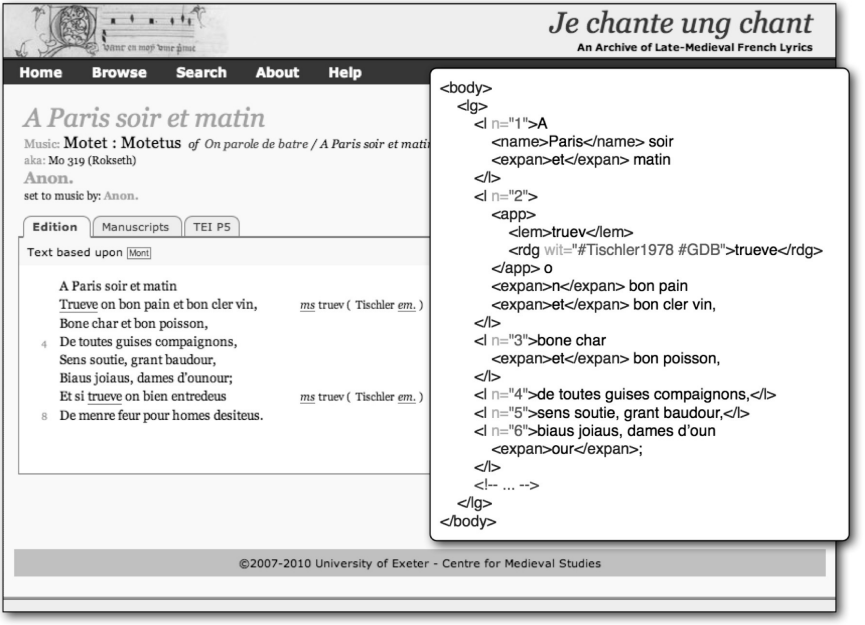

Figure 2. An example taken from the Archive of Late-Medieval French Lyrics with the XML transcription in TEI. The second line of text includes an <app> tag for a critical note with a reading encoded in the <rdg> tag.

Music digital editions

Over the last decade, music digital editing has become a new research field showing a fascinating potential for creating and publishing scholarly critical editions using digital technology. The benefits of the digital editing approach over traditional printed books have been described through abstract models and case studies.[11] At the same time, several projects have been launched, covering a wide range of music history from

11 Wiering, Frans, «Digital Critical Editions of Music: A Multidimensional Model» in Crawford, Tim and Gibson, Lorna (eds), *Modern Methods for Musicology: Prospects, Proposals and Realities,* Aldershot, Ashgate, 2009, pp. 23-46.

the 11th century, such as the DiMusEd–TüBingen[12] project, to the 19th century with Edirom[13] or the Online Chopin Variorum Edition[14] (OCVE) project. Some of the projects are still exploratory, or at very early stages, but several projects are actually producing new editions and are already beyond experiments. Among them, we can mention the Computerized Mensural Music Editing[15] (CMME) project, and Edirom. The CMME project was started in 1999 and has already published five edition sets, including the Occo Codex and the Bayeux Manuscript.[16] The project team has developed a dedicated music notation software application for preparing the editions, which are then published online through a web-based viewer and can hence be consulted using a standard web browser with a Java plug-in installed. It uses a tailored XML encoding designed specifically for 14th-16th century Europe music notation. The strength of the project lies in its ability to offer the reader great flexibility when consulting the edition with for example the possibility of changing from original notation to modern notation, and of hiding or showing variants directly in the edition. The Edirom project, begun in 2003, took another approach by packing the editions into a desktop software application that can be distributed through CD-ROMs or that can be made available for download.[17] The main difference with CMME is that the editions produced by the Edirom project make extensive use of facsimiles of primary sources, including handwritten manuscripts and printed editions. One key aspect in the Edirom editions is that the editor can create links between the different facsimiles, enabling the user very easily to compare the different versions by displaying automatically the same passage in different sources. Both projects illustrate different aspects of music digital editions. Digital editing, as envisaged and demonstrated by

12 <http://www.dimused.uni-tuebingen.de>.

13 <http://www.edirom.de>.

14 <http://www.ocve.org.uk>.

15 <http://www.cmme.org>.

16 Dumitrescu, Theodor and van Berchum, Marnix, «The CMME Occo Codex Edition: Variants and Versions in Encoding and Interface» in Stadler, Peter and Veit, Joachim (eds.), *Digitale Edition zwischen Experiment und Standardisierung* (Beihefte zu editio 31), Tübingen, Max Niemeyer, 2009, pp. 129-146.

17 Bohl, Benjamin, Kepper, Johannes and Röwenstrunk, Daniel, «Perspektiven digitaler Musikeditionen aus der Sicht des Edirom-Projekts» in *Die Tonkunst*, vol. 5, no. 3 (July 2011), pp. 270-276.

these two projects, is similar however, because both are a new way of providing the reader with an edition with which he can interact dynamically. It is certainly a major breakthrough in music editing.

Before going further, it is useful to clarify what we define by a music digital edition. Is an online score in PDF a music digital edition? How does it differ from the projects mentioned above? One can argue that it is a digital edition because a PDF is a digital file distributed through a digital network. It is important to understand, however, that music digital editions as illustrated with utmost clarity by the CMME example above, distinguish themselves significantly from music editions published online as PDF files. There is of course no value judgment involved in this distinction, but editions available in PDF files are mostly static and offer no or very limited options for dynamic interaction, except perhaps for text or lyric searching, and should be seen as digitally published editions rather than actual digital editions. In that sense, the expression «digital publications» rather than the expression «digital editions» seems more appropriate to define them. The fundamental difference is that a PDF file does not contain the logical structure of the music, nor the logical structure of the edition. The logical structure of the music notation is represented in the music notation software application, both internally and in the data file, but is not maintained in the PDF file. A PDF file is a set of graphics (lines, note heads, lyric, etc.) that are not musically meaningful, and even if a PDF is a digital file generated using a digital tool, it does not include any information representing the structure of the music notation. In a PDF file, a line is a line, and no distinction is made between a staff line, a bar line, or a stem line, for example. Similarly, the organization of the edition itself is usually not represented in an online PDF edition, or only very primitively. In a typical editorial process for creating an online PDF edition, the music section of the edition will be generated with a music notation software application, and the commentary texts and the critical apparatus separately, using a text editor. The links between the different parts of the edition will use in most cases a referencing syntax similar to that found in printed editions, e.g., bar numbers and beat numbers. That is, there will be no digital links between the critical comments and the score.

What we expect to find as the backbone of a digital edition is data where both the logical structure of the music notation and the logical organization of the edition are themselves represented digitally. Providing a model for handling such a representation is the goal of the Music Encoding

Initiative (MEI) established in 1999 by Perry Roland of the University of Virginia (VA), one of the leading institutions in digital humanities.[18] Directly inspired by TEI, it pursues the same general goals but specifically for music. In the same way, it uses XML markup and acts as a set of guidelines for recording the intellectual and physical characteristics of documents, with a focus on music notation. MEI covers a wide range of music notations, including neumes or tablature. It is flexible and modular and can easily be adapted or augmented for particular needs. One strength of MEI, as compared to other XML-based musical codes, is that it includes a whole set of philological features for describing variant readings and for including critical comments together with links to facsimile images.

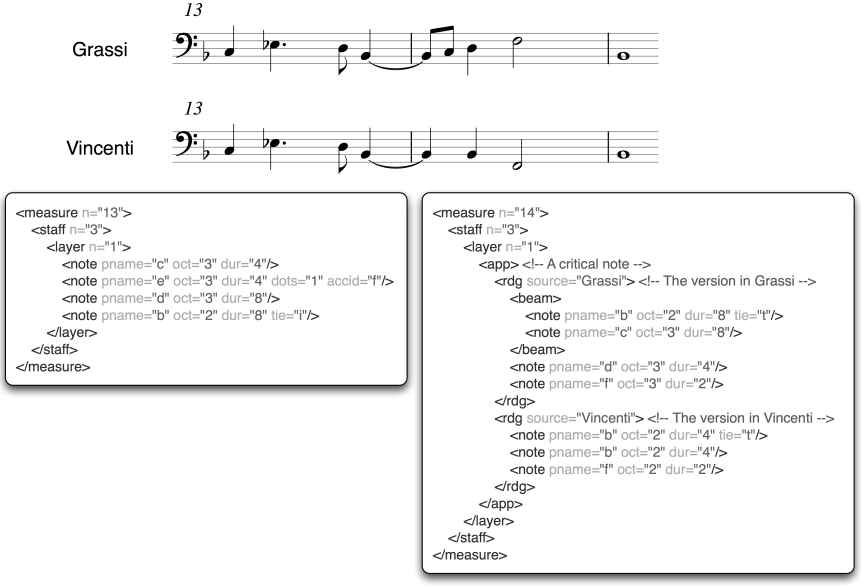

Figure 3. A snippet of MEI encoding for a passage where two editions (Grassi and Vincenti) present a variant in the Canzona XXIII *detta la Franciotta* by Frescobaldi. The <app> (apparatus) element in measure 14 contains two <rdg> (reading) elements, the first one for the version in Grassi and the second one for the version in Vincenti.

18 Roland, Perry, «MEI as an Editorial Music Data Format» in Stadler, Peter and Veit, Joachim (eds.), *Digitale Edition zwischen Experiment und Standardisierung* (Beihefte zu editio 31), Tübingen, Max Niemeyer, 2009, pp. 175-194.

These unique features make MEI a very promising approach for encoding music digital editions. This potential has become more and more recognized over the last years, and MEI is now actively developed by an increasing community of scholars.[19] The first official release of the XML Schema was made in 2010, and a second version is in preparation.

In several aspects, creating a paper-based music edition or creating a digital music edition is a similar editorial process. The starting point is the selection of the primary sources, to which access must be organized.

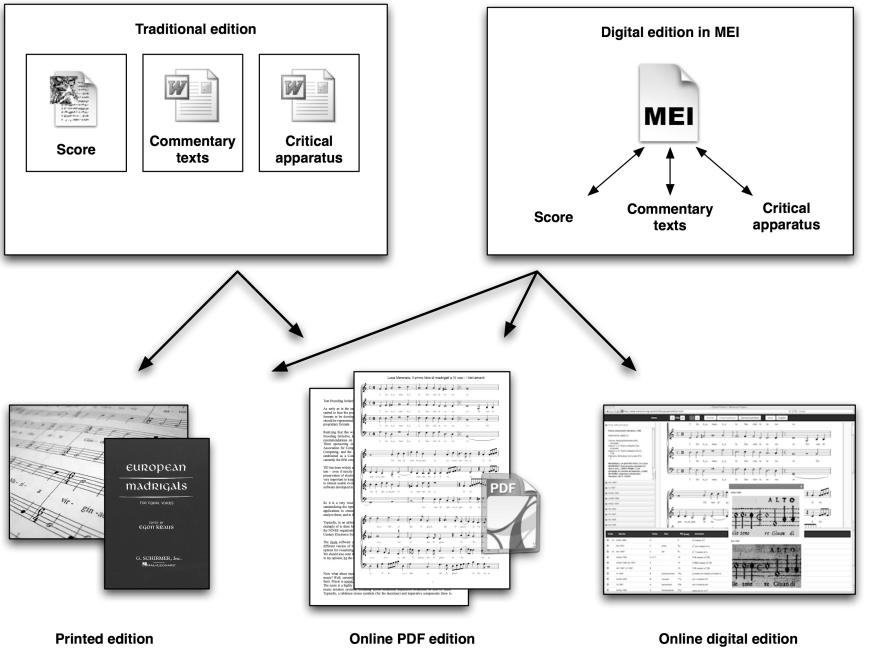

Figure 4. The organization of a traditional edition and of a digital edition in MEI. Producing a printed edition or an online PDF edition is possible with both approaches. Turning it into an interactive online digital edition requires the logical structure of the edition to be given, which is usually lacking in a traditional edition.

19 The development of MEI is currently supported by the Bilateral Digital Humanities Program of the National Endowment for the Humanities (USA) and the Deutsche Forschungsgemeinschaft (Germany).

The sources are transcribed and compared, and the critical apparatus is built upon editorial criteria that must be defined. Finally, the critical edition can be published together with its additional material, including introductory texts and comments. This is obviously an extremely shortened overview of the process, but the point is that both paper-based and digital editions have deep similarities, and it is not impossible for a project initially intended to produce a paper-based edition to be re-targeted to produce a digital edition, or both. In the end, the main difference will be the tool used for creating and publishing the final result. Changing the publishing option or choosing to have multiple publishing options can be possible even fairly late in the process, and it does not radically change the philological principles. However, all options remain feasible, or at least easily executable, only if the option that explicitly includes the logical structure of the edition is available; that is, the digital edition as envisaged by MEI.

This interchangeability means that the choice of digital edition does not preclude the printing of a paper-based edition at some point in the process. Quite the contrary, it can be a valuable path since a digital edition can act as a reservoir where the editions in preparation can be accumulated before moving to the printing step that would occur only when the project has reached an acceptable level of development. Such an approach could avoid recurrent problems typical of critical edition series where the editorial choices made for the publication of the first volume(s) of the edition later appear to have been inappropriate and must be modified for subsequent volumes. It can also be very beneficial when the sources involved in the preparation of the edition are remarkably problematic, for example in the cases of manuscripts with dubious attributions. The edition can be prepared and still made available digitally, with the option to correct it whenever necessary, before printing the entire series when its level of completeness is satisfactory.

Perspectives for sixteenth and seventeenth century music

For many years, MEI has been acting mostly at a theoretical level, and very few digital tools have been developed for handling MEI encoding, most of them being essentially conversion tools for transforming MEI from or to another musical code. Focusing at the theoretical level avoided MEI being

influenced or polluted by concepts that are application specific and was in that regard a worthwhile position for gaining a clear distinction between data and tools. As learned from the experience of TEI, it is a very wise approach and indubitably an important contribution of MEI. Formalizing and standardizing the representation might remain unproductive, however, if dedicated tools for handling it are not available. Software applications are necessary to create data, software applications are necessary to edit data, analyze them and eventually to publish them. It is particularly true for MEI and musical codes in general since the code itself, even under its ASCII human-readable format, is not or barely understandable as is. While for text encoded in TEI a fairly simple transformation can make it perfectly readable without necessarily implementing all the features of TEI, achieving similar results for MEI is a complex task. If the situation for MEI is changing thanks to the engagement of the community, the lack of tools is still the Achilles heel of MEI. It is certainly the main reason the Edirom project still relies mainly on the use of facsimile images when it comes to representing music notation. It is also the reason the OCVE project, even though it is not directly an edition project and is not based on MEI, achieves a comparison of the sources similarly by juxtaposing facsimile image snippets. Though both projects are leading enterprises and accomplish wonderful results, neither handles visual representation of transcriptions of the facsimile images because rendering 19th century music notation outside a music notation software application is, and will remain, a challenge due to the complexity of the music notation of the time.

The situation for sixteenth and seventeenth century music is different and some developments achieved over the last decade have made it possible to explore new horizons that could not be envisaged ten or twenty years ago. On the one hand, dedicated tools designed for transcribing sources and for creating music editions of late Renaissance or early Baroque music have reached a high level of development. In particular, the Aruspix and Gamera projects made it possible to perform optical music recognition (OMR) on typographic prints, which makes it conceivable to obtain a transcription of the original sources of the repertoire in a digital form very quickly.[20] On the other hand, the music notation of the reper-

20 Pugin, Laurent, Hockman, Jason, Burgoyne, John Ashley and Fujinaga, Ichiro, «Gamera versus Aruspix: Two Optical Music Recognition Approaches» in *Proceedings of the 9th International Conference on Music Information Retrieval (ISMIR 2008)*, pp. 419-24.

toire is not too complicated and certainly significantly less challenging to represent than 19th century piano notation. A madrigal score is undoubtedly simpler than a prelude of Chopin, regardless of the editorial problems each of them might raise. Having tools to transcribe sources in a digital form and at the same time a notation with a complexity that make it realistic to represent it in digital environment outside a music notation software application put the repertoire of the sixteenth and seventeenth century in a privileged situation in the development of digital editions.

Over the last decades, more and more projects in the digital humanities have adopted web-based solutions instead of CD-ROMs, widely used in the Nineties, or application-like tools that need to be downloaded and installed on a personal computer.[21] Web-based solutions offer the advantage of being easily accessible and easier to maintain since only the server side, data or tools, needs to be updated. For publishing digital editions, web browsers seem a very natural way forward because what is needed in a digital edition is essentially the ability to display text, to display images, and to activate links. These are the quintessential components of a digital edition, and they have been available for text since the Nineties when the Internet and the very first web browsers were invented. For digital music editions, web browsers have not been used extensively for displaying music notation, with the exception of the DiMusEd–TüBingen and the CMME projects, for the simple reason that displaying musical text in a web browser is as difficult as representing it in a music notation software application and there is not yet a straightforward and standard solution to this problem. In the case of the Marenzio Online Digital Edition (MODE), an editorial project that aims to produce a complete critical edition of its secular music, we set up a prototype that illustrates how music, critical material and images as encoded in a MEI digital edition can be presented together in an interactive and intuitive way.[22] An innovative aspect of the prototype is that the music is rendered natively in the web browser using the scalable vector graphics (SVG) format, a standard particularly well suited to user interaction.

21 It is the case of the Edirom project which is currently developing a web browser version of their tool. <http://www.edirom.de/software/>.

22 The prototype has been developed as part of the Aruspix software application, which itself uses visualization functions of the Wolfgang music notation software application.

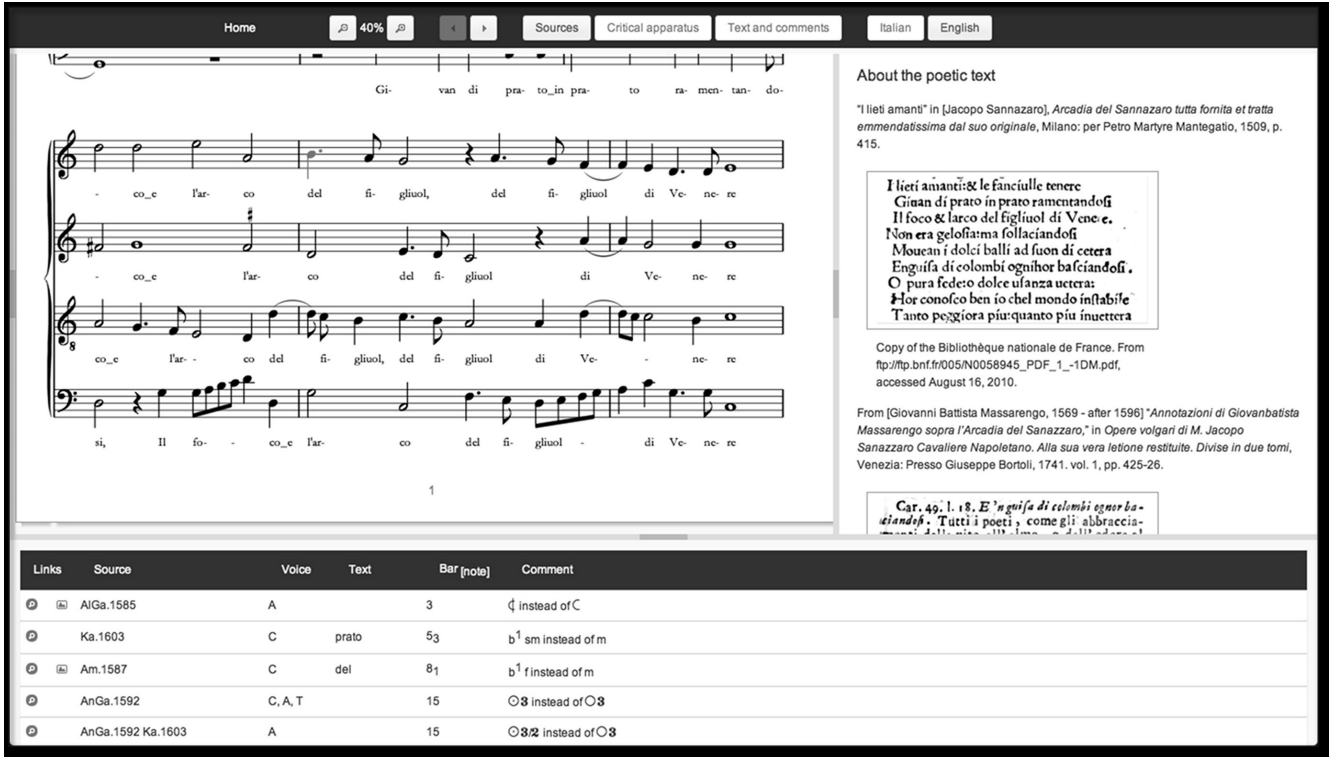

Figure 5. The digital edition prototype of the Marenzio Online Digital Edition project where the music is display natively in the web browser in an interactive way. For example, the critical notes are linked to the music notation, which means that clicking on them will immediately load the corresponding page and highlight the symbols in the score.

With such an approach, no software or plug-in needs to be installed for the visualization of the edition, which drastically reduces the problems related to software distribution and to web browser compatibilities. In the prototype, the user can turn the pages like a book, but also zoom in or out with a very high display quality. When it is relevant for the user, facsimile images are also included, and the critical apparatus can be displayed below the music page. The critical notes, which follow standard philological practice, are very easy to read and follow because they are displayed together with the music.

While the prototype still operates at an experimental level, it nonetheless shows the potential of having on the one hand a tool that is platform and web browser independent, and on the other hand data in a standardized and open format. The prototype also incarnates a digital music edition environment solution that is not limited to the repertoire, even though it is true that the reduced complexity of the scope of the variants makes it a reasonable starting point. The notation of a madrigal of Marenzio put into score is almost undistinguishable from common Western music notation, with the exception of very few idiomatic components of the repertoire such as coloration or proportion signs that might still appear. There is hence no reason such an approach could not be developed further for music of later repertoires, including the seventeenth century or even beyond. In the future, such digital editions will offer a wide range of advantages over paper-based printed editions, such as accessibility, updatability for both corrections and augmentation, and readability.[23] But such editions will also offer new possibilities, as the digital music representation of the data will *de facto* be made available for further processing. For example it will be possible, with the development of new algorithms, to make the musical content of a digital edition searchable, which is not possible with PDF online editions. Searching music notation is a field of research in itself that requires digital data on which to operate, and it will directly benefit from the development of digital editions.[24]

23 Silbiger uses the cumbersome case of the edition of Froberger as an excellent proof by contradiction. See Sibliger, Alexander, «The Promises and Pitfalls of Online Scholarly Music Publishing» in Dumitrescu, Theodor and Kügle, Karl (eds.), *Authority, Historiography, Technology: New Perspectives in Early Music Editing,* [Forthcoming].

24 An interesting example of what can be achieved in the field is the Liber Usualis project at McGill University in which a complete transcription of the Liber Usualis in plainchant (approx. 2,300 pages) has been made fully searchable. See <http://ddmal.music.mcgill.ca/research/omr/Search_the_Liber_Usualis>.

The development of music digital editions will also face a certain number of challenges. For the MEI community, it will be important to avoid as much as possible the use of customizations.[25] Whilst customizations are widely used in the TEI community, following the same *modus operandi* for MEI would certainly be a pitfall. The use of a customization enables specific encodings to be tailored, but it also makes the use of existing tools precarious if not impossible. Because of the complexity of the development of tools that will handle MEI, and because the resources available for developing the tools are much more restricted for music than for text, making sure that the tools are compliant is certainly a high priority for the MEI community. It will also be a key requirement for the spreading of MEI for it to become a standard, and also for its sustainability, and for this very reason the use of customization will need to be given considerable thought.

Another challenge for MEI will be to develop an appropriate way of describing the detailed layout of the music notation. So far, MEI has followed fairly closely the TEI approach to information representation, which is essentially text-centric. That is, as in TEI, the structure of the text is reflected in the XML hierarchy and has priority over the structure of the document. Typically, a TEI document represents hierarchically arranged chapters, sections and paragraphs, and indicates page breaks and line breaks as milestone elements in this hierarchy. Similarly, an MEI document hierarchically represents the musical content and uses milestones for page breaks and system breaks. In TEI, this approach has proven to be flexible and adequate enough for a wide range of purposes, but it has also shown some limitations, and the needs for a document-centric approach have yielded the creation of a so-called ‹special interest group› (SIG) on manuscripts.[26] The Manuscripts SIG has developed a very rich model for encoding manuscript structures, including features for representing the genetic process within one manuscript and over the course of several manuscripts. The group focused on complex and very interesting cases, and offers extremely powerful solutions, but it did not, however, consider the automatic transformation from the document-centric to the text-centric representation as a high priority. Therefore, some TEI projects consider a double encoding

25 A customization can be seen as a way to define a dialect of MEI that extend or redefine it for unusual cases. MEI offers the same customization possibilities as TEI. <http://www.tei-c.org/Guidelines/Customization>

26 <http://www.tei-c.org/Activities/SIG/Manuscript/>.

approach; that is, one encoding for the diplomatic representation of the source(s), and one encoding for the text representation.[27] MEI will have to follow another path because document and layout structure plays a significantly different role in music since they are part of the musical (i.e., textual) information in a much more imbricated way, simply because music notation is a bi-dimensional graphical system.[28] Not only can text representation and layout representation not be univocally distinguished, they are also both required for appropriately representing music notation. It is the reason the MEI development group is currently working on a new layout module that should, in the future, considerably clarify and enrich the layout representation capabilities in MEI by pulling layout information into distinct hierarchies that will be, at the same time, linked together. This approach will provide digital music editions with a more viable option for music than double encoding.

As for text, the general organization of music digital editions themselves can be envisaged in many different ways. The fact that for sixteenth and seventeenth century music, the tools such as Gamera or Aruspix will be able to produce a large amount of original source diplomatic transcriptions might suggest that the hyper-editing model proposed by McGann, where the edition is a networked repository of sources linked together, will be appropriate.[29] The output of OMR software application consists of a digital transcription of the original source directly linked with a digital image, and more precisely a transcription where each symbol in the transcription includes the exact coordinates in the image. In other words, it is exactly what is needed for building diplomatic source transcription repositories as in McGann's model, and organizing and sustaining such repositories will be one important task down the music digital editions road. In that regard, MEI is well placed to play a cardinal role in making source material for digital music editions available for ulterior projects, and avoid the currently common situation where original sources have to be transcribed again and again. But the manageability of McGann's approach,

27 Brüning, Gerrit, Henzel, Katrin, and Pravida, Dietmar, «Rationale of Multiple Encoding in the Genetic Faust Edition» in *Journal of the Text Encoding Initiative*, [Forthcoming]. See also <http://faustedition.uni-wuerzburg.de>.

28 Obviously, the Manuscript SIG considers difficult and complicated cases that are beyond what we consider for the discussion on music here.

29 McGann, Jerome, *The Relationale of HyperText,* 1995. <http://www2.iath.virginia.edu/public/jjm2f/rationale.html>.

even if the model is in itself certainly very appealing at a theoretical level for overcoming book limitations, will be challenged by the layout complexity intrinsic to music notation already underlined above. The interface to the repositories will be extremely complex to create and, presumably, to use. In the near future, a less radical change will be more desirable, and seeing digital music editions being developed and emerging in close conjunction with high quality paper-based editions can without doubt be a beneficial way to move forward. The use of the diplomatic source transcriptions generated by OMR software applications should be used throughout the workflow during the preparation of editions, and publishing the edition online in a digital environment as illustrated by the prototype of the Marenzio project will be of huge benefit in terms of accessibility, readability and updatability. The strengths of these advantages are more and more recognized by scholars. At the same time we should not forget that, to quote Geoffrey Nunberg, «it is precisely because these [electronic] technologies transcend the material limitations of the book that they will have trouble assuming its role.»[30] Clearly, moving towards digital environment should by no means signify losing the advantages of paper-based editions that tend to be forgotten, very probably because they are less immediate. Can we easily cite a digital edition? To what version do we refer? Is only the date of consultation sufficient? By creating an environment where the edition can be corrected or updated at anytime, are we not preparing a hyper-stop-press correction problem for the readers of the next generation? And most importantly, what is the sustainability of digital editions? These questions have been raised very often, but they still have to be taken carefully into account. While there may be no clear answer and no easy solution, we believe that initiatives that will bridge the gap between traditional editing and digital editing will lead the way. Producing high-quality paper-based critical editions, publishing them in innovative digital environments, and building large repositories of digital source transcriptions are not contradictory undertakings. Bringing them together, quite on the contrary, might be the most appropriate strategy to provide our descendants with material, be it digital or not, that is understandable and upon which they will be able to build.

30 Sutherland, Kathryn, «Being Critical: Paper-based Editing and the Digital Environment» in Deegan, Marilyn and Sutherland, Kathryn (eds.), *Text Editing, Print and the Digital World,* Aldershot, Ashgate, 2009, p. 21.

Abstract

Digital media are being adopted more and more widely for scholarly projects, but what do these new possibilities offer and involve for music critical editions? By looking back at the development of computer music editing since the early Nineties and at the same time at the experience of text studies with the development of the Text Encoding Initiative (TEI), the paper aims to provide a better understanding of the current situation of music critical editing. In the light of selected digital edition projects, it also discusses the perspectives and the challenges for sixteenth and seventeenth century music in conjunction with the development of the Music Encoding Initiative (MEI) and its growing community.