METAdata and metaDATA

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Abstract

Metadata are a very broad and extremely differentiated subject and ranges from rudimentary catalog data to deeply indexed scientific catalogs (e.g., catalogs of works). In this paper, the concept of metadata in the context of MEI is first examined, before two examples are used to show that metadata are more than just rudimentary descriptions. These examples are also intended to illustrate the extent to which metadata are encoded in the field of music philology and thus represent an attempt to create a little more awareness for the work of the Metadata and Cataloging Interest Group of MEI.

The examples deal on the one hand with the encoding of performance resources and on the other hand with watermarks. In both cases, the possibilities of metadata encoding with MEI version 4 are exhausted and it is discussed which steps are useful and necessary to create an even deeper, machine-readable structure so that these sub-fields of the MEI metadata can also be used for larger scientific purposes such as analyses.

Introduction

The range of disciplines that use MEI is wide, and the requirements placed on the MEI format vary greatly. The variety of metadata that are encoded is also quite large, ranging from rudimentary catalog data to deeply indexed scholarly catalogs (e.g., catalogs of works). However, MEI metadata, primarily generated in music libraries and edition projects, is not limited to these application areas.

But what are metadata in the context of an MEI file? In this paper, the concept of metadata is first examined, before two examples are used to show that metadata are more than just rudimentary descriptions. These examples demonstrate not only how diverse encoding options could be, but also the need for formalization – for example, through best practice suggestions. They are also intended to illustrate the intensity with which metadata are encoded in the field of music philology and thus represent an attempt to create a little more awareness for the work of the Metadata and Cataloging Interest Group of MEI.

The examples deal on the one hand with the encoding of performance resources and on the other hand with watermarks. In both cases, the possibilities of metadata encoding with MEI version 4 are exhausted and it is discussed which steps are useful and necessary to create an even deeper, especially machine-readable structure so that these sub-fields of the MEI metadata can also be used for larger scientific purposes such as analyses.

1 Two Ways to Understand Metadata

As anyone familiar with MEI knows, a MEI document can have two main sections: `<meiHead>` and `<music>`. It depends on the use case one is focusing on. We like to discuss two different ways of using MEI in general. In the first case, the MEI header is used as a storage of (basic) metadata. In the second, the MEI header represents the data containing part of the MEI file. We are aware that there are other forms of metadata. However, we focus here specifically on two extremes that have come to our attention in numerous discussions in recent years (GitHub, mailing list, etc.): music encoding with metadata as 'just METAdata', and metaDATA as holistic data representing the core content of, for example, catalog data.

METAdata: If we focus on encoding sheet music, the result is likely to be a rich `<body>` section and, in direct contrast, a lean header if the header is used only to describe what is in the body or the file. We do not focus here on MEI documents with full header and full body as these are ideal cases and out of the scope of this current paper. We rather focus on the descriptive function that metadata often have in the context of sheet music encoding.

So in this case, METAdata is some additional information to the 'main' data on an abstract level and follows the original meaning of the word 'meta'. This means that metadata describe the `<music>` section in more detail, but neither belong to it nor change the meaning of the main data. A description at this level often contains, e.g., the title of the file, responsibilities, and so on.

On the other hand, metaDATA can be self-contained and thus self-describing, which can be much more than data pointing to the content of the `<music>` section. Even though the description here also takes place on an abstract level detached from the body, a great deal of information (such as source descriptions, performance lists, work information or paratexts) can be described, so that the metaDATA itself must be considered as research data – especially if the header is used in 'standalone' mode, as it is the case with work catalogs.

Even this simple comparison shows: When we go beyond the description that is generally subsumed under the term metadata to a status which is an extended scientific description (such as detailed descriptions of work and sources), then 'metadata' is not simply metadata – but it is data in its own right in a meta context.

With the transition from MEI version 3 to version 4, numerous options were created in `<meiHead>` that allow machine-readable encoding of metadata. Although the extension of FRBR (Functional Requirements for Bibliographic Records[1]) already made it possible to describe works and manuscripts in detail, the Metadata and Cataloging Interest Group has been discussing for some time gaps and problems where markup options are not yet sufficient to meet the requirements for machine-readable research data. In the following, two issues are picked out to serve as examples.

2 Two Exemplary Construction Sites on Encoding Metadata

2.1 Reflections on the Performance Medium

If we look up the definition of the `<perfMedium>` element in the MEI guidelines, we learn that this element "[i]ndicates the number and character of the performing forces used in a musical composition" [9]. Let us first consider the first subset of this definition: the indication of the number of performing forces. But what is the number of the performing forces when we have, e.g., two flutes? Is it the number of (physical) instruments, the number of parts (flute 1 and 2), or the number of performers (e.g., double setup at the world premiere)?

Some information about the number of performers is given by the definition of the subordinate `<perfRes>` element, which should specify the "[n]ame of an instrument on which a performer plays". There an attribute (`@count`) is available to indicate "the number of performers" [10]. However, the fact that the coding possibilities offered by this can quite quickly reach limits can be illustrated by an example: The MEI Guidelines contain the following wording: "Where multiple instruments of the same kind are used, the `@count` attribute on `<perfRes>` may be used to encode the exact number of players called for" [6]. This means that the value specified in the `@count` attribute always indicates the number of performers. With reference to the example given in Listing 1, two players are required to play the piccolo, two for the flutes.

```
<perfMedium>
    <perfResList>
            <!-- concert band -->
            <perfRes count="2">Piccolo</perfRes>
            <perfRes count="2">Flute</perfRes>
            <perfRes count="2">1st Clarinet</perfRes>
            <perfRes count="2">2nd Clarinet</perfRes>
            <perfRes count="2">3rd Clarinet</perfRes>
            <!-- and so on -->
    <perfResList>
</perfMedium>
```

Listing 1: Example for `<perfRes>` encoding from the MEI Guidelines [6].

Following this logic the clarinets have three parts, each with three players. Already here the question arises what exactly should be indicated with `@count` or with `<perfRes>` in general. An exact indication of the number of individuals playing the parts (single, double, etc.) is not excluded, but rather unusual in the literature available, at least for earlier centuries.

If we apply this logic to the violin, we get the following constellation:

`<perfRes>violin</perfRes>`	1 performer on violin
`<perfRes>violin</perfRes>` `<perfRes>violin</perfRes>`	2 performer on violin playing different parts (e.g. violin I & II)
`<perfRes count="2">violin</perfRes>`	2 performer on violin (same part = doubling)

Table 1: Encoding samples (`<perfRes>`) for violin.

However, the interpretation of the encoding samples presented in Table 1 only works under the implicit (i.e., nowhere defined) assumption that a player always operates on one single instrument. This can be a particular source of confusion when we focus on keyboard instruments or, more generally, on instruments that can inherently be played by multiple performers simultaneously (see Table 2).

`<perfRes>piano</perfRes>`	1 performer on piano
`<perfRes>piano</perfRes>` `<perfRes>piano</perfRes>`	2 performers on 2 pianos playing different parts (primo/secondo)
`<perfRes count="2">piano</perfRes>`	2 performers on (2) piano(s) (same part)
?	2 performers on 1 piano playing different parts (primo/secondo = four hands))

Table 2: Encoding samples (`<perfRes>`) for piano.

(More recently, in contemporary and especially experimental music, there are no limits to the number of individuals on an instrument or the way it is operated!)

Following this logic and definition of `@count` above, `<perfRes count="2">piano</perfRes>` represents one piano part performed by two different performers (on two pianos) at the same time. It is therefore the doubling of the same instrumental part, as seen for the violin in Table 1. What about compositions for keyboard instruments for several hands? Finally, piano reductions of symphonies are often set for piano four hands (e.g., Joseph Joachim Raff, *Symphony No. 1 in D Major, Op. 96, "An das Vaterland"*, arranged for piano four hands by the composer)[2] but also transcriptions (e.g., Max Reger's transcriptions of the Brandenburg Concertos, BWV 1046–1051, by J.S. Bach, RWV Bach-B9). The problem that arises from this form of encoding is that the really common case of piano for four hands cannot be specified.

Of course, by nesting one can build structures that probably represent what piano four hands means, but does the result then still meet the definition of `<perfRes>`?

```
<perfRes label="piano">
      <perfRes>primo (1st part)</perfRes>
      <perfRes>secondo (2nd part)</perfRes>
</perfRes>
```

Listing 2: Encoding piano for four hands by nesting `<perfRes>`?

Finally, in this way of encoding we would use `<perfRes>` both as a wrapper element to describe an instrument and as child elements to describe two different parts. Thus, the idea that `<perfRes>` specifies the "[n]ame of an instrument on which a performer plays" is actually alienated. This is because in our example we do not specify an instrument label with 'primo', but rather the part and ultimately the function that a performer performs. Thus, by nesting the performance resources within each other, a content inaccuracy arises (see Listing 2).

Let's go one step further: There are not only works for piano with two or four hands. Besides keyboard works like Max Reger's *Spezialstudien für die Linke Hand allein* ("Four Special Studies for the Left Hand Only"), WoO III/13, there is also the configuration in which a piano is to be played with three hands, for example.

Figure 1: Excerpt from J.W. Holder's Trio in E-flat major, Op. 31. Source: Holder, Joseph William. *A Trio for Three Performers on the Pianoforte. Op. 31*. London: Goulding, Phipps, D'Almaine & Co [1810?].

Figure 1 shows a score that requires three hands. It is obvious that more than one player is required to perform this (on one instrument)!

According to the title page, this Trio by J.W. Holder is composed for three performers at one piano, even though the chord brackets (stave 2 and 3) indicate an assignment for two performers. Thus, even in this simple example, several instrumentations are possible, which should also be encoded as alternatives. Regarding the distribution of the hands (which performer plays which staves), however, the problem arises that here neither an instrument, nor a performer, but a body part of the performer, namely his hands, must be addressed. As an example: Johann Friedrich Schwencke adds to his "24 postludes in all keys and 24 transitions" a three-hand performance option "for organ with obbligato pedal, or for pianoforte (2, 3, or 4 hands)" [14]. Thus, the need to address body parts is obvious. And that is not an isolated case as shown by the examples in the MEI sample-encodings repository [13] that the authors of this text have collected to provide approaches to how these cases currently have to be solved due to missing markup possibilities. By the way: There are also examples of works for piano six hands (by Carl Czerny and Sergei Rachmaninov).

With regard to the organ, we have yet another entity to consider when addressing 'body parts of a performer': the feet. For much of the organ literature, this may sound absurd, since one performer usually plays one organ. But there are also works in the organ literature that require a certain configuration, for example, works for two players at one organ, where only one of them operates the pedal, or where each player is assigned certain manuals. There are also organ works for solo pedal, such as the "Pedal Exercitium", BWV 598, by J.S. Bach, or for four feet (Johann Strauss Jr., "Waltz", arranged for two performers on one organ [15]). In order to index these configurations as machine-readable research data, a certain level of detail in indexing is indispensable.

The few examples of organ and piano literature alone already show the need for greater differentiability within the encoding, from which, for example, the description of percussion, to name just one more, would also benefit.

In the second subset of the definition of `<perfMedium>` we learn that "the character of the performing forces" should also be described. In our understanding, this includes, e.g., the tuning of an instrument (e.g., clarinet in E-flat) – the use of the attributes `@trans.diat` and `@trans.semi` could be an approach here – but also the presupposed range. The question here is what do we encode in `<perfMedium>` and for what purpose. We can record a historical performance situation (e.g., a world premiere), but we can also record which instruments (and how many musicians) are necessary to perform a work (which is absolutely relevant for conductors, for example). Furthermore, it is extremely important to encode requirements for the performance. Although it is possible to find out from the score itself whether a double bass part requires a five-sided bass or whether a four-sided bass is sufficient, it must be remembered that this information is only available as ambitus indications in a work catalog.[3] But in a catalog, there is not necessarily a `<music>` section that contains this kind of information. Especially for vocal parts, it is extremely important that the required voice ranges can be specified. For example, Wolfgang Amadé Mozart wrote the role of the Queen of the Night in his "Magic Flute" for soprano, but this role cannot be filled by any soprano! The reasons for this are obvious.

So if we already have the possibility to encode ranges in a machine-readable way, it should be possible to use the `<ambitus>` element in an element like `<perfRes>`, in order to be able to describe the character of the performing force more in detail. At this point, the requirements for the description of the performing forces are already so diverse that the question should be asked: Why don't we define the instruments themselves?[4] — Think of the percussion instruments mentioned above, for which a detailed description of any modifications is indispensable, or for other kinds of instrument modifications (the prepared piano).

To conclude this chapter, let us take one last additional step. The best practice recommendations of the Metadata Interest Group suggest that the MARC Instruments and Voices Code List [5] or the UniMARC Medium of Performance List [3] should be used for the identification of instruments, but these lists are too incomplete in some places for general use. Therefore, the question arises whether it is not up to the music encoding community to remedy this deficiency with the creation of its own authority files which are usable for scientific purposes. We envision here, for example, a taxonomy that is made available to, and maintained and expanded by, the entire community. This would allow the community to create its own instrument database that meets the requirements of musicology and can serve as a reference for all MEI related research (#standardization). In addition, such a central database could list instrument names and their equivalents in various national languages and eventually serve as an interface to other formats such as MARC.

2.2 Reflections on Watermarks

Watermarks in music manuscripts[5] present a particular challenge for description in the metadata section of MEI and discoverability in general. In addition to the verbal description of the watermark itself, other parameters such as the position of the watermark on the page, its completeness, information about the paper mill and the possible production period, and the period of use by the composer are necessary for drawing conclusions about the composition periods of the notated works and the composer's use of the paper.

In general, carefully catalogued watermarks provide dating assistance for compositions that are not autograph-dated but may have been written on the same kind of paper as dated works. This does not only apply to papers used by the same composer; if, for example, contemporaries such as Ludwig van Beethoven and Franz Schubert obtained their paper from the same merchants, comparisons can also be made across composers.[6]

Even such a basic comparison, however, presupposes that, on the one hand, a relatively large corpus of watermarks described in the same quality is available for a given composer of interest and, on the other hand, that other researchers and projects carry out the indexing according to the same criteria, since only then it is

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3   Ambitus indications are most common for vocal music, although there are many other instruments where such indications would be helpful.

4   There is the element `<instrDef>`, but this can't be used for describing instruments because it is a "MIDI instrument declaration" [8].

5   The following section mainly describes watermarks in music manuscripts of the late 18th and early 19th centuries. The authors are aware that manuscripts from earlier periods are only comparable to the manuscripts discussed here to a limited extent due to changes in paper production.

6   The mere dating on the basis of watermarks generally allows a range of ± 5 years, but the example of Schubert shows that this range can also be reduced.

possible to compare different watermarks and thus music papers. This provides enough justification for discussions about systematizing and standardizing the description and long-term archiving of watermarks.

Description and standardization

For several MEI versions, it has been possible to store verbal descriptions of watermarks by means of the `<watermark>` element in the `<physDesc>` of the source description. In order to ensure standardization and improve discoverability at this point, the vocabularies and taxonomies from watermark research should always be preferred for the verbal description of watermarks.

The *Bernstein Project*, for example, offers a multilingual vocabulary for describing watermarks as well as a basic three-level system for describing the symbols or motifs of watermarks themselves [1, 2]. If a watermark description is based on such a standardized vocabulary, the interoperability of the collected data increases enormously, even if the three-level systematization reaches its limits due to the complexity of individual watermarks.

Another standardization approach for cataloging watermarks is the IPH (International Association of Paper Historians) standard, whose task is described as follows:

> The IPH Registration Standard ensures the registration of all historical and modern papers and paper items, with or without watermarks. Therefore some criteria are defined which apply to single paper types only. The IPH Registration Standard is both a technical standard of normalized criteria as well as a standard defining criteria and paper or watermark types, fixing their name and specification in the most important languages, in order to ensure the international compatibility of the paper data [4, p. 2].

The underlying rules are: (1) the use of the extended ASCII character set for machine readability, (2) fixed codes for field names, (3) prescribed subcodes for field contents, and (4) a number of required fields that must be collected [4, p. 22]. The degree of complexity that this encoding of characters can reach, can be seen in the following example:

> Description in full (according to 3.1.5): Eagle, crowned, overlaid with italic capitals FWR, holding sceptre and sword in the left claw, an orb in the right claw, at the top the name "G W Loeschge", at the bottom "in Ansbach".
> Completely coded description (according to 3.1.4 and appendix I): D5/1 [R3/1 - {c: (i: X 'FWR")-C1: p06 [R7 - M14 - {r: p06 [R4 - {t: → Y "G W L0ESCHGE" - {b: → Y "IN ANSBACH" }]] [7, p. 18].

Such a description – and the example cited here does not yet include a fragmentary or composite watermark – can apparently not be generated manually but only with a specially created editor and input mask. Therefore, software-specific restrictions were created with the aim of standardization, even though the structuring and description possibilities for watermarks can be described as extraordinary.

It is obvious that this kind of indexing – using ASCII codes – can only be implemented with great effort in an XML-based markup format such as MEI; however, a first attempt at implementing IPH-norms in XML-based formats as a TEI extension module was published by Ermenegilda Müller [11, 12]. Müller adopted the basic structure of the IPH standardization, but relied on linking and nesting in the description of (partial) watermarks as well as meta information such as the paper mill and the paper manufacturer. A similar structure seems to be feasible for MEI.

Because the indexing of a watermark can be extremely complex, it is important to first mention some parameters that are either recommended or optional, such as: (1) the verbal description, (2) whether it is a standalone, fragmentary, or composite watermark, (3) possible countermarks and the connection to them, (4) the size of all symbols, (5) the positioning of the symbol on or next to the chain lines, (6) the distance between the chain lines, (7) the positioning of the symbol on the paper, (8) information on the period of use of the paper, (9) information on the paper mill and the paper manufacturer, and (10) the inclusion of graphics on the specific watermark.

The abundance of information already indicates that the existing markup options for `<watermark>` within `<physDesc>` or `<support>` should be more structured for further machine data processing. Here, it would be preferable to create a wrapper element such as `<watermarkDesc>`, which stores – analogous to Müller's conception – the information on the mark itself and the meta information on the paper production in two separate child elements `<watermark>` and `<papermill>`.

The information on the paper manufacturer as well as the references to it can be marked by `<persName>`, `<corpName>`, `<geogName>`, and `<bibl>` in the usual way, whereby especially the production period of the paper and possible changes of ownership of the paper mill make a `<history>` element seem more sensible. Because changes of ownership often involve changes in the watermark itself – such as a change of initials or additions to the motif – either a secure period of use should be indicated or the described watermarks should be linked to an owner.

The verbal description of the motif of the watermark should, as mentioned, be based on existing vocabularies, but since these databases are by no means complete, the existing form of description by means of free text should be retained. In addition, there is the option of adopting systematizations by means of `<identifier>` and `<termList>`.[7]

As Müller already proposes, an attribution with a closed list is suitable for differentiating between main, counter, or partial watermarks [12, p. 15]. Equally relevant is the question of whether it is a composite motif (see below), whereby a distinction must rather be made as to whether the motif was described as a composite motif or its parts individually. Therefore, it should not be asked for part 1 or 2, but whether a reconstructed watermark is already present or not (`@composite="true/false"`).[8]

In order to define the connection between the main watermark and its countermark(s), the common solution in the MEI header using `<relation>` can be applied – contrary to Müller's suggestion of a `<countermark>` element [12, p. 8]. This way, a linking mechanism similar to the FRBR relations could be established here, utilizing `@rel` with values `hasCountermark` and `isCountermarkOf`.[9]

For the description of the size of the motif, existing markup forms can be used by means of `<dimensions>`, `<height>`, and `<width>`. Likewise, the mere verbal description of the positioning on a page and on which page could be mapped using `<locus>`. The integration of already existing depictions of the watermarks – whether taken with transmitted light, thermography, manually, or by means of radiology procedures – could be realized trivially via `<graphic>`, but seems to be particularly important in view of the analysis of large watermark corpora through signal processing and machine learning.

The need for a precise description of the position of a watermark on the page becomes particularly clear when attention is directed to fragmentary motifs:
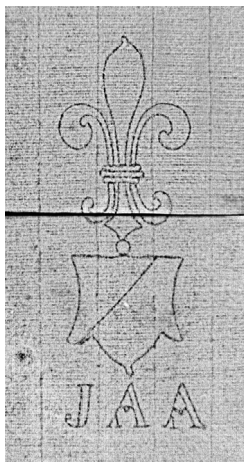
Figure 2: "Watermark DE0960-Schubert13_5". Source: https://www.wasserzeichen-online.de/?ref=DE0960-Schubert13_5 (accessed January 12, 2022).

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7 Cf. file `../Watermark/watermark_ex_03_connecting_to_WZIS_and_using_terms.xml` in [13].

8 Exact linking for page positioning can also only be established for composite marks if the sub-characters are described separately.

9 Cf. file `../Watermark/watermark_ex_02_countermarks_and_fig.xml` in [13].

The two fragmentary parts of the *Welhartiz* watermark (Figure 2) are each located at the margins of the sheet, so that it is only through reconstruction that the 'original' and uncut paper as sold by the paper-maker can be 'restored'.[10] Particularly when composers used many separate individual sheets for their compositions, as in the case of Schubert, the reconstruction of the 'original' and uncut paper can provide information about the compositional process and period. However, with a larger number of individual sheets, 'analogue puzzling' out possible matches manually is subject to restrictions – due to access to the manuscripts and their preservation protection –, the digital storage of this information offers advantages both in terms of time economy and manuscript conservation.

`<watermark>` *like* `<patch>`

Information on layer order and physical additions (such as cutouts and patches) to a manuscript can be already stored in `<foliaDesc>`. So it would make sense to encode the positioning of watermarks on the manuscript page in the same way as a `<patch>` is contained by `<folium>` or `<bifolium>`, so that `<watermark>` is also possible in `<foliaDesc>` and thereby also takes over the attribution of `<patch>`. The existing limitation for `<patch>` that "[a]t this point, it is not possible to specify rotation" [7] needs to be overcome for watermarks as well, since the rotation of the motif matters in a special way for the reconstruction. A more detailed description of the motif could then be linked via `@xml:id` to `<watermarkDesc>`.

Similar methods will probably have to be used to indicate the position on the chain lines, the number of chain lines, and the distances between them. For the purposes of mere discoverability, it seems useful to add the position of the watermark on or next to the chain lines as an attribution to the description of the motif itself (`@chain "in.between"`, `"on.it"`). And also to add the number of visible chain lines on which the motif is positioned by means of `@quantity`. However, it is a description of the `<surface>` so that it seems consistent to store this information also in `<foliaDesc>`. As Müller suggests [12, p. 13], an element `<chainLines>` could be used as a child of `<folium>`, specifying the starting point of the first chain line on the page (`@start`), the number of chain lines on the page (`@quantity`) as well as the distance between these lines (`@distance`), and thus making it possible to precisely determine the positioning of the watermark on or next to the chains. In addition, it is necessary to specify whether the chains run horizontally or vertically (`@orientation`), which is determined by the orientation of the paper after scooping.

Of course, it should not be forgotten that there are already databases for recording watermarks and linking to them using `<ptr>` may be sufficient for certain use cases of manuscript description. For more complex and extensive source databases, however, it is necessary to create the description of the watermarks yourself, since only with the standardized recording of these metaDATA, analyses can be carried out on the use of papers by a composer. It can be shown that the standardized recording of watermarks requires a multitude of parameters that go far beyond the mere verbal description of the motifs. For music manuscripts in particular, MEI should therefore be the format that enables the capture of such data.

Résumé

The question of what metadata are and why they should not be provided just because of the 'mere' documentation obligation was to be discussed. Even the simple distinction between METAdata and metaDATA makes it clear that data recorded in the MEI header should not only be understood as mere additional information for encoded musical content, but also be regarded as research data. In many aspects, standardization and machine-readability are the main focus when collecting such research data, as this is the only way to ensure comparability within one's project data as well as exchange within the community.

In the case of the performance medium, it becomes apparent that a multitude of possibilities of musical practice are not yet adequately recorded with best practices. Existing organ and piano literature and their instrumental disposition can only be recorded up to a certain point, which prevents further (automatic) analysis, e.g., to inquire about repertoires for certain arrangements. Likewise, another possible problem to be solved is the linkage between existing part material and historical performance scenarios as well as the

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10   To complete the reconstruction, the two other folios of the original sheet are also needed, as they contain the eponymous writing "Welhartiz" and refer to the location of the paper mill.

linking between persons who, for example, performed a work in piano arrangement for four hands would be a necessary further development, in order to connect work information with musical (historical) practice. An important goal on this path would be a database for instruments managed by the MEI community.

The markup of watermarks also shows that, on the one hand, the high complexity and number of parameters to be considered requires a high degree of standardization. Although, on the other hand, existing databases offer many of these possibilities – i.e., composition of the watermark or its verbal description – and watermarks can be included as graphics, MEI as a format for describing music manuscripts should both offer a best practice suggestion for indexing watermarks and be interoperable with other indexing systems, in order to exploit the synergy effects that can arise, for example, from the exchange with other paper-related research areas.

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