Richard Freedman

Advancing Music Scholarship in a Digital Age: A View from the Renaissance

New technologies of digital writing and reproduction have made music portable and repeatable, and thus increasingly independent of its divine origins in figures like mythic Orpheus, the preternaturally consummate composer-performer. Differentiating author from interpreter, first notation, then printing, then sound recording have presented musicians with a series of contradictory effects. On one hand these forms seemed to offer composers the means to fantasize about having their imagined music reach the ears and minds of listeners unmediated by the less-than-divine realizations of human performers. But at the same time, each new form of representation (in graphical notation, in print, and later in sound recording) re-opened the musical text to new kinds of uses or transformations. Technological transformations of music and music making have been especially profound during the last century, as anyone knows who has considered the works and writings of figures like the composer Edgar Varèse, or pianist Glenn Gould. But technologies of musical reproduction hold a pivotal place in the world of early music, in the legacies of Leonin (called by Anonymous IV the notator of the Magnus liber organi), of Guillaume de Machaut (perhaps the first composer to curate his own archive), and for Orlando di Lasso (the first to be utterly self-conscious about print).

Now Musikwissenschaftler (and Musikwissenschaftlerinnen) are also being drawn into the process of technological change: we once viewed print (books, journals, editions) as the durable means through which we put our best ideas before colleagues and the wider musical public in durable form. But as digital texts remake the world of scholarship as surely as YouTube and iTunes have remade the curatorial function of the recording industry, critical authority and responsibility are changing, too. Digital editions can be shared across any computer system, and can preserve with remarkable detail almost any level of intervention in a text, and distinguish my vision of a text from yours. It is an inherently destabilizing medium, both layered and collaborative. The tools of the trade are reshaping scholarly cultures, no less than artistic ones, in exciting (but also challenging) ways. This essay attempts to survey some of these developments in three large sections: Notations, Readings, and Citations. In each we will consider some of the general developments in the world of digital scholarship in recent years, and in each we will also pause to explore some of the special needs of music scholarship. Many of these musical projects focus on Renaissance repertories, a circumstance that owes much to the spirit of collaboration that has always thrived in the field.
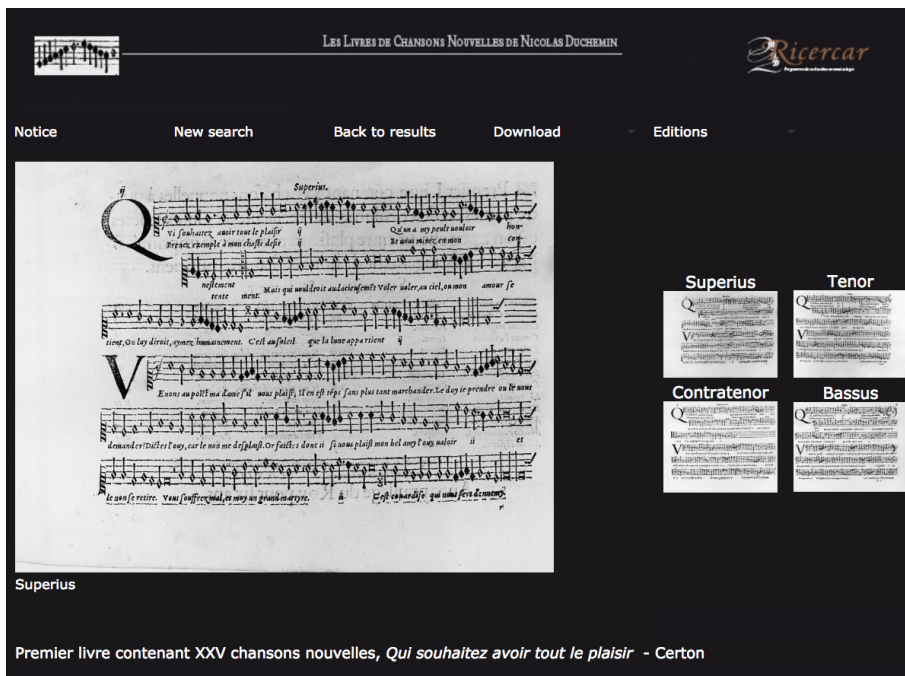
Figure 1. Sample image of digital facsimiles of Renaissance partbooks, from *Les livres de Chansons nouvelles de Nicolas Du Chemin* (Tours, 2014) URL: http://ricercar.cesr.univ-tours.fr/3-programmes/EMN/Duchemin/pages/notice.asp?numnotice=178&voice=S, accessed September 7, 2018.

Figure 2. Engraved modern edition (PDF format) of the composition presented in Figure 1, from *Les livres de Chansons nouvelles de Nicolas Du Chemin* (Tours, 2014) URL: http://ricercar.cesr.univ-tours.fr/3-programmes/EMN/Duchemin/sources/15507-01/15507-01-pdf-moderne.pdf, accessed September 7, 2018.

I. Notations

For roughly the last decade I have sustained a productive collaboration with Philippe Vendrix and his capable team of the Programme Ricercar at the Centre d'Études Supérieures de la Renaissance (CESR) in Tours.[1] Together we've explored an expanding set of Renaissance repertories through a rapidly-developing array of tools and methods. The beginnings now seem humble: a digital archive of 16 sets of partbooks published in mid-16th-century Paris by Nicolas Du Chemin, complete with high-quality images and expertly-engraved modern editions in PDF format. There was musicological value here, we thought: modern editions of nearly four hundred »new« chansons, presented according to the editorial »sets« that would have been familiar to the musicians who first sang from them over 450 years ago (see Figures 1 and 2).[2]

This sort of editorial work is quite familiar to our musicological colleagues: the transcription into modern score and notation of materials originally notated in partbooks or other separated materials, in which performers normally read from their own parts. Modern editors also resolve certain ambiguities never fully preserved in the original notation, such as the precise alignment of text and music, and the indication of accidentals (commonly called *musica ficta*) that were understood but unwritten. These are the familiar tradecraft of musicological work. In the digital domain, however, we can see with the help of machine no less than human eyes. Consider, for instance, two representations of the title page of a recent book by our colleague David Fallows. In one, *graphical* conventions (boldface, italics, placement on the page) convey the essential information about the names presented here—a personal name as title, and as author. In another, we can imagine a markup that identifies the *logical* relationship between the names: that Fallows is the author; Josquin is the title (see Figure 3).

---

1 URL: http://ricercar.cesr.univ-tours.fr/, accessed August 23, 2018.
2 Our work on Du Chemin's publications consists of two complementary web sites: *Les livres de Chansons nouvelles de Nicolas Du Chemin* (Tours, 2012–2014), URL: http://ricercar.cesr.univ-tours.fr/3-programmes/EMN/Duchemin/, and *The Lost Voices Project* (Haverford, PA, 2012–2014), URL: http://digitalduchemin.org/. The first offers digital facsimiles (in TIFF format), modern editions (in PDF format), commentaries, and a searchable database of the set. The second provides critical digital editions, a database of thousands of analytic observations, and over 100 modern reconstructions of contratenor and bassus parts from pieces found in the last five volumes of the series, which survive in an incomplete state. Further on these projects, see Freedman, »The Renaissance Chanson Goes Digital: digitalduchemin.org,« *Early Music* 42 (2014), pp. 567–78 and Freedman, Jamie Apgar and Micah Walter, »In Search of Lost Voices,« *Journal of the Alamire Foundation* 9/2 (Autumn 2017), pp. 319–53. For *The Lost Voices Project* web application code (Andrew Hankinson, Raffaele Viglianti, and Micah Walter, developers) see URL: https://github.com/DuChemin.

```
<author_name "David">

<author_surname "Fallows">

<title "Josquin">
```

Figure 3. Title page of David Fallows, *Josquin* (Turnhout, Belgium, 2009): Graphical and Logical Representation of Author and Title.


```
<measure  n="4">
    <staff n="1">
        <note  dur="2" oct="4" pname="e"> </note>
        <note  dur="1" oct="4" pname="d"> </note>
        <note  dur="2" oct="4" pname="c">
            <supplied reason="edit">
                <accid accid="s" func="edit" place="above"/>
            </supplied>
        </note>
    </staff>
</measure>
```

Figure 4. A graphical modern edition of a chanson by Nicolas Regnes, *Venons au poinct*, with indication of editorial accidental (*musica ficta*) above the staff, and the same accidental as it is represented in a simplied MEI encoding of measure 4 from the superius part. From *Les livres de Chansons nouvelles de Nicolas Du Chemin*. URL: http://ricercar.cesr.univ-tours.fr/3-programmes/EMN/Duchemin/sources/15507-02/15507-02-pdf-moderne.pdf, accessed September 7, 2018.

Western musical notation of course is a symbolic system. Trained musicians understand these signs as the script for the realization of tone. As an aside, we might observe that the German language nicely preserves this distinction between *Schrift* and *Ton*; English language speakers conflate the visual and aural phenomena as a single concept: note. Scholarly editions add their own complexities to these symbolic scores, using graphical conventions to make distinctions between what was in the original notation and what has been supplied by a modern editor, or to indicate alternative readings found in different copies of the same composition. Two sets of examples from recent Ricercar projects help to demonstrate the differences between graphical and logical representations of music. The first (from *The Lost Voices Project*), shows editorial accidentals (musica ficta) above the staff and in digital form (see Figure 4). Another, from the *Gesualdo Online* project (with critical editions and reconstructions of the infamous Neapolitan composer's music) shows how variant readings in different sources can be encoded in digital form (see Figure 5).[3]

Figure 5. An excerpt from Gesualdo's *Bell'angioletta de la vaghe piume*, showing graphical score with variant readings alongside digital encodings of the same passage. A composite image from *Gesualdo Online*, URL: https://ricercar.gesualdo-online.cesr.univ-tours.fr/items/show/5989, accessed August 23, 2018.

3 *Gesualdo Online* (Tours, 2016). URL: http://ricercar.gesualdo-online.cesr.univ-tours.fr, accessed August 23, 2018. The Omeka content management system used in *Gesualdo Online* is available for use by anyone. See *TiKiT Musica*, Acatus Informatique, developers (URL: http://www.acatus.fr/). Code at URL: https://github.com/Acatus-dev/tikit-musica.

Symbolic notation will continue to serve those of us with human eyes, ears, and hands quite well. But the logical markup of the sort just illustrated invites us to consider ways of reading (and using) musical texts that are otherwise impossible on the flat printed page. By virtue of their declared structure, digital texts remain open to interrogation, adaptation, or re-use beyond the particular aim imagined by the scholars who originally prepared them. The effect is profoundly disorienting: thanks to structured encodings known as XML (for »extensible markup languages«) one scholar can make a transcription of a text, but another person can search it, add variant readings, suggest alternative readings, make annotations, or reconstruct missing parts without ever effacing the original work. Unlike the real thing, these digital palimpsests are infinitely reusable but also indefinitely recoverable. They are held up as the acid-free paper of the computer age.

For the last two decades *The Text Encoding Initiative* (TEI) has put the power of XML technology to work in the service of a wide range of scholars concerned with literary works and historical documents.[4] Consider, for instance, *The English Broadside Ballad Archive,* which has assembled a vast archive of facsimiles, transcriptions, and research tools relating to this important genre of popular literature of the sixteenth through early eighteenth centuries.[5] The same TEI file contains both graphical and logical markup, and is used to produce both a diplomatic rendering of the original (complete with italics for the names of the characters in the story) and a modern edition in regularized format (complete with header fields for terms that will provide the basis of digital indices, such as »first line« and »refrain«; see Figures 6 and 7).

Musicologists, too, are making use of the TEI. The *Tasso in Music Project*, directed by Emiliano Ricciardi at the University of Massachusetts in Amherst, Mass, for instance, is using TEI to explore the complex source traditions represented in hundreds of settings of lyrics by the great poet.[6] The poetry found in these music books sometimes corresponds closely to the version preserved in Tasso's authorized publications, but in other cases reflects manuscript versions of his poetry that circulated in advance of those prints (see Figure 8 for a summary of the readings assembled for a single poem from musical and literary sources alike). The *Tasso in Music Project* will allow readers to compare these readings in a dynamic environment, switching among divergent readings as they relate to the

---

4 *The Text Encoding Initiative* is an open-source standard maintained by governing consortium. See URL: http://www.tei-c.org/, accessed August 23, 2018.

5 *The English Broadside Ballad Archive*, Patricia Fullerton, Director. URL: https://ebba.english.ucsb.edu/, accessed August 23, 2018.

6 *Tasso in Music Project*, Emiliano Ricciardi, Director. URL: http://www.tassomusic.org, accessed August 23, 2018.

Figure 6. *A New Ballad of Saint George and the Dragon*, digital facsimile from *The Early English Ballad Archive*. URL: https://ebba.english.ucsb.edu/ballad/34079/image, accessed August 23, 2018.

Figure 7. *A New Ballad of Saint George and the Dragon*, two editions produced from the same digital encoding, from *The Early English Ballad Archive*. URLs: https://ebba.english.ucsb.edu/ballad/34079/transcription and https://ebba.english.ucsb.edu/ballad/34079/xml, accessed August 23. 2018.

musical and literary source traditions. And because the TEI encodings are durable and extensible, they can also be re-used in subsequent work by others, who might (for instance) want to make some large-scale comparison of which composers tended to follow which sources of Tasso's poetry.

There is much more to *The Tasso in Music Project* than this, but for the moment, we will pause to consider the *Music Encoding Initiative*.[7] The MEI is not a tool for engraving music (like Sibelius, Finale, MuseScore or any of the other fine programs for graphical representation). Like the TEI just explored, it is a structured standard that accommodates the full range of bibliographical and critical details that are essential to any scholarly approach to musical texts—it keeps the data (the notes) together with the metadata (where they came from; who selected them), all in a way that remains open to re-use, inquiry, and study by the scholarly community. Indeed, during the last decade we have seen the rapid development of a wide array of projects and tools that make MEI a practical standard for a range of exciting research projects. MEI was the technology behind the examples we have just encountered from *Gesualdo Online* and *The Lost Voices Project*. And it

Figure 8. Modern edition and variant readings for Tasso's *Non può l'angusto loco*, from *The Tasso in Music Project*. URL: http://www.tassomusic.org/variorum/#source/Trm0319a-Canto, accessed August 23, 2018.

7 *The Music Encoding Initiative* (URL: http://music-encoding.org/, accessed August 23, 2018), like The TEI, is maintained on a collaborative basis, with ongoing support from the Akademie der Wissenschaften und der Literatur in Mainz. URL: http://www.adwmainz.de/startseite.html, accessed August 23, 2018.

Figure 9. MEI encoding and diplomatic transcription of a motet from the Montpellier Manuscript (ca. 1300), from *Measuring Polyphony*, Karen Desmond, Project Director. The MEI has been simplified somewhat for clarity, omitting information about the verbal texts and also the XML ID's. URL: http://measuringpolyphony.org/display.html?/assets/mensural/306_MENSURAL.mei, accessed September 7, 2018.

is being used in a wide range of other scholarly projects. Work on early music is especially rich in this respect, in part because it provokes us to adopt a new self-consciousness about the relationships between systems of notation and the musical patterns they prescribe. This is particularly helpful for those who are interested in early music, for whom modern notation has often obscured musical thought even as it has made individual pieces accessible for readers whose native musical literacy is bound up with modern scores and not the subtleties of mensural notation. Indeed, two other projects are explicitly concerned with the power of digital tools to help us probe the complexities of rhythmic notation itself.

Karen Desmond's *Measuring Polyphony* project, for instance, aims to produce digital editions of fourteenth-century motets using the mensural module of MEI.[8] Formalizing the musical logic behind the symbols, Desmond's editions encode the meanings of the notes no less than the graphical forms themselves. In the piece shown in Figure 9, for instance, two otherwise identical semibreves must

---

8 *Measuring Polyphony*, Karen Desmond, Director. URL: http://measuringpolyphony.org/, accessed August 23, 2018.

by the rules of mensural notation be performed differently. The modern edition captures the sounding sense of the passage; the diplomatic edition conveys its graphical form. Both are represented via MEI. And by virtue of their declared structure, multiple encodings of this sort could be explored in a search for corpus-wide patterns of notational usage, no less than musical pattern.[9]

A project centered on the theoretical writings of Johannes Tinctoris (under the direction of Ron Woodley, Jeffrey Dean, and David Lewis) takes things one step further, imagining what they call »a 21st-century response to a challenge posed by the notation of late medieval music as told by the 15th-century music theorist Johannes Tinctoris.«[10] They imagine a machine-assisted »expert system« that will put Tinctoris's theoretical writings to the test against the evidence of 15th-century notation to see if his rules can be modeled as the logical basis of a machine-assisted mode of reading and transcription. Here *Schrift* itself is the focus of the inquiry, testing the limits both of Tinctoris's reasoning and our capacities to encode and manipulate digital representations of musical signs. The result will be of interest to a wide range of users—those who want to read mensural notation, those curious to understand the relationship between notation, rhythm, and counterpoint, and those keen to understand the systems of knowledge that make such notation possible in the first place.

II. Readings

We have already noted how the advent of digital musical texts allows us to produce dynamic critical editions that are as useful to scholars as they are to performers. *Gesualdo Online* (as we saw) allows users to rearrange an edition to reflect to any base text, or even some combination of them. The structured encodings, moreover, permit us to read synoptically across many pieces simultaneously, assembling instances of any detail we might want to study: just the rhythmic variants, or only those involving chromatic alterations, or perhaps to search for the overall pattern of agreement among sources across many compositions. But in recent years formats such as MEI have invited scholars to think about new modes of reading musical texts on a previously unimaginable scale.

---

9 For the MEI encodings of the piece shown in Figure 9, see http://measuringpolyphony.org/display.html?/assets/mensural/306_MENSURAL.mei, accessed September 20, 2018.

10 *Johannes Tinctoris: Complete Theoretical Works*, Ron Woodley, Jeffrey Dean, and David Lewis, Directors. URL: http://earlymusictheory.org/Tinctoris/#, accessed August 23, 2018. The quoted passage is from the original project proposal, given on the accompanying blog for the project. URL: http://earlymusictheory.org/blog/, accessed August 23, 2018.

Each of us has spent long years of study acquiring a mental storehouse of the patterns and preferences that typify a given composer or style. Such human expertise can never be replaced. But now it can be made newly legible, shared with others via databases, controlled vocabularies, and systems of discovery and citation. Echoing a seemingly absurd question posed by digital scholar Gregory Crane[11] (»what do you do with a million books?«), various projects on Renaissance music are exploring what it might be like to read many hundreds of compositions (and perhaps millions of notes) at once. What questions might one pose of such repositories? What might the responses look like? And how might such distant readings of music relate to our detailed, up-close considerations of individual musical works?

The Du Chemin corpus, for instance, had a glaring gap that suddenly seemed like an opportunity: the last five sets of partbooks were incomplete, since the book containing the contratenor and bassus voices has not survived. (In all, about 120 of almost 400 compositions were affected in this way.) The phenomenon is hardly unique, as many here can attest, for there are hundreds of similar instances of fragmentary or damaged sources (and pieces) scattered throughout the repertories of the period. Regarded from a purely musical standpoint, the task of reconstructing pieces from the Du Chemin books was not as difficult as it might be for other repertories, inasmuch as these pieces were built according to a tightly-controlled vocabulary of contrapuntal types—cadences, stretto fugues, and other interval patterns. And so with the help of scholars like Peter Schubert, Julie Cumming, Jesse Rodin (among others) we pooled our collective expertise as a handbook of the style (this thesaurus of examples runs to some 150 pages).[12] This shared vocabulary of concepts and examples became a training manual for a dozen graduate students who went in search of these musical patterns among the extant complete pieces. Together they compiled a database of some 11,000 detailed observations of patterns. These data could themselves be viewed from a distance using a variety of tools, both visual and computational. In one experiment, we mapped hundreds of cadences by tone and type as a chord diagram (see Figure 10).[13] In another we build a computational similarity network, which uncovered whole constellations of cadential types, here mapped according to a

---

11 Gregory Crane, »What Do You Do with a Million Books?,« *D-Lib Magazine* 12/3 (March 2016). URL: http://www.dlib.org/dlib/march06/crane/03crane.html, accessed August 23, 2018.

12 The Thesaurus is available for download via the companion Editor's Forum for *The Lost Voices Project*, at URL: https://sites.google.com/haverford.edu/lostvoices/home, accessed February 14, 2020.

13 For links to the visualization tools, see http://digitalduchemin.org/, accessed August 23, 2018. The challenge of interpreting these data are considered in Freedman »Close and Distant Reading: Data Analysis meets the Renaissance Chanson,« *The Oxford Handbook of Corpus Studies*, ed. Daniel Shanahan (Oxford University Press, in press).
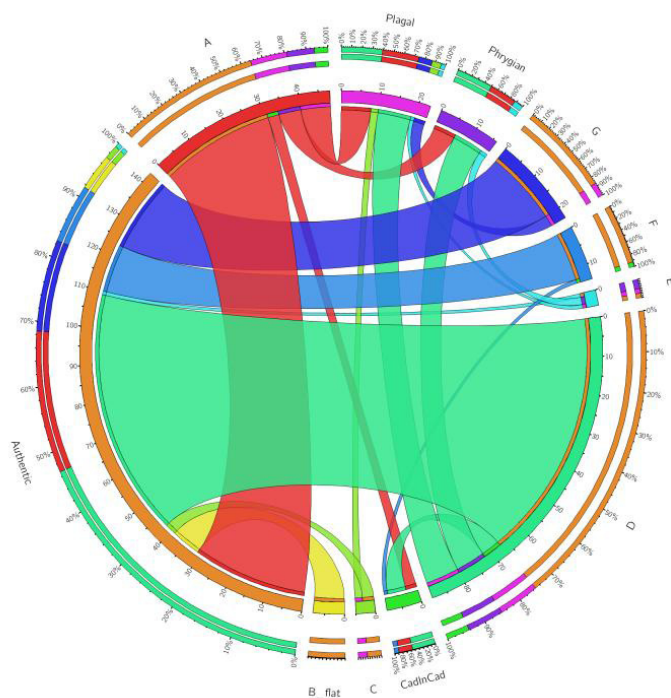
Figure 10. *The Lost Voices Project*: Visualization of Cadences as Chord Diagram.

half-dozen shared factors: not only the final tone and type, but also voice roles, neighboring cadences, etc. (see Figure 11). (The algorithm that rests behind this, by the way, is the same algorithm that allows Google to discover related material on the internet.)

Visualizations like these are strange to behold, for they represent patterns only manifest from a great distance. But our detailed inventory of musical types in the Du Chemin corpus was also put to work up close in the service of the lost voices. The same students who made the original observations also used the database to help them imagine what the lost voices might have sounded like (they composed over 100 reconstructions in all). Our search engine allowed us to sift and sort the observed patterns according to dozens of criteria, through which it was quickly possible to propose a likely solution. The resulting reconstructions were encoded using MEI, which allowed us to navigate rapidly among the local musical details and also to present rival reconstructions for debate and discussion.

The Lost Voices Project used machines to help us navigate among thousands of readings undertaken by human eyes and ears. But some other projects are explo-
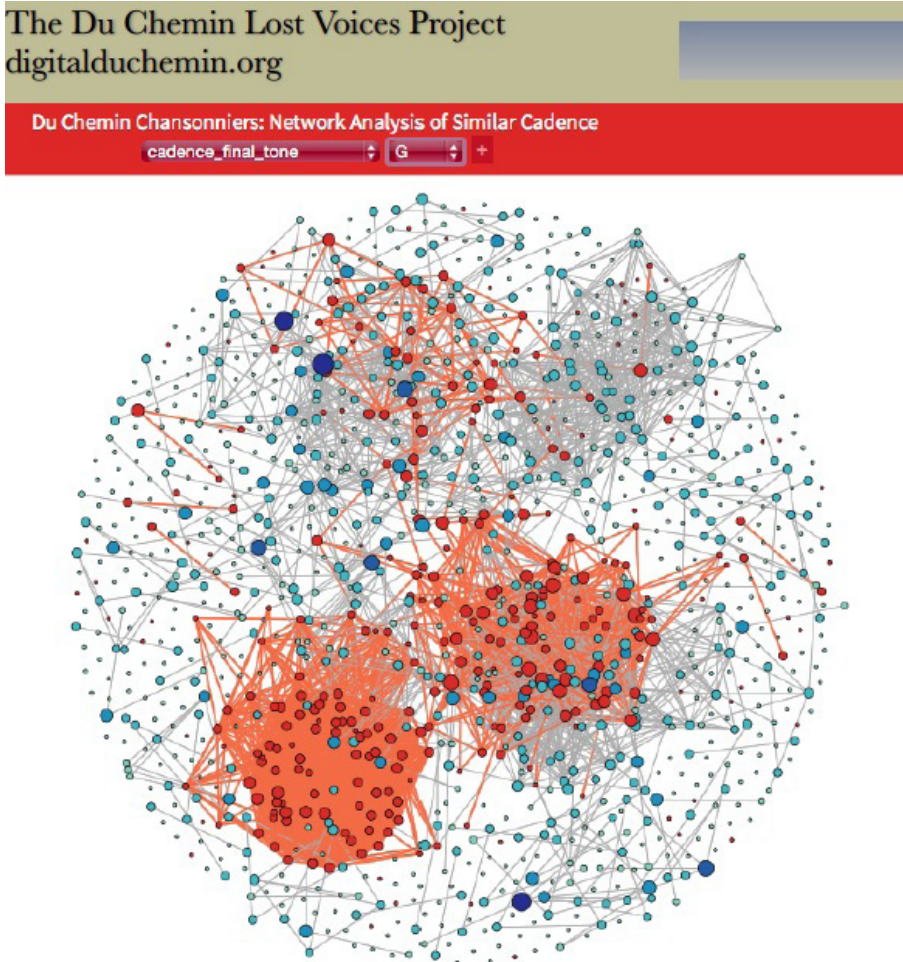
Figure 11. *The Lost Voices Project*: Visualization of Cadences as Similarity Network.

ring what it might mean to let the machines do some of the reading on our behalf, leaving us the harder job of formulating meaningful questions to ask them, and interpreting the answers they provide. Jesse Rodin's *Josquin Research Project*, for instance, shows us the truly staggering potential of such assisted reading. It presents encoded versions of all pieces ascribed to Josquin (and much else from the years around 1500, too), in all some 1000 pieces (and well over a million

notes!).[14] All of it can be rapidly searched for all sorts of strings and patterns: rhythms, intervals, ranges, parallel octaves and fifths. The engine returns results rendered in modern scores (with the relevant passages highlighted in orange). The original aim of the project was to probe questions of authenticity (given the many works dubiously attributed to Josquin this is no small problem). But meanwhile the portal opens music of the long fifteenth century to all sorts of systematic inquiry about melodic style, rhythmic patterning, and contrapuntal design.

The scores of the *Josquin Research Project* (JRP) are available in a variety of digital forms, including MEI. But the corpus-based search function at the core of the project relies on another format for the same information: HumDrum, that makes rapid work of finding strings of all sorts. Indeed, the tools developed for the JRP by Craig Sapp (and more recently, by Alexander Morgan from McGill University) are also available for anyone to use via the *Verovio HumDrum Viewer*, an open-source tool that will ingest any of a variety of digital encodings, render the music in modern notation (directly in any browser), and then perform a dazzling array of pattern and string searches (for points of imitation, for contrapuntal dissonance, no less than melodic or rhythmic patterns).[15] The tool will be used in the *Tasso in Music* project.

The advent of machine learning based on musical data is also upon us. Julie Cumming, Cory McKay, and their colleagues at McGill University are using software called *jSymbolic* to undertake some automatic classification of Renaissance musical scores with impressive results.[16] They can, for instance, distinguish between the compositional style of Josquin and Pierre de la Rue with an accuracy rate

14 *The Josquin Research Project*, Jesse Rodin, Director. URL: http://josquin.stanford.edu/, accessed September 20, 2018. For a recent review of the project and the possibilities it provides for scholars, see Andrew Kirkman, »The Josquin Research Project by Jesse Rodin and Craig Sapp,« *Journal of the American Musicological Society* 68/2 (Summer 2015), pp. 455–65. DOI: 10.1525/jams.2015.68.2.455.

15 *Verovio Humdrum Viewer*, Craig Sapp, developer. URL: http://verovio.humdrum.org/. Some of the new features in this system were created by Alex Morgan while he was a graduate student at McGill University. See URL: https://groups.google.com/forum/#!topic/musicology-announce-2/YfUZgFDdwjE), accessed August 23, 2018.

16 Corey Mckay, Tristano Tenaglia, Julie Cumming, and Ichiro Fujinaga, »Using Statistical Feature Extraction to Distinguish the Styles of Different Composers,« Paper presented at the 45th Medieval and Renaissance Music Conference 2017, Prague, Czech Republic, 4–8 July 2017. Under the guidance of Cumming and Fujinaga, researchers at McGill are at work on a wide range of projects that explore the possibilities of machine-assisted analysis of musical patterns. See *Single Interface for Music Score Searching and Analysis project* (SIMSSA), Ichiro Fujinaga and Julie Cumming, Directors. URL: simssa.ca/, accessed August 23, 2018). Renaissance repertories figure importantly in this work. See David Garfinkle, Claire Arthur, Peter Schubert, and Ichiro Fujinaga, »PatternFinder Content-Based Music Retrieval with music21,« *Proceedings of the 4th International Workshop on Digital Libraries for Musicology, Shanghai, China, October 28, 2017*. DOI: 10.1145/3144749.3144751. Developed by Myke Cuthbert, music21 is a suite of Python scripts for the analysis of encoded musical scores. See URL: http://web.mit.edu/music21/, accessed August 23, 2018.

of more than 85% – an impressive achievement that few experts could manage. They extract features from a training repertory of secure pieces, including range of voices, levels of rhythmic variety, the proportion of melodic leaps or steps, dissonances among parts, and many other factors. Statistical analysis then reveals where (among these secure pieces) the preferences of one composer can be distinguished from another (La Rue tends to have more vertical octaves and fourths in his music; Josquin tends to have more vertical unisons and thirds). Some scholars worry that work like this will soon make humans obsolete, as we outsource the labor of reading (and listening) to artificial eyes and ears. But that is far from the case: the machines find patterns only when guided by human expertise, who must declare their methods, criteria for selection, and encoding if their results are to be meaningful to others.

III. Citations

The question of how we will cite and share our knowledge remains the next big challenge for digital work. From proof text to commentary, and from quotation to paraphrase, the mechanisms of citation are the lifeblood of scholarly discourse. Renaissance humanists were obsessed with these modes of discourse, as we can see in a page from English Bishop John Fisher's anti-Lutheran *Defensio Regie Assertionis* (printed in Köln in 1525).[17] The marginal quotation marks indicate passages drawn from the writings of Martin Luther, who in turn cites a particular Psalm as it appears on a particular part of a page of his original Hebrew Psalter (in Luther's words: »in fine ultimae paginae litterae B 12 versus«). The result is a graphical riot of reference (see Figure 12) to texts and to their emplacement on particular pages of particular books. The conversation is certainly polemical, but the citations are not easy to follow, and are almost impossible to check unless armed with the same editions of the same books under discussion.

Today scholars interested in Biblical and classical texts rely on canonical citations rather than the idiosyncratic »at the bottom of a certain page in a certain book« references of the sort just encountered. Digital resources like the *Canonical Text Services*,[18] coordinate collections, indexes, and texts in ways that help to resolve references to standard corpora, linking passage-level citations to digital corpora like the *Perseus Digital Library*. CTS provides structured Universal

---

17 Bishop (Köln, 1525). For a facsimile of this page (and the entire book), see the digital collection of the Bayerische Staatsbibliothek (Munich), at URL: https://daten.digitale-sammlungen.de/~db/0002/bsb00023859/images/index.html?seite=25&fip=193.174.98.30.

18 *Canonical Text Services* can be consulted at URL: http://cite-architecture.github.io/cts/, accessed August 23, 2018.
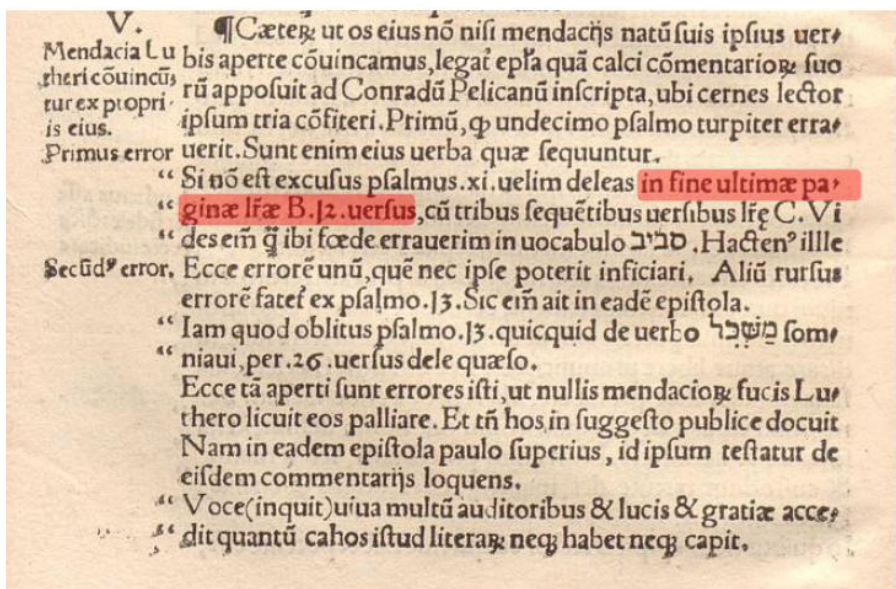
Figure 12. Bishop John Fisher, *Defensio Regie Assertionis* (Köln, 1525), Fol. 4ᵛ [highlights added].

Resource Numbers in ways that define corpus, language, work, section and verse. The digital canonical reference to Chapter 1, Verse 26 of the *Iliad*, for instance, is »urn:cts:greekLit:tlg0012.tlg001:1.26«, which can be used by resources like the *Perseus Digital Library* to build a persistent URL that will take a reader to any of a number of digital editions or facsimiles of the section in question.[19]

Now thanks to the efforts of our colleague Raffaele Viglianti, we are able to cite musical texts with similarly logical precision, and in ways that go beyond the generic, bar-level containers we often rely upon. His *Enhancing Music Notation Addressability* (EMA) format follows a standard sequence of elements that allow the citation and retrieval of »any combination of notes in any combination of staves and bars from any encoded score anywhere on the web« (see Figure 13).[20]

---

19 *The Perseus Digital Library*, URL: http://catalog.perseus.org, accessed August 23, 2018. For links to editions of the passage of the Iliad just mentioned, see URL: http://catalog.perseus.org/catalog/urn:cts:greekLit:tlg0012.tlg001, accessed August 23, 2018.

20 *Music Addressability API*, Raffaele Viglianti, developer. URLs: http://mith.us/ema/ and https://github.com/umd-mith/ema/, accessed August 23, 2018. See Viglianti, »The Music Addressability API: A draft specification for addressing portions of music notation on the web,« *Proceedings of the Third International Digital Libraries for Musicology Workshop (DLfM 2016), New York, USA — August 12–12, 2016*, pp. 57–60. URL: http://dl.acm.org/citation.cfm?id=2970044.2970056 and https://mith.umd.edu/music-addressability-api/, accessedAugust 23, 2018.
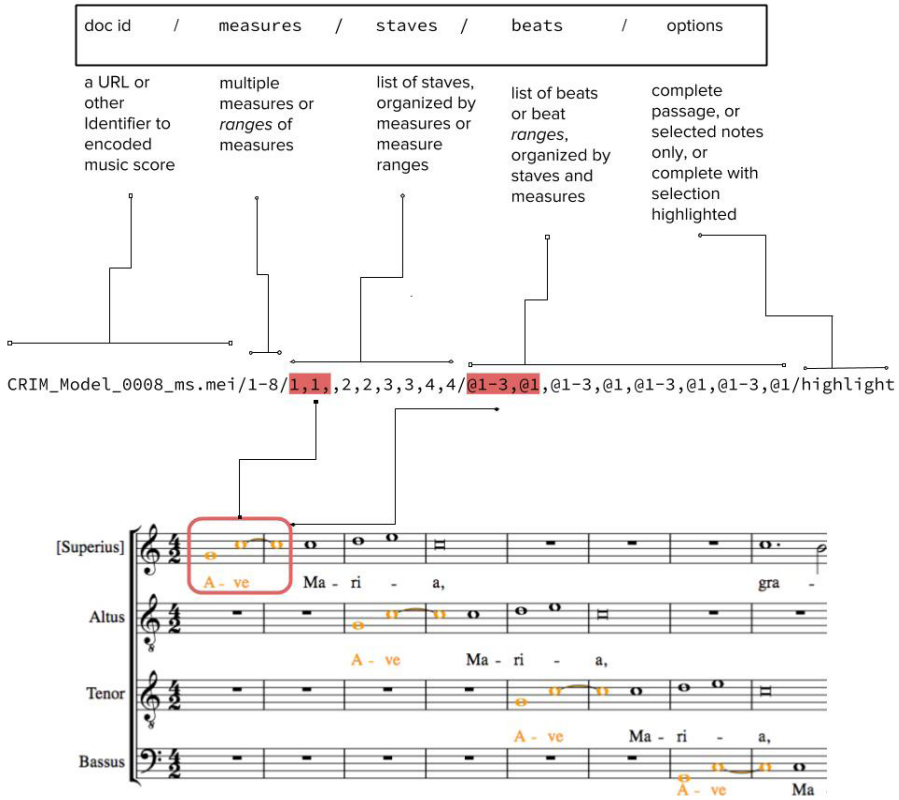
Figure 13. EMA Selection Explained, showing URL, score, and highlights.

For those of us using MEI files, Raffaele has also created an *Open Music Addressability Service* (OMAS) that makes the creation of citations a matter of point and click: MEI files are rendered in any browser using Laurent Pugin's *Verovio* javascript tool.[21] The user clicks to select notes, then Raffaele's service creates a unique URL that will return the same passage at a moment's notice. Such citations can be used as portable examples in traditional narrative arguments. But we can also imagine modelling them as publications in their own right, parts of critical assertions about the material at hand, expressed in digital form, including various

21 *Verovio*, Laurent Pugin, developer. JavaScript application to render MEI files as notation directly in any HTML5 browser; URL: http://www.verovio.org, accessed August 23, 2018. Code at URL: https://github.com/rism-ch/verovio, accessed August 23, 2018.

modes of identification, annotation, or interpretation. Architects of the semantic web call such mapped relationships among entities »ontologies,« and they can be published as durable digital objects in their own right, using standards such as *Open Annotation*[22] and *Linked Open Data*[23]. In their simplest form, ontologies like these take the form of tripartite data structures (»triples,« in the parlance of the widely-used *Resource Description Framework*[24]) consisting of linked concepts, like »gene X causes disease Y in humans«. The *subject* (gene X) is linked to the *object* (human disease Y) by a *predicate* (causation). Such assertions are not simply data, but are claims made by someone about something, and thus require information about the *provenance* of the claim: its author, its motivation, its validity, as well as any specific vocabularies.

Colleagues in the visual arts are exploring shared vocabularies that will help us discover connections among concepts, styles, and figures used in many different forms and media. The *Emblematica Online* project, for instance, links thousands of didactic and moralizing images of the sixteenth through eighteenth centuries with conceptual markers drawn from the *Iconclass*[25] vocabularies widely used in the study of representation. The *Iconclass* system uses hierarchical categories of related themes and concepts, including forms from the natural and man-made world, as well as notions of time, emotion, and power. An emblem containing stringed instruments (as we see in Figures 14 and 15, for instance), might be associated with *Iconclass* label 48C7322 (among others), situating that specific image in a series of increasingly broad concepts: musical instruments, music, the arts, and culture.[26] A web of semantic triples in turn variously identifies the specific image in which the symbol appeared, the physical source of the image, and the persons or project responsible for making the assertion in the first place. Such tags are of course a powerful system of cross-indexing and discovery. Paired with the semantic logic of *Open Annotation*, moreover, they expose deeper patterns of claim and counterclaim among participating scholars, since each annotation is in

---

22 On the *Open Annotation* standard, see URL: http://www.openannotation.org/, accessed August 23, 2018. *Open Annotation* is used in *The Shelley-Godwin Archive*, Elizabeth Denlinger and Neil Frastat, Project Directors. URL: http://shelleygodwinarchive.org/about/, accessed August 23, 2018.

23 For information on the *Linked Open Data* concept, see URL: http://linkeddata.org/, accessed August 23, 2018.

24 *The Resource Description Framework* is a standard model for data interchange on the web. See URL: https://www.w3.org/RDF/, accessed August 23, 2018.

25 The *Iconclass* project is developing multi-lingual vocabularies for the description and annotation of cultural objects and forms. See URL: http://iconclass.org/, accessed August 23, 2018.

26 View this *Iconclass* category at URL: http://iconclass.org/rkd/48C732/, accessed August 23, 2018.
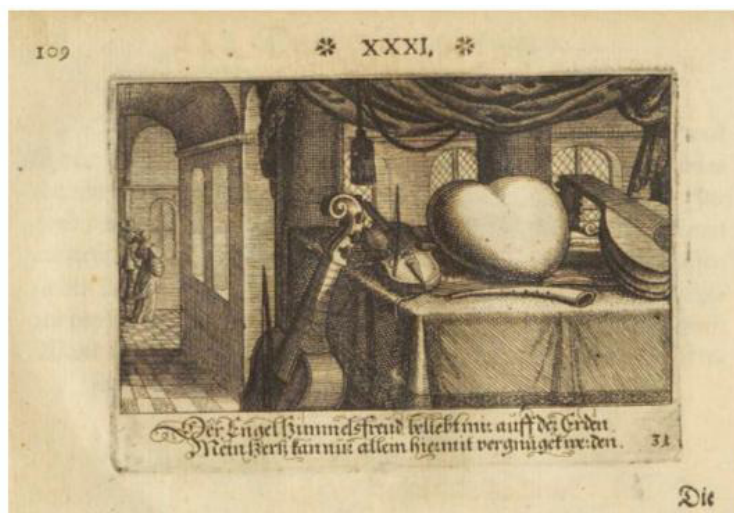
Figure 14. *Die Hertzens Music*, from the *Emblematica Online* Project. URL: http://emblematica. grainger.illinois.edu/detail/emblem/E018901.

fact a critical assertion about something.[27] The semantic capacities of *Linked Open Data* are key to this work.

How might such technologies be adapted for the study of early music? Biographical identifiers are one clear need, for with them we will be able to distinguish between persons with the same name, or the same person referred to by different names. Resource such as The *Virtual Internet Authority File*, for instance, helps us distinguish among the many names of Josquin des Prez the Renaissance composer (active in the years around 1500) and Josquin des Prez the Belgian funk

---

27 *Emblematica Online*, Mara Wade, et al., Directors. URL: http://emblematica.grainger.illinois.edu/, accessed August 23, 2018. For a detailed explanation of the promise and challenge of using Linked Open Data in the context of their project, see their interim report, Timothy Cole, Myung-Ja Han, Thomas Kilton, and Mara Wade, »Annotation of Digitized Emblematica, Final Report,« Open Annotation Collaboration Phase II (Champaign-Urbana: University of Illinois College of Liberal Arts and Sciences, Department of Germanic Languages and Literatures, 2012). URL: http://emblematica.grainger.illinois.edu/EmblematicaFinalReport.pdf, accessed September 7, 2018.

Figure 15. Iconclass summary. URL: http://iconclass.org/rkd/48C732/.

bass player active since the 1970's.[28] But if such systems of interoperable identification are to work we will also need to find some agreement on terms for the many »roles« that musicians fulfill. *The Music Ontology* has mapped out the sorts of roles we typically encounter in the world of popular recorded forms of music heard today (such as arranger, producer, sound engineer, and so on).[29] But for the classical concert tradition and early music in particular, we can imagine many other roles not available in that resource. The Renaissance Josquin (for instance) was not simply a musician or even exclusively a composer, but was, depending on the particular document or context at hand a singer, a cleric, an employee, a rival, a venerated master, or any of a number of other possible roles, only some of which are available to his modern-day namesake. Indeed, some other digital projects on music show us that the roles we enact in music could be quite varied.

---

28 *Virtual Internet Authority File*. URL: https://viaf.org/, accessed August 23, 2018. For the Renaissance Josquin, one *Virtual Internet Authority File* identifier is URL: viaf.org/viaf/100226284/#Josquin_des_Prez_1521, accessed August 23, 2018. For his modern namesake, see URL: https://viaf.org/viaf/23829271/#Josquin_des_Prez, accessed August 23, 2018.

29 See *The Music Ontology* at http://musicontology.com/, accessed September 6, 2018.

In her work on a circle of traditional Irish musicians, for instance, Lynnsey Weissenberger has imagined the multiple semantic triples that might connect two fiddlers in a variety of ways: as parent, mentor, model, and so on (see Figure 16).[30]

The *Linked Jazz* project, to cite another example of this sort of semantic elaboration of musical roles, has undertaken a systematic markup of connections among dozens of jazz players of the 20th century, based on archival interviews and other documents in which one musician mentions their connection with another, as collaborator, rival, mentor, pupil, and so on.[31] The resulting semantic network of relationships is then made available via various tools that help users explore the

Figure 16. John Kelly Relationships, from Lynnsey Weissenberger Study

many nuanced connections among players and their roles. Similarly, Music Librarian Sergio Oremas and his colleagues have demonstrated the capacities of *Linked Open Data* to draw connections among people, places, and roles mentioned in music reference materials.[32] Tim Crawford and his colleagues are similarly using *Linked Open Data* to integrate library meta-data.[33]

---

30 Lynnsey K. Weissenberger, »Stories, Songs, Steps and Tunes: A Linked Data Ontology for Irish Traditional Music and Dance,« *International Society of Knowledge Organization, UK/Ireland Chapter. 2017 Annual Conference, Knowledge Organisation: What's the Story? 11–12 September, 2017, London, United Kingdom*. doi/10.5281/zenodo.1002055.

31 *Linked Jazz*, Cristina Pattuelli, Director. URL: https://linkedjazz.org/, accessed August 23, 2018. The network visualization tool can be explored at URL: https://linkedjazz.org/network/, accessed August 23, 2018.

32 Sergio Oremas and Mohamed Sordo, »Knowledge is Out There: A New Step in the Evolution of Music Libraries,« *Fontes artis musicae* 63 (2016), pp. 285–98.

33 David Weigl, David Lewis, Tim Crawford, Ian Knöpke and Kevin Page, »On providing semantic alignment and unified access to music-library metadata,« *International Journal of Digital Libraries* (2017), pp. 1–23. URL: https://doi.org/10.1007/s00799-017-0223-9, accessed September 7, 2018.

Scholars have also modelled the ways in which *Linked Open Data* can be used to preserve analytic and critical observations about music itself tagging scores, recordings, and other representations of sound with claims made about patterns and gestures heard in particular pieces or performances. Kevin Page and his colleagues in Oxford, for instance, have devised a system whereby listeners might append their insights about particular performances of a work (in the case of their pilot study, operas by Richard Wagner) to a score and recording of that piece.[34] *The Lost Voices Project* has done something similar with some 300 Renaissance chansons, producing some 11,000 analytic observations about the various contrapuntal patterns found throughout the Du Chemin corpus. Each of these »nanopublications« (to borrow a term coined by Tobias Kuhn[35]) in *The Lost Voices Project* includes various machine-readable fields that expose key pieces of information about each claim.[36] Figure 17 shows one such analytic claim, including:

- A permanent URL for this observation.
- A motivation: the aim of identifying or tagging the passages with style-analytic information; in short, a particular vocabulary.
- The semantic details of the tag; in the instance shown in Figure 17, this is a cadence of a particular type, with particular final tone and voice roles.
- Target: in the case of *The Lost Voices Project*, an EMA expression pointing to an MEI file, with precision to the level of individual staves and notes.
- Provenance: the analyst responsible for the observation, and when it was created.

---

34 Kevin Page, et al., »A Toolkit for Live Annotation of Opera Performance: Experiences Capturing Wagner's Ring Cycle,« *Proceedings of the 16th ISMIR Conference, Málaga, Spain, October 26–30*, 2015. URL: http://ismir2015.uma.es/articles/311_Paper.pdf, accessed September 7, 2018.

35 On the Nanopublication standard, see *Nanopub*, Tobias Kuhn, et al., developers. URL: _http://nanopub.org/wordpress/, accessed September 7, 2018. Further on the uses of the Nanopublication model, see Christine Chichester, et al., *The Open PHACTS Nanopublication Guidelines*, 2012. URL: http://www.nanopub.org//guidelines/1.8/, accessed September 7, 2018, and Stefan Heßbrüggen-Walter, »EMTO Nanopub: An Infrastructure for Collecting Doxographic Facts,« (2012). URL: http://emto-blog.tumblr.com/post/27837095978/emto-nanopub-an-infrastructure-for-collecting, accessed September 7, 2018.

36 In *The Lost Voices Project* each piece was analyzed by two or three participants. The practice was intended as a means to help us generate confidence factors for our work, since redundant claims would have a high degree of reliability. Redundant claims would in addition serve to confirm the reproducibility of results and therefore the validity of the analytic method, too. Such double-keying is entirely compatible with the *Open Annotation* system, since any particular claim can have multiple provenances (just as a single provenance or author might produce multiple claims).

Figure 17. Analysis 7222 from *The Lost Voices Project* rendered as a Nano Publication. URL: http://digitalduchemin.org:8080/nanopub-server/RAJM6n0mm1h8tKfy7PgiipVEn5F7QcEckzTtwE1A0Tx3Y, accessed September 7. 2018.

We can also imagine linking pairs of such annotations (or ontologies) to show relationships among *different* works. Indeed, in my current project (also undertaken in collaboration with the CESR), we are doing just this. *Citations; the Renaissance Imitation Mass* (CRIM) focuses on the so-called »imitation« Mass of the sixteenth century, notable for the ways in which its composers derived new, large-scale

31

works from pre-existing ones.[37] A chanson, madrigal, or motet would in this way serve as the scaffolding for a much larger cyclic setting of the Ordinary of the Mass, with its five standard movements: Kyrie, Gloria, Credo, Sanctus, and Agnus dei. The relationship between model and Mass was often quite intimate: composers evoked the *sound* of the music they borrowed even as they transformed its contrapuntal *structures and procedures*. Sometimes material is simply quoted, or transposed, in some mechanical way. Other times it is prolonged to fit a new need; other times it is truncated, or even omitted. Thus in addition to the controlled vocabulary of musical types we used in *The Lost Voices Project*, we also require in the case of the Imitation Masses a complementary vocabulary of relationships among works. Moreover, since both the musical schemata and the allusive action are defined according to sets of controlled vocabularies, we can map them as digital objects, which in the case of CRIM might look like »Subject (Excerpt A of Mass 1)> Predicate (Borrows in Manner X)> Object (Excerpt B of Model 2).« This semantic triple will in turn be surrounded with an array of information about who made the assertion and why.

Figure 18 shows an example of one such relationship in graphical form, and in the web interface of the CRIM project itself. In these, we can see how a pair of separate analytic observations involving a motet and a mass (each with its own musical type involving different voices and the contrapuntal pattern they make) are bound together in a higher level relationship involving one or another kinds of quotation, transformation, omission, or new material, all as asserted by one of our project participants.

This growing array of individual analytic observations, in turn, will form the basis of discussion (also hosted the CRIM web site) and scholarly presentations and essays that aim to regard the corpus (and our participants' understanding of it) from larger historical and critical vantage points. In brief, the CRIM project will use the connections between the Masses and their models to answer a number of pressing questions about Renaissance music, both as it was understood in its own time and today. We have already collected 2500 »relationships« of this kind in some dozen Masses and their models. In the coming years we will expand that corpus to perhaps 10,000 relationships, and use them as part of scholarly debate and dialogue.

---

37 Citations: *The Imitation Renaissance Mass (CRIM)*, Richard Freedman and David Fiala, Directors. See URL: https://sites.google.com/haverford.edu/crim-project/home (accessed August 23, 2018) and URL: http://crimproject.org, accessed February 14, 2020. Further on the Mass corpus, see The Mass Database, produced by the Department of Musicology, University, Johannes Gutenberg-Universität Mainz. URL: http://www.mdb.uni-mainz.de/Default.aspx, accessed August 23, 2018.

Vidi speciosam → Missa Vidi speciosam: Agnus Dei <R369>

Observer: Max LeMee

Non-mechanical transformation

Musical type:
Embellished: False
Reduced: False
Amplified: True
Truncated: False
New counter-subject: False
Old counter-subject shifted: False
Old counter-subject transposed: False
New combination: False

Model: Johannes Lupi, Vidi speciosam

< highlight >   <752>

Imitative duo

Voices:
  Superius
  Contratenor
  Primus Tenor
  Bassus
Strict: False
Flexed: False
Flexed, tonal: True
Invertible: False
Melodic interval of entry: 4-5-4-
Time interval of entry: S3/5/3

Derivative: Mathieu Sohier, Missa Vidi speciosam: Agnus Dei

< highlight >   <753>

Imitative duo

Voices:
  I. Tenor
  [Bassus]
  [Superius]
  [Contratenor]
  [II. Tenor]
  [Bassus]
Strict: False
Flexed: False
Flexed, tonal: True
Invertible: False
Melodic interval of entry: 4-4+4-5-4+
Time interval of entry: S3/4/3/4/3

Figure 18. Motet and Imitation Mass, showing relationship and musical types, from CRIM Project. URL: http://crimproject.org/relationships/424/, accessed February 13, 2020.

Next Steps

As we have seen, new media can be put to work in the service of old, inviting new sorts of research questions, and prompting new collaborations. There is much of promise in this work—for musicological work in general and for the complexities of Medieval and Renaissance repertories in particular, as we can see from the several projects considered in this report. It is too soon to predict where digital scholarship is heading during the next few years.[38] But it is likely (regarded from the standpoint of 2018) that we will soon need to think carefully about several of the following:

---

38 As Laurent Pugin observed during the conference in Mainz, we tend to underestimate the degree of transformation that will take place in the short term, but also overestimate the change in the long run. Only time will tell what comes next.

- Standards for Data and Metadata. We need these as a system of exchange, and also a system of discovery of texts and also of the roles we assume in interacting with them. For the purposes of early music, we might imagine roles such as author, arranger, performer, listener, editor, commentator, analyst, and reconstructor, to mention but a few.

- Representations: Systems like MEI that will permit the layered presentation of musical texts. Such representations are not simply a written page, nor are they the critical apparatus, but something that is a combination of both, capturing both the logical and graphical sense of our original texts. And to the extent that particular resources are capable of being configured according to the needs of a particular reader, we will need to anticipate the need to cite or reproduce those views as part of other arguments, reference, or research.

- Quotable Digital Texts and Resources. It is surprisingly easy to find interesting details in digital resources. Finding them again is a different matter. How will we cite such electronic editions, archives, or databases, which are resistant to the patterns of citation better suited to the printed page?

- Tools for Visualization (of statistical patterns, of geo-spatial data or other mapping applications, or networks of relationships) are other areas ripe for development. They are being used in intellectual history, in social history. They might be useful for musicology, too.

- Musical Queries. Being able to search for a string of notes is not a bad thing. But what else would we like to find? What sorts of patterns might we want to find and describe? How can we teach digital technologies to search for contrapuntal combinations, for formulas, or to discover related types in different pieces and corpora?

- Models for Collaboration. What kinds of scholarly communities will emerge from all of this work? What will it mean to comment on a forum, or to contribute a layer of interpretation to a text edited by someone else? What will such contributions mean for our systems of evaluation and peer review? How will we sustain projects across institutions and departments with very different ways of working?

Only time will tell what scholars will want to do in the next decade, or what tools and texts will prove the most productive and sustainable.