Modelling the relationship between scientific and bibliographic classification for music

Deborah Lee, Lyn Robinson and David Bawden

Centre for Information Science, City, University of London, Northampton Square, London, EC1V 0HB

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Abstract

Scientific classification is an important topic in contemporary knowledge organization discourse, yet the nature of the relationships between scientific and bibliographic classifications has not been fully studied. This article considers the connections between scientific and bibliographic classifications for music, taking general discourse about scientific classification and domain analysis as its starting point. Three relationship characteristics are posited: similarity, causation, and time. In discussions about similarity, "accords" and "discords" are analysed. Furthermore, the idea of a scale of accord is introduced, and issues with assuming a univocal scientific or bibliographic classification of music are discussed. Causation and the idea of influence between scientific and bibliographic classifications for music are unpicked. The connections between accordance and influence are explored, and the concept of differing purposes for different classification approaches is analysed. A temporal dimension is considered, and the dynamic nature of connections between music scientific and bibliographic classifications is established. The idea of bifurcation is introduced – a change of accordance over time – which is prominent for musical instrument classification. The concluding model visualizes similarity, causation and temporal aspects as three dimensions, showing how scientific and bibliographic classifications for music are connected through a set of interconnected and complex relationships.

Introduction

The organization of knowledge within a domain is a vital issue in contemporary library and information science (LIS), and a call-to-arms has been issued by a number of classification theorists asking for more research into scientific classification within knowledge organization (KO). A scientific classification refers to the organization of knowledge by those working and researching within that domain, and therefore reflects the knowledge's creators and extenders, and individuals who embody that knowledge. (Note we use the term "scientific classification" as a broad term which could cover any subject area including music. The problems with terminology in this area of KO, and the rationale for using the term "scientific classification" are discussed in the next section.) However, analysis of the relationships between scientific classifications and bibliographic classifications has received patchy coverage in KO discourse. So, this paper explores the nature of the relationships between the scientific and bibliographic classifications of a particular area: music. In doing so, it not only takes a novel perspective on music classification, but also demonstrates the value of studying the relationships between scientific and bibliographic classifications.

This study is situated within a particular domain: music, and more precisely, notated Western art music – where "notated" is taken to mean music as text rather than sound, "art music" as a

particular style of music which is usually defined by excluding popular music or traditional music, and "Western" broadly pertaining to the European music tradition. Specific scientific classifications of music are compared to bibliographic classifications for music, either directly or through examining secondary literature. However, it is not always possible to find direct equivalents between scientific and bibliographic classifications, and there are conceptual difficulties in labelling any bibliographic classification or scientific classification of music as "the" classification of a particular topic. These conundrums and their impact will be discussed as the article unfolds; however, to partially mitigate some of these issues, where possible, the scheme analysis will be supplemented with general classificatory discussions from the music and LIS domains.

The article starts by exploring existing works about scientific classifications. It analyses literature about the interrelations between scientific classification and bibliographic classification, and shows how the study of such connections fits into domain analysis. Three types of connections between scientific and bibliographic classifications are considered, starting with similarity. Examples of accords and discords in music classification are discussed, highlighting some of the methodological difficulties in ascertaining relationships between scientific and bibliographic classifications in music. The idea of causation is then contemplated, including an exploration of how scientific music classifications influence bibliographic classifications and questioning how a classification's purpose fits into a framework of causation. The temporal dimension is then explored and the dynamism of the connections between music scientific and bibliographic classifications is established. Finally, the different aspects are brought together in a series of visualisations, including a model which postulates three dimensions of relationships between music scientific and bibliographic classification approaches. Therefore, this article analyses the relationships between scientific and bibliographic classification for music, showing the interlinked and complex nature of these connections.

Introducing scientific classification

To discuss the nature of organization of knowledge within a domain, it is first necessary to unpick some terminological entanglements. Beghtol (2003) articulates two types of classification: she uses the terms "naïve" and "professional" to differentiate the classifications produced by those working in the domain itself ("naïve") and within LIS practice or theory ("professional"). The term "naïve" attracted particular dissent from Hjørland and Nicolaisen (Hjørland & Nicolaisen, 2004; Nicolaisen & Hjørland, 2004), as they perceived it as attaching a lesser value to scientific classification (an interpretation which Beghtol (2004) refutes). These are not the only terms which are proposed: for example, both Hjørland (2008a) and Mai (2004) use the terms "scientific" and "bibliographic". However, to complicate matters, there are multiple types of non-bibliographic classifications, of

which scientific classification is only one. For example, Mai (2004) distinguishes between scientific and philosophical classifications, both of which refer to a wider brief than LIS; in addition, Hull (1998) suggests that there are "structural" and "historical" classifications, when discussing classification as a philosophical concept.

This paper is going to use the terms "scientific classification" and "bibliographic classification" to refer to the two different approaches to classification and the relationship between them. One reason for this is that these terms have been used in key works in the literature, such as Hjørland (2008a) and Mai (2004). So, "bibliographic classification" will be used to discuss the classifications designed primarily for the arrangement of bibliographic information, for example schemes such as the *Dewey Decimal Classification* (DDC) and *Library of Congress Classification* (LCC). The term "scientific classification" will be used to describe a scheme created by those organising scientific (or more generally scholarly) information. Bibliographic and scientific classifications are differentiated for the purpose of this article by the main scope and purpose of the classification. However, it must be remembered that they are part of a continuum of knowledge organization; for example, Ørom (2003), in his study of art classification, derives three levels of discourse, of which two would loosely fall into our label of "scientific classification" and the third within our category of "bibliographic classification". In other words, we are distinguishing two types of classification in this paper – scientific and bibliographic – in order to fully understand how they interact, while also acknowledging they are in reality different manifestations of the same fundamental thing: the classification of knowledge.

The study of scientific classifications is an extremely important part of knowledge organization discourse. For instance, despite strong differences between Beghtol and Hjørland/Nicolaisen (Beghtol, 2003; Beghtol, 2004; Hjørland & Nicolaisen, 2004; Nicolaisen & Hjørland, 2004) about the nature and terminology of non-bibliographic classification systems, the *need* to study non-bibliographic classifications is keenly stated by all these authors. The desire to study and utilize scientific classifications has a long pedigree, and is discussed in the early twentieth century (Hjørland, 2008c, p. 97). For example, Bliss (1933, p. 36) writes about what he calls the "scientific and educational organization of knowledge". Even before Bliss' seminal work on classification, authors such as Cushing Richardson (1901, pp. 67-69) were comparing "theoretical" and "book" classifications. So it could be seen that Bliss' (1933, p. 36) writings about "scientific and educational organization of knowledge" is transfigured in the intervening years into studies of scientific classifications.

Existing discourse about scientific classifications usually falls into three categories. One category is directly concerned with a particular scientific classification scheme; for example, Hjørland (2008b; 2011) and Scerri (2011) write about the *Periodic Table* as a classification system, and Hjørland (2008a) discusses the *Diagnostic and Statistical Manual for Mental Disorders*. Another category concerns classification within a particular domain; for instance, Blake (2011) writes about zoological classification, and Ørom (2003) writes about art classification. The third category is concerned with the theory of scientific classification, usually also including examples drawn from specific domains; for instance, notable examples include works by Beghtol (2003, 2004), Hjørland and Nicolaisen (Hjørland & Nicolaisen, 2004; Nicolaisen & Hjørland (2004), Jacob (2010) and Mai (2004, 2011). This article falls chiefly into the second category as it is examining scientific classifications of music; however, although the relationships discussed refer to a specific domain, its novel perspective on analysing the nature of these relationships, means that this article is also partially positioned in the third category.

Key ideas in the connections between scientific and bibliographic classification

It is important to consider the general framework of the scientific/bibliographic classification interaction. Therefore, four theories and vignettes from KO literature are discussed which contextualize the specific discussions about music scientific classification.[1] (Note that there are other ways in which scientific classification links to bibliographic classification: for example, we could view literary warrant (Barité, 2017) as evidence of a close connection between scientific classification and bibliographic classification. There is no space to explore further how literary warrant fits into the ideas discussed in this paper.)

The first idea notes that contemporary classification theorists considered there to be a classification approach in the first part of the twentieth century which directly linked scientific and bibliographic classification; this is (now) called the "traditional approach" (Hjørland, 2008c, p. 89). For example, Bliss (1933, p. 36) writes about what he calls "library classification" and how it interacts with organizing knowledge itself, imploring readers to make library classification "conform to the scientific and educational organization of knowledge". Hjørland (2008c, p. 89), when writing about the historical development of scientific classification within LIS, summarizes the traditional approach as follows:

"Natural order → Scientific Classification → Library classification (KO)" (Hjørland, 2008c, p. 89)

So, the scientific order reflects the natural order – in other words, the way knowledge is ordered in the world without human interference; then, library classification reflects the scientific classification. As this approach directly linked scientific and bibliographic classification, it is illuminating to consider it in more detail. First, one type of classification is dominating the other (the scientific classification) so the classificatory knowledge moves in one direction only – namely, the direction indicated in the arrows. The idea of a common, historical idea of bibliographic classifications depending on scientific ones is also mentioned by Mai (2004, p. 41). Second, there is an inferred preferable outcome in the "traditional approach": those LIS schemes which mirror their scientific counterparts are "correct" and those which do not are "incorrect". In other words, once LIS schemes are cast as reflections of scientific classifications, then appropriation of the scientific classification automatically becomes a metric of criticism (see Lee (2015) for a description of criticism as part of reception-based analysis of classification schemes). Thus, this "traditional approach" sees accords between scientific classification and bibliographic classification as "right", and discords as "wrong". However, this traditional approach is considered to be a historical view: Hjørland (2011, p. 19) stresses that the idea of LIS schemes following and merely reflecting their scientific counterparts disappeared in the middle of the 20th century.

The second idea asks whether scientific classification is a method, an approach, or something else entirely. Hjørland (2011, p. 19) suggests that general developments in classificatory theory during the twentieth century such as facet analysis and user-centric classification have "ousted" LIS schemes as simply reflecting scientific knowledge. If bibliographic classifications reflecting their scientific counterparts are defined as a method, then this could be problematic when considering bibliographic schemes which both reflect scientific knowledge and use faceting techniques. Such a situation is described later in this article when discussing the facets of music. So, this article considers that a bibliographic scheme reflecting scientific classification was an approach rather than a method, and the paradigm shift which ushered in Ranganathan and faceted classification largely replaced this approach.

The third idea considers scientific classification within the framework of domain analysis. The domain-analytic approach, as developed initially by Hjørland and Albrechtsen, "is a theory about and approach to LIS and KO" (Hjørland, 2017, p. 437). As domain analysis perceives knowledge to be situated within a domain and domain analysis also highlights the importance of subject expertise, it is particularly relevant for this article. First, the domain analytic approach also emphasizes the importance of the social organization of knowledge, and is based on a historical, situated view of scientific knowledge. Mai (2004, p. 46) suggests that in the contemporary paradigm of KO,

bibliographic classifications are dominated by the social organization of knowledge. For this article's purpose, this can be seen as bibliographic classification still having a non-bibliographic classification parent; the scientific classification of the early twentieth century, being in some ways replaced by sociological classification. This is important to a study of relationships between classification approaches. Second, this article looks at the relationship between scientific and bibliographic classification for a specific domain. While developing a classification within a specific domain is not itself domain analysis (Albrechtsen, 2015, p. 559), this article considers the characteristics of the domain (music) when considering the scientific classifications. Hence, this article arguably utilizes a domain-analytic approach to exploring the relationship between scientific and bibliographic classifications for music.

A fourth point concerns the *nature* of the connections between different approaches to classification. Mai (2011, pp. 714-715) describes an example of a "cyclical relationship" between a bibliographic classification (in this case DDC) and scientific classifications of race (within anthropology and sociological scholarship, amongst others). In the process, Mai illuminates how the relationship between bibliographic and scientific classifications might be more nuanced and complex than just a direct, one-way influence. This discussion of a nuanced, multi-directional relationship suggests that there are intricacies and complexities in relationships between scientific and bibliographic classifications, and there is value on focussing on these relationships. Therefore, the focus of this article is to analyse in detail the types and dimensions of relationships for the specific domain of music.

Similarity: accords and discords

The first aspect to be considered is similarity. Similarity considers whether the scientific and bibliographic classifications resemble each other; therefore, it considers only the resulting similarity, not the process which created this similarity. (The causes of similarity or how the similarity might change over time are considered in subsequent sections.) A study (Lee, 2017) of music scientific classification and bibliographic classification relating to three aspects of music – medium, form/genre, function – gives a preliminary set of 26 aspects of music where there is a relationship between scientific and bibliographic classifications. So, this relationship of similarity could be categorized into accords and discords – see Table 1. (Note, "Organology" is the area of music research devoted to the study of instruments.) This table does not aim to be complete; rather, this categorized list demonstrates the usefulness of breaking down a scientific/bibliographic classification relationship into individual aspects showing how there can be many different relationships within a subject such as Western art music.

Accords	**Discords**
Three main facets of music: medium (or, "Sound-medium"), form (/genre), and function/purpose	Importance and nature of the vocal/instrumental categorization
Medium is considered a building block/facet of music	Assigned genre and instrumental/vocal assignation of specific choral symphonies
Difficulties of classifying specific choral symphonies and separating out form/genre from medium	Performers' preference for classification of arrangements
Confusion in terminology for arrangements/transcriptions	Current organological and current LIS broad categories of instruments
Arrangement primarily an instrumental concern	Current organological and current bibliographic classification of keyboard instruments
Early organological and current LIS broad categories of instruments	Current organological and current bibliographic classification of percussion instruments
Early organological and current bibliographic classification of keyboard instruments	Current organological and current LIS division into bowed and plucked string instruments
Early organological and current bibliographic classification of percussion instruments	The extent of opera categorization into subgenres
Utilization of *Hornbostel and Sachs* instrument classification	Importance of categorization into "autonomous" and "functional" music
Early organological and current LIS division into bowed and plucked string instruments	
Confusion over types of opera	
String quartet as part medium, form, and genre	
Function is an important categorization/facet of music	
Three important types of function: dramatic, religious/church, and concert	
Dramatic function often overtaken by medium	
Important sacred/secular division	

Table 1: List of accords and discords between scientific and bibliographic classification for music

Accords: when bibliographic and scientific classification concur

In order to examine the idea of similarity between scientific and bibliographic music classification, an example is taken from the above list: the facets or building blocks of music. Determining the facets of music is surprisingly complex, and a number of sources are used to ascertain a sense of standardized classification: an examination of three example classification schemes (Coates, 1960; Dickinson, 1938; Pethes, 1967 – these are selected due to their importance to the development of music classification (Lee 2017), and it is acknowledged that they are all what might be termed "historical" schemes); discussions in music classification discourse; a detailed analysis of three systems of so-called "super-facets" which proscribe centralized systems of music facets (Dorfmüller, 1975; Elliker, 1994; Redfern, 1978). Even the super-facets do not agree which facets exist or the total number of music's facets. However, there is consensus about the *most important* facets of music. Analysis of three example classification schemes (Coates, 1960; Dickinson, 1938; Pethes, 1967), the music classification literature (see for example, works by Lee (2012, 2017), and Smiraglia and Young (2006)) demonstrate that the facets of medium and form/genre are particularly important. Furthermore, Elliker's (1994) important study which systematically analyses 24 music classification schemes found a typical order of importance for music's facets: medium is first, form/genre is second, and a nebulous facet of character/function is third. So, bibliographic classifications of music generally consider medium, form/genre and function to be the three most important facets of music.

Examining the music domain's ideas of building blocks for music shows that there are difficulties in even locating music scientific classification schemes for most areas of music (with musical instruments being an exception). Due to the limitations of finding a broad enough music scientific classification to ascertain the basic building blocks (or facets), an alternative is utilized, namely implicit discussions about classification from the domain of music. Extracts from a treatise on musicology by the composer Busoni (1957) are used, which discusses how music can be broken down into a series of attributes and debates about the perimeters of these attributes. Busoni (1957, p. 1) states what he considers to be the traditional constituents of music according to music philosophers and theorists: "purpose", "form", and "sound-medium". Busoni (1957) not only offers a few subdivisions for these but also offers examples, which in a faceted world, could be considered to be equivalent of examples of the facets' foci. A summary of Busoni's (1957) facets using Busoni's terminology are presented in Table 2, alongside the facets' corresponding subdivisions and examples. This triumvirate of elements could be relabelled using bibliographic classification terminology: character/function, form/genre, and medium. So, comparing the scientific and bibliographic classification schemes and/or discussions shows an accord between the most

important facets of music for bibliographic classification and the traditional building blocks in the music domain (according to one theorist).

Element/Facet	Subdivisions	Examples
Purpose	Opera, Church, Concert	
Form		Song, Dance, Fugue, Sonata
Sound-medium	Human voices, Instruments	Orchestra, Quartet, Pianoforte

Table 2: An example of a scientific classification of music's facets: Busoni (1957)

Examining this example of an accord is insightful, as it raises a number of questions and issues about methodology and the plurality of classifications. While this facets example attempted to ascertain a consensual position on bibliographic classification of music by using a mixture of super-facets, analysis of classification discourse, and analysis of various bibliographic classification schemes, it still only represents a generalization of bibliographic music classification. Amongst other issues, the fluctuating paradigms of KO suggest that bibliographic classifications will change over time; therefore, what is being discussed is a consensus which may have more or less weight at different times in classification history, and is not *the* bibliographic classification of music, just our best estimate and a generalization. Conversely, Busoni's ideas were given as a univocal account of music scientific classification; in other words, only one scientific classification was used. Busoni (1933) implied a consensual view at a particular moment in time, which he was attempting to modernize. (Note that different subject areas have differences in the plurality of their scientific classifications; if we were discussing, say, chemistry, there would be a different weight attached to a single view of a chemistry scientific classification than for music.) So, when considering accord, discord and the other aspects under consideration for music classification, we are really only discussing the interactions between a particular scheme or consensus of classification ideas, and, another scheme or consensus of classification ideas.

Discords: when bibliographic and scientific classification differ

The antonymic relationship to an accord between a scientific classification and the equivalent bibliographic classification is the discord; so, a discord occurs when the music bibliographic classification does not follow the organization of knowledge as seen in the domain. To discuss discords further, an example from the medium facet is used: vocal/instrumental categorization. In a study of vocal/instrumental categorization, Lee and Robinson (2018, p. 266) found that 14 out of 19 classification schemes for music had a primary categorization into vocal and instrumental categories, with some categorization also seen in four out of five of the remaining schemes. Therefore, these bibliographic classifications show a strong adherence to dividing musical medium between vocal and instrumental. Again, this offers a consensus approach, while acknowledging that each specific bibliographic scheme acts slightly differently.

Like the accord example above, determining the music domain's organization of knowledge is not straightforward, and had to be reconstructed from musicological sources and discourse. Lee (2017) used ideas from musical aesthetics which considers text and concert music, and an analysis of 25 examples of composer worklists from the music encyclopaedia *Grove Music Online,* to determine whether the vocal/instrumental categorization exists in the music domain. The exploration found that while the vocal/instrumental categorization is indeed found in the music domain, it is somewhat equivocal (Lee, 2017): in certain situations and for certain temporal-stylistic time periods, the indicators of such a divide are present, whereas for others, the categorization becomes blurred or even non-existent.

This vocal/instrumental example illustrates how an accord can have a level of dilution; a partial categorization in the scientific classifications becomes a watertight division when reflected in bibliographic classification. In this example, a classificatory idea which is part of the music domain's organization of music knowledge is used in a more rigid way in bibliographic classifications. Therefore, instead of a binary accord/discord categorization, actually the similarity relationship between a scientific classification and bibliographic classification could be considered as more of an axis of accordance, with accord and discord as its poles.

Causation: exploring influence and purpose

This section considers causation, and the influences of music scientific classification on bibliographic classification. The *Oxford English Dictionary* defines "influence" as "to have an effect on" (Influence, v., 2018, definition b), so any sign of one classification having an effect on another could be said to be an influence. To some degree, a bibliographic classification is inevitably influenced by knowledge of the domain: the creation of terms in a bibliographic classification, hierarchies of those terms, or even the creation of basic categories, all require some level of subject knowledge. So, at the most basic level, music scientific classification inevitably influences bibliographic classification. (Note that this section focuses on music scientific classifications influencing a bibliographic classification. It is possible that in certain circumstances, this relationship could be reversed, and a scientific classification could be influenced by bibliographic classification; the influence of DDC notation on the musical instrument classification by Hornbostel and Sachs (Lee, 2014; Lee, 2017) provides a musical example, and biomedical ontologies provide a possible non-musical example of this phenomenon.) However, moving beyond basic subject knowledge, how can we analyse how music classification within the domain of music has influenced bibliographic classification? Again, the paradigm shifts in KO are important here: in the early 20th century, Bliss and others espoused the idea that there was a straight line between scientific knowledge, scientific classification and bibliographic knowledge, and

that line can be seen as a line of effect. Yet, while the paradigm shifts in KO which followed – the faceted approach and later the domain analytic approach – might move away from scientific classification as the prevailing approach to bibliographic classification, they do not necessarily move away from influence entirely.

So, it could be assumed that when considering the accords between music scientific and bibliographic classifications, for example in Table 1, that these are all caused by influence. However, before exploring whether this statement is even true, proving that accord is caused by influence is methodologically problematic: we usually only have the evidence of the resulting similarity (or not), which can be constructed post-facto by classification scheme detectives, rather than evidence of influence. Fortunately, examples such as the connections between the *Phoenix schedule* of DDC – which became the 20th edition of DDC, and is the structural basis of the contemporary DDC music schedules – and the instrument classification scheme, *Hornbostel and Sachs*, are exceptions; here, documentary evidence helps to inform us of the intentions of the scheme's authors and in these examples show how the *Phoenix schedule* was directly influenced by the scientific classification of instruments. In areas where explicit evidence of causation between scientific and bibliographic classification do not exist, one future possibility is to consider comparing theories which drive the classifications, in order to elicit meaningful comparisons. While it is not possible to explore this further in this article, this could be considered for future research.

Even more significantly, influence is not a quality which automatically results in accord. It is vital to detangle the act of affecting and the resulting similarity. Although within two scientific schemes, Lee (2014, p. 202) gives a useful example where one scheme (a scientific instrument classification by Sakuri) is designed specifically as a reaction to another scheme (another scientific instrument classification, *Hornbostel and Sachs*). In this case, one classification influences another, but the result is discord rather than accord. This type of influence could be seen more broadly within the context of classification scheme criticism, a phenomenon articulated by Lee's (2015) application of reception theory to classification schemes. So, translated to scientific and bibliographic classifications, influence can sometimes lead to discord between scientific and bibliographic classification, and in scheme-criticism terms, the bibliographic classification would be seen as an act of criticism and a correction to a "wrong" scientific classification. In other words, scientific classifications may not always be perceived as being "correct", especially if there are questions of out-of-date knowledge and thinking. Therefore, while this particular combination of influence and discord was found to be rare in music classification, it is conceptually possible and therefore important to modelling causation.

Music classification also shows how influence may only lead to a partial accord. For example, the *Phoenix schedule* (Dewey et al., 1980) uses various terms from, and partially echoes the structure of, the scientific classification *Hornbostel and Sachs*. Due to the importance of the *Phoenix schedule*, documentary evidence exists which shows how DDC consciously utilized *Hornbostel and Sachs* – see, for example, the introduction to Dewey et al. (1980), written by the scheme's authors. Yet, when the DDC schedules are examined, it is shown that while some aspects of structure and vocabulary are in accordance with *Hornbostel and Sachs*, there are differences. For example, the *Phoenix schedule* has a separate keyboard class with prominent treatment of the piano; yet, this negates *Hornbostel and Sach's* treatment of pianos as just one example of a specific type of zither within the chordophones category (stringed instruments), and their scheme has no keyboard class. This illuminates two important points about influence. First, influence between a single bibliographic classification and a scientific classification can be considered as a range, rather than a single, discrete attribute; we could describe this range as existing between poles of "influence" and "non-influence". Second, the pianos example shows that while scientific classification had a known influence on the construction of the *Phoenix schedule*, a different, as-yet-undiscussed phenomenon must have also had an influence to have led to the final placement of pianos. One explanation for this is the idea of "purpose".

On a theoretical level, scientific and bibliographic classification schemes are fundamentally different in their reasons for existence, a quality succinctly described by Jacob (2010, p. 112) as "purpose". While the generic purpose of a bibliographic classification is primarily information retrieval, a scientific classification will have other purposes – for instance, see Beghtol (2003) who discusses knowledge creation as a key aspect of naïve classifications. So, it is logical to expect two things designed for different purposes to be different from each other in their realization. In some sense, the differing purposes could be seen as a direct competitor to the idea of influence. The DDC and *Hornbostel and Sachs* keyboard example can be used to illustrate this. The purpose of the DDC schedules was to organize works of music and works about music, and in the 1970s and 1980s, keyboard instruments such as the piano would have been an important part of the collections being classified. Conversely, the purpose of *Hornbostel and Sachs* was for organising instruments (and works about instruments) and to demonstrate a scientifically sound organisation of musical instrument knowledge, which can be used to illustrate relationships and propagate scientific knowledge about instruments; in such a system, there is no category of keyboard instruments, as instruments such as the piano are classified as being an example of a specific type of zither, belonging in the chordophone category. Therefore, we could hypothesize that while *Hornbostel and Sach's* placement of the piano as an example within a very detailed class of chordophone was known

by the authors of *Phoenix schedule*, the needs of the users of DDC who would be seeking their libraries' significant piano and keyboard collections, trumped the influence of the scientific scheme.

So far, situations have been discussed where music scientific classifications might have been deliberately ignored, either as an act of criticism of the scientific classification or due to the bibliographic classification's overriding purpose of retrieval of music information. However, it is also useful to consider examples where there is no sign that music scientific classifications were considered in the creation of bibliographic classifications. For example, there is a lack of explicit mention of Busoni's facets (1957) or mention of any other scientific music classification's building blocks within the music bibliographic classifications considered for this study, despite the strong accord between Busoni's facets and the consensus of facets used in bibliographic classifications. Lack of evidence does not in itself negate the hypothesis of influence from a scientific classification; influence is a notoriously difficult essence to prove. However, this does asks an interesting question: do philosophers of music and LIS scheme creators/theorists *independently* break down music into its constituent elements and get the same result? In other words, do the music bibliographic classifications bypass the scientific classification; or, do we have an undocumented or unconscious influence from scientific classification?

Furthermore, lack of influence which results in discord is also of interest. There are a number of possible explanations for this type of situation. One example is a lack of expertise about scientific classifications of music from the person designing the bibliographic classification, and this can be considered within the framework of domain analysis and the importance of subject expertise (see for example, Hjørland, 2008c, p. 89). Furthermore, utilizing out-of-date subject knowledge could be seen as a variation of this non-influence/discord combination, as the classification author is not influenced by current scientific classification due to unawareness of current scientific classification (as a non-music example, see Blake (2011) for a discussion about zoological classification, where bibliographic classifications adhere to out-of-date scientific classification).

Temporal aspects: dynamic relationships and bifurcation

So far, similarity and causation have been discussed, but from a fixed temporal perspective. In reality, the relationships between any scientific classification and bibliographic classification exist in time. A relationship itself could change over time, and it will also be influenced by general developments in the production of scientific knowledge in music and general bibliographic classification theories. Therefore, the temporal dimension is especially important to a study of relationships between classifications.

Analysing scientific and bibliographic music classifications reveals that time plays a particularly important part in one area of musical knowledge: the main structure of instrument classification. Within the music domain, organological studies – research focused on musical instruments – reveal that the most common categorization of instruments was a "traditional" three-category system which divides instruments into wind, strings and percussion. For instance, Kartomi (1990, p. 136) suggests that the three-prong system was in place from Medieval times through to the 18th century; in fact, some writers cite an even older "source", suggesting that the three-category system is actually biblical (Galpin, 1937, p. 25). However, during the late 19th and 20th centuries, there was much criticism within the music domain of this three-part system: for example, Hornbostel and Sachs, authors of the eponymous and critically important scheme of instrument classification, describe three-category schemes as "inadequate" and "illogical" in the introduction to their scheme (Hornbostel & Sachs, 1992, p. 445). In 1880, there was a seismic change in conventional organological thinking about instrument classification: Mahillon's classification scheme created for the Musée Instrumental du Conservatoire Royale de Musique in Brussels (Kartomi, 1990, p. 163) took the revelatory approach of dividing the population of musical instruments into four, not three, families and these four categories were used in *Hornbostel and Sachs* in 1914. The four categories used by *Hornbostel and Sachs* divide instruments on how the sound is activated, rather than how the instrument is played, and in *Hornbostel and Sachs'* terminology are labelled idiophones, membranophones, chordophones and aerophones .

Analysis of bibliographic classification schemes is a useful way of determining the broad categorization of instruments within LIS. For example, in a study of instrument classification, Lee (2017, p. 244) found that 14 out of 15 example LIS schemes showed structural adherence to the three-part categorization of instruments; furthermore, even when specifically considering schemes which originated at similar times to Mahillon (1880) and *Hornbostel and Sachs* (1914) – the 1st, 7th and 10th editions of DDC and the original and revised editions of LCC – it was found that bibliographic classifications still followed the three-category system (Lee, 2017, p. 244). Therefore, it seems that a bifurcation in the categorization of instruments occurred in 1880. The established, three-category system used by those working with instruments up until the 19th century was replaced by Mahillon's scientific classification, and this was popularized by *Hornbostel and Sachs* from 1914 to the present day. However, the bibliographic classification schemes largely continued to use a three-part categorization system despite the change in scientific classification.

So, in terms of similarity, the relationship between scientific classifications of instruments and bibliographic classifications of instruments can be seen as both accord and discord; however,

whether the similarity aspect of the relationship between the scientific classification and bibliographic classification is accord or discord depends on time. So, it is a dynamic relationship. We could call this particular relationship "bifurcation". According to the *Oxford English Dictionary*, a bifurcation is a "division into two forks or branches (viewed either as an action or a state)" (Bifurcation, n., 2017, definition 1a). In the context of a relationship between a scientific classification and bibliographic classification, bifurcation means that the accord between scientific classification and bibliographic classification turned into discord.

It is interesting to question the reasons for this bifurcation of scientific and bibliographic classification of instruments. What explanations could be offered as to why bibliographic classifications did not follow scientific classifications in having the *Hornbostel and Sachs* four categories of instruments, as devised in 1914? One possibility is that there were competing classifications taking place in the 20th century from others working in the domain of music: as well as those who are formally involved with classifying instruments and knowledge about instruments (organologists), instrument categorization is also part of practical music-making. Organologists writing in the later 20th century maintain that the traditional three-category system of wind, strings and percussion is still the prevalent organization system in place for orchestras and performers (Dournon, 1992, p. 252; Hood, 1971, p. 124). Even today, the average symphony orchestra's divisions into strings, woodwind, brass and percussion (Campbell & Greated, 1987, p. 183) bear more similarity to the traditional three-category division than to the structure of *Hornbostel and Sachs*. Therefore, while scientific classification from organologists changed in structure over time during the 20th century, this was not echoed in another part of the domain – namely, the performers of Western art music. So, one possible reason that bibliographic classifications of instruments did not radically change their structure during the 20th century to match the changes in scientific classification, was that they were following the classification structures of a different part of the domain. These instrument examples show the importance of studying the temporal nature of the connections between scientific and bibliographic classifications. In addition, the instrument examples show that in addition to multiple scientific classifications, there also might be differing classifications between different agents in the same domain. This results in a rich set of relationships between classifications of music.

Modelling the relationships between music scientific classification and bibliographic classification

This article has discussed three characteristics of the relationships between music scientific and bibliographic classifications: similarity, causation and time. Three important patterns emerge for the

music domain in the realm of similarity: accord, discord and bifurcation. Therefore, the 26 examples from Table 1 can be divided between these three groups – see Figure 1. (The number of music domain relationships differs between Table 1 and Figure 1: some relationships listed as both an accord and discord in Table 1 only need to appear once when they are described as a bifurcation in Figure 1.) Figure 1 is novel as it emphasizes that there is no singular relationship between scientific and bibliographic music classification, and that similarity is dynamic.

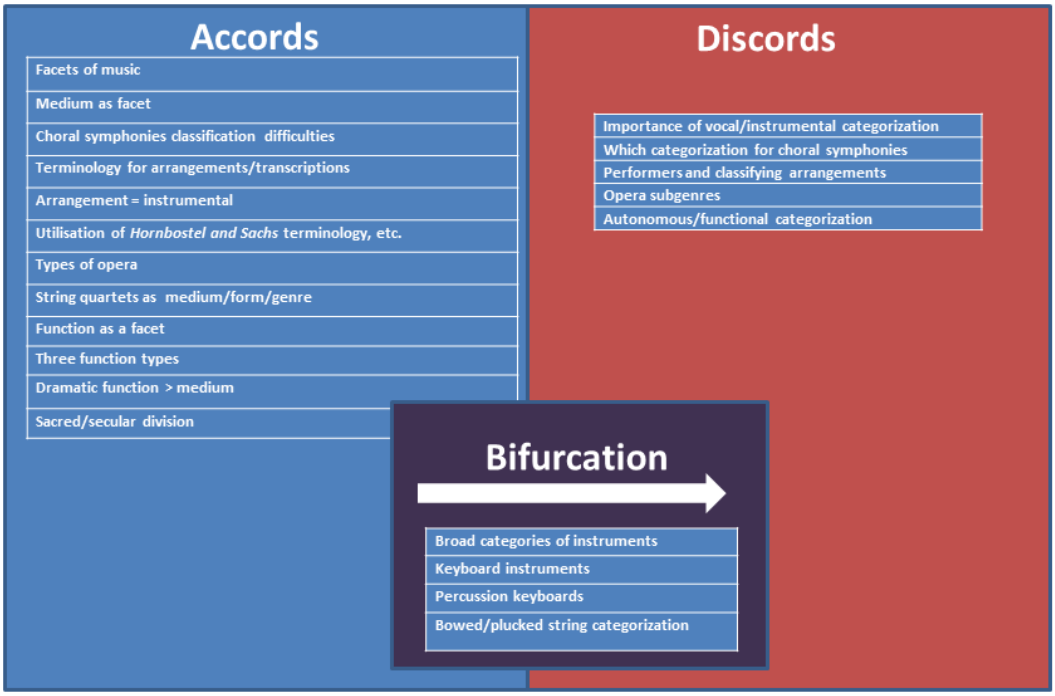

Figure 1. Three realizations of similarity in the relationships between scientific and bibliographic classification for music

When discussing causation, it was shown that there was no automatic connection between similarity and influence. While it might be expected that scientific classifications for music influence bibliographic classifications and this leads to accords, this was not the only possibility. Other possibilities are illustrated in Figure 2, which also shows the so-called traditional approach in a darker box.

	Influence	Non-influence
Accord	Traditional approach, where scientific classification influences bibliographic classification	Bibliographic classification similar to scientific classification, without being explicitly influenced by scientific classification
Discord	Bibliographic classification acts as criticism of scientific classification and/or to amend errors	Lack of subject knowledge by bibliographic classification creator; or, influenced instead by non-scientific classification from domain

Figure 2. Combinations of similarity and influence

The music classification examples and the discussions about similarity, causation and temporal aspects, illustrate that the relationship between music scientific and bibliographic classifications could be considered as three separate dimensions. These are combined in a model and visualized in Figure 3. This model shows the accordance dimension as a thick arrow, with accord and discord as its two poles. The accordance dimension plots the actual similarities between a music scientific classification and bibliographic classification. Furthermore, situations where a music bibliographic scheme follows a scientific scheme for some aspects but not for others, could easily be accommodated in this model by placing such a relationship partway between the accord and discord poles.

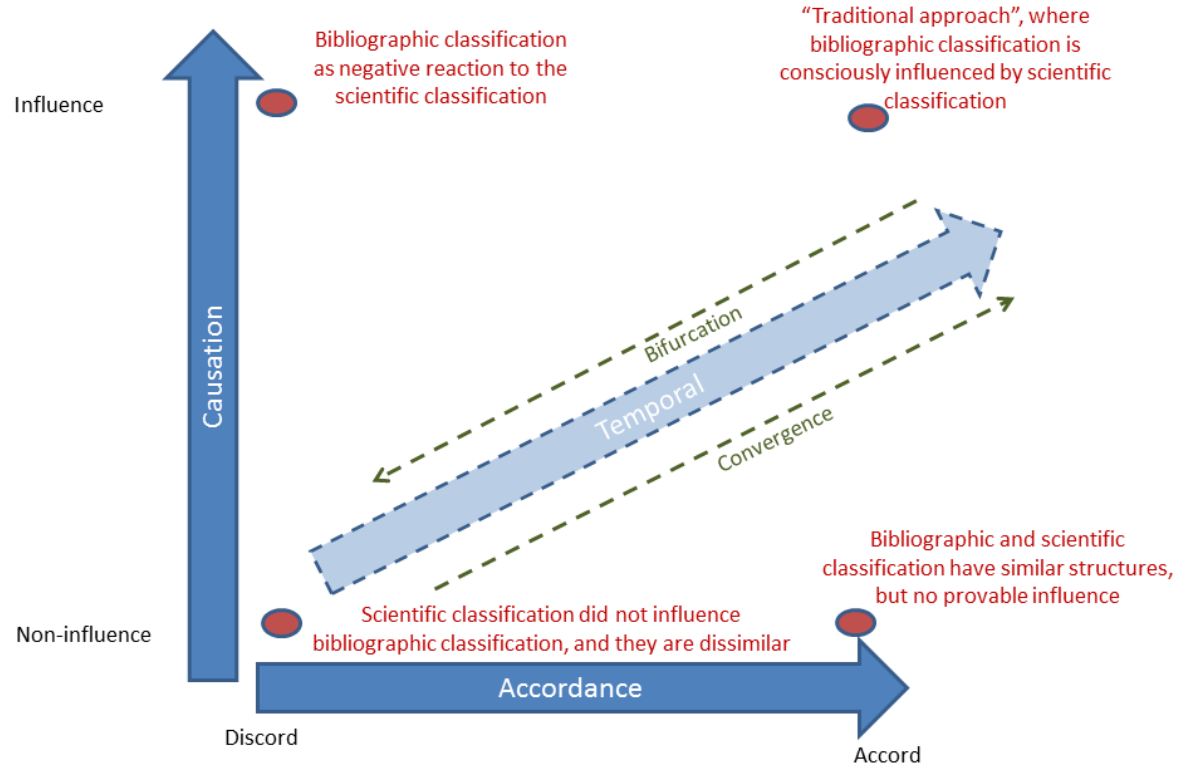

Figure 3: A model of the three dimensions of relationships between scientific and bibliographic classification for music

The causation dimension is indicated by a thick arrow: "non-influence" is one pole, and "influence" is the other. The traditional approach is depicted in this model as a red circle, placed where accord and influence are both high – see Figure 3. However, this visualization also allows for the situations discussed previously, which have different combinations of causation and similarity. For example, a second red circle represents the cases where the bibliographic and scientific music classifications had the same structure, but no direct influence was proven; this is shown as a high level of accordance but near the non-influence pole. A third red circle plots the possibility of a bibliographic classification disagreeing with the scientific classification, and being a reaction to it; this red circle is placed where influence is high, but accordance is low. The fourth red circle depicts those situations where the music scientific classification did not influence the bibliographic classification, and the schemes are dissimilar – perhaps caused by lack of subject expertise by the creator or updater of the bibliographic classification.

The temporal dimension is important and is also shown as an arrow – see Figure 3. Note that this arrow is illustrated with a dotted outline and fainter colour block, due to the limitations of representing a third dimension on a two-dimensional graphic. This shows how any combination of influence and similarity also has a position in the temporal dimension. Changes of accordance and/or similarity over time can be plotted using arrows; for example, the idea of bifurcation – as seen, for example, between the broad categorization of musical instruments in scientific and bibliographic classifications – can be plotted as an arrow which moves from a point of high accordance to low accordance over time. (Note the use of arrows rather than points for temporal relationships such as bifurcation, is due to the relationships being defined by their *change* of accordance over different values of time.) Furthermore, this model is also useful for illustrating relationships which were not found in this study of music classification, but could be sought in further research. For example, although no examples of convergence were discussed, in other words, a music bibliographic classification becoming more similar to a scientific classification over the progression of time, and a near-opposite of bifurcation, this model shows how this relationship could exist, and generates potential research questions for future study.

So this model (Figure 3) shows how the connections between music scientific classifications and bibliographic classifications are actually an amalgamation of various, interconnected relationships in three different dimensions. Furthermore, the delineation of these dimensions could also help discovery of new connections between different music classification approaches.

Conclusion

This article considers an aspect of knowledge organization which has not previously received much attention: the nature of the relationship between scientific classification and bibliographic classification, in this case, using the specific example of the music domain. The need for more exploration of scientific classifications has been clearly announced within KO; accordingly, this article

adds to the literature *about* the nature of scientific classification for a particular subject area, using a novel focus point. The article showed that for music classification, there was no singular scientific/bibliographic classification relationship; instead, there were a variety of different relationships. Three dimensions encapsulated the differing connections between scientific music classification and bibliographic music classification: similarity, causation and temporal aspects. Similarity and causation were teased apart, showing how influence does not always lead to similarity and how similarity does not always derive from influence; the connection between scientific and bibliographic classifications of music were shown to change over time, making the temporal frame a vital part of analysis. The methodological limitations of analysing scientific/bibliographic relationships were discussed, including the problems of "representative" classification schemes to use for comparison, and issues in tracing influence. The originality of this study lies in positing a complex set of relationships for music classification, and discussing types of connections and dimensions between scientific and bibliographic classification that are seldom discussed, let alone analysed.

There are a number of ways this research could be extended. This paper considered the relationship between scientific and bibliographic classifications for a specific domain: a particular type of music. So, this article and its findings could be used as a prototype for studies of other domain classifications, for example, chemistry, art, history, and so on. While generalizations between the domains would not be the intention of such studies, the usefulness of the type of study proposed in this article could see the emergence of a new way of considering scientific classifications. Another future extension would consider the subject expertise of those designing and updating bibliographic classifications, in particular how changing trends and attitudes towards subject expertise within LIS might be reflected in bibliographic classifications.

However, the impact of the study reaches beyond music scientific/bibliographic classification relationships. First, the research showed how examining connections between different classification approaches leads to epistemological questions: how do we know the intentions underpinning classification schemes, and where do causation and scheme criticism fit into our knowledge of classification schemes? Second, Hjørland (2011, p. 12) says KO would benefit if it were "better integrated" with scholars from other fields and KO contained more interdisciplinary research. The results for this article showed the fruitfulness of examining music scientific and bibliographic classifications side-by-side, and potentially this could bring us closer to a more holistic and interdisciplinary understanding of music classification. Finally, there is an impact to the analysis and model beyond knowledge organization. Understanding and consciousness of how scientific and

bibliographic classifications interact can be fed into the design of future knowledge organization systems. This would create systems which better reflect a domain's metadata and could in turn be used to improve the retrieval of information.

Note

1. Despite the paradigm shifts discussed in this section, it is acknowledged (see for example, Hjørland, 2008c) that different approaches and theoretical orientations co-exist today, and have co-existed at different points in KO history.

References

Albrechtsen, H. (2015). This is not domain analysis. *Knowledge Organization*, *42*(8), 557-561.

Barité, M. (2017). Literary warrant. Version 1.0. In B. Hjørland & C. Gnoli (Eds.), *ISKO Encyclopedia of Knowledge Organization*. Retrieved from http://www.isko.org/cyclo/literary_warrant.

Beghtol, C. (2003). Classification for information retrieval and classification for knowledge discovery: Relationships between "professional" and "naive" classifications. *Knowledge Organization, 30*(2), 64-73.

Beghtol, C. (2004). Response to Hjørland and Nicolaisen. *Knowledge Organization, 31*(1), 62-63.

Bifurcation, n. (2017) In *Oxford English Dictionary*. Retrieved from http://www.oed.com/view/Entry/18829.

Blake, J. (2011). Some issues in the classification of zoology. *Knowledge Organization, 38*(6), 463-472.

Bliss, H.E. (1933). *The organization of knowledge in libraries and the subject-approach to books.* New York: H. W. Wilson

Busoni, F. (1957). *The essence of music and other papers.* London: Rockliff.

Campbell, M., & Greated, C. (1987). *The musician's guide to acoustics*. London: J. M. Dent & Sons.

Coates, E. (1960). *The British catalogue of music classification.* London: Council of the British National Bibliography.

Cushing Richardson, E. (1901). *Classification: Theoretical and practical.* New York: Charles Scribner's Sons.

Dewey, M., Sweeney, R., Clews, J. & Matthews, W.E. (1980). *DDC: Dewey Decimal Classification: proposed revision of 780 music based on Dewey Decimal Classification and relative index.* Albany, NY: Forest Press.

Dickinson, G.S. (1938). *Classification of musical compositions: a decimal-symbol system*. Reprinted in Bradley, C.J. (Ed.) (1968). The Dickinson Classification: A cataloguing & classification manual for music, including a reprint of the George Sherman Dickinson classification of musical compositions. Carlisle, PA.: Carlisle Books.

Dorfmüller, K. (1975). Working commissions: Subkommission für Klassifikation. [Report from the 10th international congress of music libraries in Jerusalem]. *Fontes Artis Musicae, 22*(1/2), 48-49. Retrieved from http://www.jstor.org/stable/23506187.

Dournon, G. (1992). Organology. In H. Myers (Ed.), *Ethnomusicology: An introduction* (pp. 245-300). London: Macmillan.

Elliker, C. (1994). Classification schemes for scores: Analysis of structural levels. *Notes, 50*(4), pp. 1269-1320. Retrieved from http://www.jstor.org/stable/898291.

Galpin, F.W. (1937). *A textbook of European musical instruments: Their origin, history, and character.* London: Ernest Benn.

Grove music online (*2016*). Retrieved from http://0-www.oxfordmusiconline.com.wam.city.ac.uk/subscriber/.

Hjørland, B. (2008a). Classifying madness: A philosophical examination of the Manual of Mental Disorders. *Knowledge Organization, 35*(4), 259-263.

Hjørland, B. (2008b). Eric R. Scerri: The Periodic Table: Its story and its significance. [Book review]. *Knowledge Organization, 35*(4), 251-255.

Hjørland, B. (2008c). What is knowledge organization (KO)? *Knowledge Organization, 35*(2), 86-101.

Hjørland, B. (2011). The Periodic Table and the philosophy of classification. *Knowledge Organization, 38*(1), 9-21.

Hjørland, B. (2017). Review of concepts in knowledge organization: Domain analysis. *Knowledge Organization*, *44*(6), 436-464.

Hjørland, B., & Nicolaisen, J. (2004). Scientific and scholarly classifications are not "naïve": A comment to Begthol (2003). *Knowledge Organization, 31*(1), 55-61.

Hood, M. (1971). *The ethnomusicologist.* New York: McGraw-Hill.

Hornbostel, E.M., & Sachs, C. (1992). Classification of musical instruments. In H. Myers (Ed.), *Ethnomusicology: An introduction* (pp. 444-461). London: Macmillan.

Hull, D.L. (1998). Taxonomy. In E. Craig (Ed.), *Routledge encyclopedia of philosophy* (pp. 272-276). London: Routledge.

Influence, v. (2018) In *Oxford English Dictionary*. Retrieved from http://www.oed.com/view/Entry/95520.

Jacob, E.K. (2010). Proposal for a classification of classifications built on Beghtol's distinction between "naive classification" and "professional classification". *Knowledge Organization, 37*(2), 111-120.

Kartomi, M.J. (1990). *On concepts and classifications of musical instruments,* Chicago: University of Chicago Press.

Lee, D. (2012), Faceted music: towards a model of music classification. In A. Gilchrist & J. Vernau (Eds.), *Facets of knowledge organization: proceedings of the ISKO second biennial conference, 4-5 July 2011, London, U.K.* (pp. 339-351). Bingley: Emerald.

Lee, D. (2014). Webs of 'Wirkung': Modelling the interconnectedness of classification schemes. In W. Babik (Ed.), *Knowledge organization in the 21st century: Between historical patterns and future prospects*: *Proceedings of the thirteenth International ISKO conference, 19-22 May 2014*, *Krakow, Poland* (pp. 200-207). Würzburg: Ergon Verlag.

Lee, D. (2015). Consumption, criticism and Wirkung: Reception-infused analysis of classification schemes. *Knowledge Organization, 42*(7), 508-521.

Lee, D. (2017). *Modelling music: a theoretical approach to the classification of notated Western art music* (Unpublished doctoral dissertation). City, University of London, London. Retrieved from http://openaccess.city.ac.uk/17445/.

Lee, D. & Robinson, L. (2018). The heart of music classification: toward a model of classifying musical medium. *Journal of Documentation, 74*(2), 258-277. doi:10.1108/JD-08-2017-0120.

Mai, J.-E. (2004). Classification in context: Relativity, reality, and representation. *Knowledge Organization, 31*(1), 39-48.

Mai, J.-E. (2011). The modernity of classification. *Journal of Documentation, 67*(4), 710-730. doi:10.1108/00220411111145061.

Nicolaisen, J., & Hjørland, B. (2004). A rejoinder to Beghtol (2004). *Knowledge Organization, 31*(3), 199-201.

Ørom, A. (2003). Knowledge organization in the domain of art studies: History, transition and conceptual changes. *Knowledge Organization, 30*(3/4), 128-143.

Pethes, I. (1967). *A flexible classification system of music and literature on music. Preprint*. Budapest: Centre of Library Science and Technology.

Redfern, B. (1978). *Organising music in libraries. Volume 1: Arrangement and classification.* 2nd ed. London: Clive Bingley.

Scerri, E. (2011). What is the nature of the Periodic table as a classification system? *Knowledge Organization, 38*(1), 9-23.

Smiraglia, R.P., & Young, J.B. (2006). *Bibliographic control of music, 1897-2000.* Lanham: Scarecrow Press.