Toward a universal, meta-theoretical framework for music information classification and retrieval

Lynnsey Weissenberger
School of Library and Information Studies, Florida State University, Tallahassee, Florida, USA

Received 21 August 2013
Revised 2 December 2014
Accepted 4 December 2014

Abstract

Purpose – The purpose of this paper is to present a new framework for representing music for information retrieval that emphasizes socio-cultural aspects of music.

Design/methodology/approach – Philosophical and theoretical concepts related to the nature of music, aboutness, musical works are explored as they inform how music is represented. Multidisciplinary perspectives on music information representation, classification, and retrieval provide insight into how information science can better accommodate music information within its disciplinary boundaries.

Findings – A new term, music information object (MIO), is presented and defined. Downie's (2003) theoretical statements are reconceptualized into a theory of representational incompleteness and three meta-classes for music information object representation.

Practical implications – This new framework incorporates more dimensions of music representation than existing frameworks allow and can facilitate comparisons between classifications of MIO representations by music practitioners, scholars, and system developers.

Originality/value – The meta-classes form a much-needed theoretical framework for classifying and defining MIOs from any musical tradition for retrieval. This fills a gap in music information retrieval research, which lacks a theoretical framework that can accommodate musics from all traditions without attempting to organize them according to a western-centered understanding.

Keywords Classification, Reflexivity, Theory, Representation, Music information retrieval

Paper type Conceptual paper

Introduction

The nature of information, specifically music information, is a topic with diverse and conflicting opinions. Music's representational complexity has brought many challenges to music information retrieval (MIR) and classification research (Smiraglia, 2001a; Downie, 2004). Jacob and Shaw (1998) describe numerous theoretical viewpoints surrounding representation, encouraging interest in representation as it informs information retrieval and numerous organizational processes. Information science's heavy focus on information retrieval emphasizes the "last and most obvious component of a complex system that begins with the processes of representation and organization" (Jacob and Shaw, 1998, p. 134).

Theoretical frameworks specifically designed to accommodate music information in its diverse representations are scarce; indeed Downie's (2003) theoretical statements have been the basis for disciplinary developments in MIR, and alternate theoretical frameworks have not since emerged. It is important for subsequent MIR theories to

The author wishes to acknowledge the encouragement of Dr Corinne Jörgensen while pursuing this line of inquiry.

Journal of Documentation
Vol. 71 No. 5, 2015
pp. 917-937

0022-0418
DOI 10.1108/JD-08-2013-0106

have the flexibility and sensitivity to encompass the scope and depth of future MIR research, particularly in the areas outside of western classical or popular musics. Current MIR theories and research center around western classical and western popular musics, with emerging interest in what is termed within the field "non-western" or "ethnic" musics.

With all musics in mind, this paper completely reconceptualizes Downie's (2003) facets of music representation, concept of representational completeness, and five challenges for MIR. Representation becomes the central figure in the discussion of music's aboutness, incompleteness, and organization. Reflexivity – the ongoing, reciprocal process where humans exert influence upon their contexts and contexts influence humans – in representation and organizational practices is also emphasized. Alternate theoretical conclusions are drawn regarding the nature of music information and its representations, leading to the three meta-classes for music information object (MIO) representation. The three meta-classes create a reflexive and flexible structure that does not compromise a music's cultural contexts, but instead respects the different ways music is conceptualized and defined across cultures and by individuals. Together, these form a theoretical framework for classifying and defining western classical, popular, and non-western MIOs for retrieval.

The nature of music

Before music information can be organized, sought, discovered, and manipulated, "music" must first be defined. The defining the nature of music becomes the initial step before representations of music can be discussed. As an information phenomenon, music can be approached from socio-cultural, cognitive, and physical or systems-centered perspectives.

Anthropologist John Blacking wrote of the nature of music:

> Music is a synthesis of cognitive processes which are present in culture and in the human body: the forms it takes, and the effects it has on people, are generated by the social experiences of human bodies in different cultural environments. Because music is humanly organized sound, it expresses aspects of the experience of individuals in society (1973, p. 83).

This perspective seems to be both cognitive and socio-cultural, but it implies a physical component as well – how music is manifest in various forms. Blacking, along with other anthropologists and ethnomusicologists, acknowledges how "different societies tend to have different ideas about what they regard as music" (Blacking, 1973, p. 10). While Blacking's definition does not speak to perhaps every element that could be used to describe and define music, his thoughts conceive of music at the highest level of human expression.

Music is a diverse, complex, physical, and abstract phenomenon; not always manifest in sonic form. Conversely, sonic creations heard as music to one culture may not be identified as such within the native culture (McCollum, 2007). An example of non-musical "music" is the chanting of the *al-Qur-an*, which is not considered music by Muslims even when its sound to outsiders is musical, and yet it is studied by ethnomusicologists (McCollum, 2007, p. xiv). Identifying this chanting as music can be considered insulting to the Islamic interpretation of music. As with many other instances in music, it can be difficult to separate where the individual definition ends and the socio-cultural defining of music begins.

In discussing the nature of music and the musical work, Levinson (1980) expresses dissatisfaction with defining music purely in terms of physical sound qualities and

attributes. His support of the cognitive processes involved in music composition leads him to state, for example, that an identical sound structure or composition created by two different composers would still comprise two separate musical works. These arguments about the cognitive aspect of a musical work may be true within some areas of music, but may not exactly describe how other music cultures view music cognition or composition. Within Irish traditional music, for example, it is customary to have multiple settings of tune compositions, yet these settings are considered the "same" musical work or object at a macro level. Different Irish tune settings might still be associated with certain musicians, regional styles, idiomatic, or instrument-specific transcriptions, making them not the same at a micro level.

Additionally, Levinson's arguments about the individual composer contrast with beliefs of Plains and Flathead Indian tribes. In these cultures, music composition is an indirect process that happens through visions or through supernatural encounters, meaning the composer does not necessarily take individual ownership of the resulting composition (Merriam, 1964, pp. 166-171). Improvization and re-construction of musical works or objects is another area where all music cultures, including western classical and western popular musics, vary widely. Some have clear boundaries for when a new composition emerges, and others do not (Merriam, 1964).

Aboutness

With varying definitions and considerations about what music is to individuals and cultures, as well as its use or function in which contexts, it is no surprise that musical "aboutness" and meaning is equally varied. Raber (2003, p. 131) notes how "aboutness is at the heart of representing, organizing, and interpreting information, and we must resolve it if we are to retrieve and use information." If we are to retrieve and use music information of any culture, we must have some sense of its contextual elements and how it might be interpreted and be meaningful within its culture and trans-culturally. Musical meaning and interpretation differs across cultural, social, and political boundaries, and between individuals.

The music of Shostakovich – to choose an example from the western classical arena – varies in aboutness depending upon the exact composition, Shostakovich's own political situations, his own symbolic or programmatic intentions, the reception of various audiences, and other contextual elements. The musical aboutness and meaning(s) some political leaders ascribed to Shostakovich's Symphony No. 4 directly led the composer toward different intentions and double meanings in Symphony No. 5, which was received very differently by these same political forces.

Music's integration into other art forms can be programmatic or not; for instance, music may be interpreted through dance, such as Irish sean nós (old-style percussive) dancing to traditional Irish tunes, but the "meaning" is not to depict a particular thought, emotion, or extra-musical idea. Sean nós dance steps to accompanying music are intended to "dance" the tune's unique character and melodic features visually and percussively, thus participating in the music itself. It is partially dance "to" music and dancing music. Musicological and philosophical literature provides a more in-depth discussion of the complexities in the related concepts of meaning, aboutness, interpretation, and context(s) in music and interwoven arts such as dance, drama, and film, which cannot be thoroughly addressed within this discussion. The work of Lippman (1977, 1981), Maconie (1990), Talbot (2000), and McCollum/Nercessian (2007) provides ample additional writing on these subjects.

The musical work

Defining the boundaries or scope of a "musical work" vs its representations is a large undertaking. Numerous scholars have grappled with the theoretical concept of the musical work and how this concept differs from music representation, or even music documents (Smiraglia, 2001a, p. 85). Colorful descriptions serve to illustrate this descriptive and definitional challenge, with musical works named "ontological mutants" (Goehr, 1992, p. 2), or "puzzling objects – their essence and existence unclear" (Ingarden, 1986, p. 6). Smiraglia (2001b) defines the musical work as "an intellectual sonic conception" with works having a known creator and consumer.

The viewpoint of Krummel (1970), as described by Smiraglia (2002), is one where a musical work "is existentially viewed as an abstract concept in time rather than a particular physical entity in space." Physical instantiations represent instances of the work, none of which can be equated fully with the work itself, something also echoed by Ingarden (1986). Goehr (1992) goes further, suggesting that musical works are neither wholly physical/concrete, mental, or "ideal" objects (p. 2). Presuming the very existence of a musical work, as well as its stability, are the two "fundamental assumptions" Bowen (1993, p. 139) claims musicologists perpetuate.

Ingarden (1986) views the musical work as a non-physical, non-cognitive, non-social entity at a higher level than any of its various representations. The score and the performance of the work are then only lower-level manifestations of the work. One notable assertion while discussing performances of the work is Ingarden's statement: "How can it possibly be that in different performances one can hear the same – that on each occasion the one and the same work should, if I may so state it, appear as its original self?" (p. 3). He later expands upon this statement to present a proposition with a phenomenological and cognitive argument: "Yet perhaps no […] musical work actually exists, but only particular performances. Perhaps we are also wrong in assuming […] that all listeners at the same concert hear the same performance" (p. 5). Another philosophical viewpoint states plainly that works are not the same when performed in various instances, nor are they identical to their scores; they exist separately (Goehr, 1992, p. 3).

Bowen (1993) makes two clear theoretical claims to combat the western classical viewpoint dominating the assumptions of what constitutes a musical work and how it differs from a performance of the work. He argues that scores are not works themselves, they are "merely spatial representations; they are not the temporal musical work" (p. 141). Regarding the performance-work relationship, this viewpoint is decidedly ethnomusicological in how it sides with the impreciseness and variability inherent in performing the same musical work: "Even two performances which contain the same instrumentation and sequence of pitches (even by the same performer) vary in virtually every other respect […] jazz […] so clearly demonstrates that even the most sophisticated scores do not alone contain musical works and that performances of the same work can vary dramatically" (Bowen, 1993, p. 141). In addition to jazz, the same could be said of realizing a tune in Irish traditional music, where melodic variation, ornamentation, finger pressure slides, chromaticism, inflection, and other subtle elements can change the actual performance of the same tune (Su, 2013; Weissenberger, 2014).

Levinson (1980, pp. 5-6) views a musical work as "a variety of abstract objects," that "[…] can be heard through its instances and yet exists independent of its instances." This perspective, along with that of Ingarden (1986) and Bowen (1993), form the basis for the view presented in this paper. That music can be physical, cognitive, abstract, and potentially described in other ways throughout the world, is central to the need for theoretical frameworks to accommodate such views.

Representation and reflexivity

Representation is a difficult to define term, along with "information" and "document," all of which have had modified meanings over time and as information science disciplinary mindsets have shifted (Buckland, 1991, 1997). Some define representation as both an activity and as the products created by these activities (Fabian, 1990, p. 753; Jacob and Shaw, 1998, p. 146). Sociological and anthropological texts tend to use the plural representations to refer to information in various forms, or "entities, products of knowledge or culture" (Fabian, 1990, p. 753). In her discussion of sensemaking and information design, Dervin (1999, p. 36) illustrates the diversity of what constitutes information in its many representations: "data, knowledge, or fact, song, story, or metaphor." Representations of music information could be as numerous as the people that create them, if one considers each variation in transcription or recording to be a unique representation of the work.

Many representations of music information are manifest in texts, images, video, and sound; there are additional representations that stem from movement, expression, emotion, and other aspects related to music. These unconventional "representations" might be very conventional in other music traditions, such as the idea in Irish music of musical memory, memorization, or metaphor as representations of music within Irish traditional music. They can be documented, but that is not where they really "exist," much like music exists at a conceptual level and can be documented. Other representations could potentially include data-based representations such as pitch histograms or dynamic linked data visualizations such as the Linked Jazz project that displays linked composer-performer-contextual data.

Within this paper, representation is framed as an ongoing process that encompasses both activities and their outputs within the same macro, reflexive act. The act of representing is a reflexive one, something that draws influences from those involved with representation, their influences and ideologies, as well as the numerous contexts that build from subsequent organizational and retrieval methods utilizing representations. To represent is to declare; that is, when components are brought together and organized in a meaningful way with the intention to communicate and bring about change, we call this the act of creating information. Information cannot exist without the idea that there are receptors who will come into contact with information and experience a change. This change is the act of becoming informed (Hjørland, 2007).

The representation of music information could be seen as one of the most important and insightful components in defining not only what music information is, but how it contributes to how musical identities are constructed; communication practices; cultural, social, and historical contexts; and moral value systems. This discussion will not focus specifically on representation and how it emphasizes cultural difference, such as the concept of western music vs musical "others," however the work of Fabian (1990, 2002) and Born and Hesmondhalgh (2000) are recommended for in-depth cover of these topics. Instead, focus is placed on how representation mirrors its creator(s) and context(s).

Reflexivity

Reflexivity is the acknowledgment that people's acts and thoughts are both influenced by experience and act as influencers to experiences. Representation is an act and a process (Fabian, 1990, p. 753); it is inherently reflexive. The act of coordinating ideas, data components, intents, and contexts to produce something intended to communicate is the act of representation. It is an act, foremost, even when the products of these actions can

also be termed as such. The act of representation demands the actors involved negotiate or translate throughout the process. When faced with the challenge of representing musics of the world, ethnomusicologists typically consider "what factors influence the attempt to translate the reality of other musical cultures into audio and visual recordings, verbal accounts, and transcriptions in musical notation" (Agawu, 1992).

All attempts at representation reflect the constructs that create, maintain, and employ them. For example, music notation represents sound that is produced by a human, machine, or perhaps nature-based sounds that are interpreted by humans as music. To create a representation of a sound object using western music notation on a page (digital or physical) reflects the value systems, social, cultural, and historical contexts, communication practices, and identity of its creators, but it may not reflect those of the subject being represented. Agawu (1992) considers whether it is possible to "study any music without taking note of the social, economic, political, and technological circumstances of its producers" (p. 246).

The concept of reflexivity is also present in classification and categorization literature, such as the idea that classification systems are the "products of classificationists," products of their times, and of privileged and powerful discourses (Olson, 1998, p. 234). Smiraglia (2002) provides a look back to the theoretical foundations of classification and knowledge organization, and how these have progressed over time. When describing the western-centered norms reflected within categorization, Lakoff calls for new ideas that are not only "more accurate, but more humane" (p. 9). A reflexive approach to representation and subsequent organization structures would increase transparency, reduce bias and assumptions, and change our understanding of the world (Lakoff, 1987).

Information science spends considerable effort examining how information is used, accessed, sought, organized, described, and employed, and should spend equal time examining the influences behind the structures we study. No information environment is safe from the influence of its creators. To create: an organizational structure; information objects to be housed in that structure; descriptors and methods of locating the objects housed; and purposes or uses for the objects or structure by others, is to declare through representation. These declarations reflect numerous conscious and sub-conscious ideologies and influences of the people creating them, thus the act of representation is a reflexive one.

Reflexive representation acknowledges that the act of representing anything is a physical, cognitive, and socio-cultural act. The contexts may be numerous and complex, but they are always there. Any information object – whether text, image, sound, video, or other – is constructed by people for people. As such, "people developing the classification tools and performing the classifications should […] be in a position to differentiate theoretical positions as well as to have a basic understanding of their inherent values and consequences. They should be able to understand different views and to base their classification on a negotiation between different views. Such a view might be termed reflexivity" (Hjørland and Pedersen, 2005, p. 593). Negotiation between viewpoints, as suggested, becomes crucially important in constructing theoretical frameworks.

When representations are made of objects that would not typically be made by those who claim closest proximity to the information object's source, that act might be viewed as colonial representation. The idea of appropriating information objects and modifying the representations of them is both an act of colonialism – to claim something for another group, purpose, intent – and is still reflexive. The act reflects the contexts, value systems, communication strategies, and identities of the appropriator, now the creator of the new representation.

Representation is framed in ethnomusicological literature as primarily a product of colonialist mentality and appropriating and distorting the original intents of those possessing the cultural artifact (Bohlman, 1991). As Bohlman explains, in music, this is evident in early writings of ethnomusicologists working in the field, transcribing music much different from the western classical music of their training. Bohlman calls the person engaged in colonial representation an "interloping European," and says of the act of music representation in these contexts: "[…] such acts of reformulating the exotic served to some degree as a means of extending the colonizer's power goes without saying. But they also tendered new means of representing music of the Other, forging a place for it in European thinking, and empowering it to subvert the unquestioned supremacy of a musical culture that knew of nothing else" (p. 132).

In Bohlman's view, the colonial representations were both detrimental and beneficial to the music culture under study. The transcriptions and written accounts served to legitimize musics that were seen as lesser developed and inferior to western classical music. Transcribing "other" musics into western notation were challenging for those in the field, yet these transcriptions proved the music's complexity against the perception of its inferior status. Bohlman also argues that understanding ethnomusicological history and its influence on present practices in that field lies in the process of representing music objects. He notes, "these processes of representation have formed the literature constituting the history of our field, a literature whose ethnographic richness we are only now […] beginning to plumb" (p. 136). As most music information research is conducted by those from a computer science background concerned with audio representations, a more human-centered and holistic view of music as information remains elusive.

Although representation as a term is employed differently by ethnomusicologists and anthropologists than by information scientists, there is a larger and more holistic view that encompasses the various acts, processes, and products of this phenomenon. Representation implies that there can be multiple ideas of a truth – making "truths" – and reflections of those truths, manifest in various realities and contexts. Music representations are all those of a higher-level MIO (Ingarden, 1986), and so can be manifest in numerous formats.

Representation and classification structures

Representation can be seen as a starting point for classification and ultimately retrieval, therefore issues that influence one will influence the others (Jacob, 2004). Classification is the organizational process that humans undertake to make sense of information phenomena that is represented in some way. Olson (1998) describes classification's two main tasks as gathering similar information together and placing it near related information.

The emphasis of information science is "not primarily involved with descriptive studies of how people actually classify things […] LIS is primarily concerned with a normative theory of classification: which criteria should be used to classify documents in order to optimize IR?" (Hjørland and Pedersen, 2005, p. 593). As a cognitive linguist, Lakoff's (1987) work offers an alternative perspective; he details the differences across how individuals approach the idea of categories. The past two decades have also seen increased interest in socio-cultural and cognitive approaches to classification. While Hjørland and Pedersen's criticism is largely warranted, some scholars such as Olson (1998) and Dick (2006) have instead chosen to address issues of power, bias, and assumptions in information structures and models. This scholarly approach has made valuable contributions to the dialogue surrounding the practice of representation, classification, and information retrieval as related areas of inquiry.

Scholars have examined numerous issues related to classification approaches and classification problems. In their discussion of theory and classification, Hjørland and Pedersen (2005) note how various theories, goals, and values of disciplines and individuals impact the process of classification. A reflexive approach to classification acknowledges that a classification structure is based upon influences and properties of those who created the representations of them. Hjørland and Pedersen state how "different human interests emphasize different properties of objects" and that within LIS and in other fields, "different theories and 'paradigms' also emphasize different properties" (p. 586). Because of the variation in emphases, biases are inherent within classification structures because of their socially constructed nature, making classification structures very complex (Olson, 1998; Beghtol, 2002).

Representation and those structures created to house them serve a variety of purposes. Those purposes vary depending upon a complex array of social, cultural, economic, and logistical circumstances, but there is some general agreement among LIS scholars that these organizational structures will arrange similar information representations differently. The role of theoretical approach must be emphasized in classification building, as well as the "goals, purposes, and values" those theories – created by humans to make sense of their world – play in classification construction (Hjørland and Pedersen, 2005, p. 591).

While information representation does not necessarily lead in a linear progression to larger structures of classification and then organization within systems, it is a logical starting point to discuss bias and begin the reflexive approach. A theoretical model of classification that is transparent in revealing bias and complexities would involve "[…] examination of the characteristics of classification, testing various conceptions against those characteristics, and reflexively reworking the model" (Olson, 1998, p. 235). These three elements are essential to classification, yet their application to information representation should not be overlooked. Representation is at the heart of what classification systems are built around, and thus also contain assumptions, biases, and complexities of their own, even before being classified.

There is another crucial issue related to the problems of powerful and majority discourses in classification and information seeking and retrieval theories as raised by Olson (1998), Beghtol (2002), Dick (2006), and others. If, as Olson implies, classification structures are influenced by powerful societies and reflect the views of the majority, as well as are designed primarily to deal with documents, then music representation is an important starting point for examining these greater issues within classification. Representations of music as information are also products of these same discourses, as documents, music transcriptions, and recordings from non-majority societies became legitimizing artifacts to the majority.

Musical traditions where oral/aural transmission of information is the norm can lack standardized methods of transcribing music information for performance, if it is written down at all. In addition, these music cultures may or may not have scales equivalent to western scales, pitches equivalent to western temperaments, or music within single simultaneous meters. Indian classical music scales, Indonesian pelog and slendro gamelan tuning, and the polymeters and polyrhythms found in many African music cultures are all examples. In music cultures that value memorization and aural learning over transcriptions – either to develop the ear, improvizational skills, or simply as a value system that promotes committing music to memory and muscle – these musics may not have the same representational accessibility as western classical music, which has a long history of developing specific transcription

and markings for music scores. Any theoretical framework for MIR cannot exclude or demote musics that are not easy to represent using western classical music standards.

As a phenomenon, music is challenging to represent completely within retrieval systems, as music representations are only aspects of the higher-level music object. Without acknowledging how diverse and abstract a phenomenon music is, music representations, classification systems, and ultimately retrieval systems cannot adequately cope with all musics. The MIR field has had increasing interest in musics outside of the western classical and western popular, what they term "non-western," "ethnic," "folk," or by specific genres such as Indian Carnatic music. Theoretical gaps remain in MIR, specifically in the foundations of music as an information object and how it is conceived of around the world.

With many types of music objects in mind, Liem *et al.* (2011) argues for a multimedia retrieval approach, instead of MIR's primary focus on the audio signal: "[…] multiple other modalities hold useful information that contribute to the way in which the music is conveyed and experienced: e.g. visual information from video clips and cover art, textual information from metadata, lyrics and background articles, and social community information on listening and rating behavior. This existence of complementary representations and information sources in multiple modalities makes music multimedia content" (p. 1). Information retrieval is affected by representation and organization of information, but it is not necessarily the default end product of such processes, nor the only end product.

Reflexive representation and theory

During the process of creating representations of information objects – and subsequently in the process of curating, organizing, and disseminating these representations – the idea of reflexivity becomes critically important. A reflexive approach to representation is one that questions what influences and implications there are during the representation process – from abstract idea, to the declaration through representation, to the manipulation of that representation. If representation declares, it must reflect the dialogue between the object and those creating and influencing that object. The dialogue becomes an increasingly diverse conversation as that representation is modified and interpreted across time and space.

The most fundamental idea of reflexive representation is this: classification and information retrieval research is concerned with managing information in many forms and for many uses and functions, however information representation has been overlooked as a central component. As scholars and practitioners, we must begin to examine the influences present when representation occurs and think about how this impacts all future uses of and actions regarding those objects. This trickle-up concept acknowledges that the biases and influences from the moment of representation will only amplify once this representation is organized and housed within systems, or as a part of databases or other repositories.

Reflexive representation as an approach to theoretical problem solving changes the assumptions typically built into classification and information retrieval theory and practice because it acknowledges that, even at the most fundamental level, any representation reflects the numerous conscious and sub-conscious ideologies and influences of its creators. It is surprising, therefore, that representation does not play a more significant role in MIR, as information must be manifest in some form before it can be processed, organized, and retrieved.

Music classification challenges

Classification research has been increasingly concerned with issues of domain-specific and culture-specific accuracy and meaning, in addition to addressing the suitability of current classification systems. Kwasnik and Rubin (2003) emphasize the importance of terminology across cultures and how these terms are treated within knowledge representations. In their study of kinship terminology across cultures, specificity and rigidity of vocabularies and classification structures took on critical importance in accurately representing cultural knowledge according to their own terms – the ideal goal for any knowledge structure (Kwasnik and Rubin, 2003).

The ideas of worldview and cultural context have also become a discussion point for classification and knowledge organization researchers. Beghtol (2002) asserts, "[…] information – what kinds of information people in a culture need and want, what they do with it, to what extent they value it, and whether they choose to perpetuate one or another of its various elements – helps to define a culture. In this sense, culture resides in information" (p. 510). Cultural contexts and bias are also persistent problems for those involved in classification, knowledge organization, and in the building of MIR systems. Western classical music and western popular music are overwhelmingly dominant in music libraries and retrieval systems, and for various reasons (Abrahamsen, 2003; Downie, 2003; Lidy *et al.*, 2010). Abrahamsen (2003) articulates this influence on the construction of systems designed for music, from the choices in objects to be included to how knowledge is classified, described, and organized. However, his resulting discussing of music genre as a clear basis for a classification system for music does not seem as plausible when considering the problems inherent in genre as a construct (Merriam, 1964, p. 56).

In her discussion of the MIRACLE project, an internet-based library of music, Adcock (2001) displays a common viewpoint among researchers working with music information, where the norms and practices of western classical music are used as a basis for constructing and organizing music information within a retrieval structure. Adcock discusses accommodating cultural differences in classification ideas and acknowledges that no structure is free from bias, however her conflicting statements regarding the lack of interdisciplinary influence on new knowledge creation within music, and the "concrete" nature of music, argues against her previous statements.

The interdisciplinary nature of music is neither unified nor homogenous, and the "domain of music will be treated as everything that can be connected to, or defined as music" (Abrahamsen, 2003, p. 146), including other disciplines' discussion of music in education, philosophy, business, or information science. Although not addressing music specifically, Beghtol (2003) describes classification as a transdisciplinary activity. While a broad definition of music as a phenomenon and domain makes discussions of classification and organization more problematic, it is all the more necessary to embrace the complexity and work toward solutions that address long-articulated classification needs.

As discussed earlier, music is an abstract, higher-level phenomenon and thus presents challenges for representation, classification, and organization. Music is more than audio files or text-based representations of a visceral performance. In many music cultures, information about music or musicians is equally as significant as transcriptions or recordings, and should be incorporated into any organizational and retrieval structure that houses them. User-constructed musical knowledge is also important in many music cultures, as practitioners of these traditions have a unique authority to define and describe the phenomenon of music in its various cultural applications, an example being

the online community and tune database Thesession.org for Irish traditional musicians (Weissenberger, 2014). It is essential to re-conceptualize representation as it applies to music, with special emphasis on how MIOs might be represented differently in cultures around the world by practitioners of those music cultures.

Representation and the MIO

In both philosophy and in traditional classification theory, an information object as thing is separate from the information about it (Butterfield, 2002; Beghtol, 2003). Beghtol (2003) explains the differences between "artefact" and "mentefact," with regard to classification, taken from Bulletin No. 11 of the Classification Research Group and the work of Barbara Kyle. The artefact is the physical object or product created by the hand, whereas the mentefact is an abstract product created by the mind. Her discussion of the history of classification activities makes note of how the mentefacts were first of interest to classifiers, and then the artefacts themselves.

More contemporary thought in ethnomusicology and philosophy rejects the idea of clear separation between physical, individual/cognitive, and socio-cultural aspects of a music object. Small's (1998) concept of "musicking" deliberately blurs traditional boundaries of performance, participation, and audience, thus making music a process and not an object. Practitioners of non-western classical music traditions may not see the distinction between object and surrounding information. Merriam's (1964) examples of the Basongye in Africa and Flathead in North America reject this western tendency to separate the object and its abstract product or it's contextual information (pp. 262-263).

The MIO

When music is the subject of information science and information retrieval research, it is discussed with wide variations in the assumptions of what constitutes the phenomenon under study. The nature of music is a fundamental starting point for the ensuing discussions of the many ways music might be represented, and to what end the representations might be organized and operationalized. Music, like other art forms, is a reflexive construct of the historical, cultural, individual, and social contexts either surrounding it or – as some music cultures might describe it – inseparable from it (Butterfield, 2002). This leads to the expectation that MIO representations are equally reflexive as the classification and organization structures utilizing them.

Functional Requirements for Bibliographic Records (FRBR) is a conceptual model of the bibliographic universe, including "anything a library might wish to collect or make accessible to its users" (Tillett, 2005a, p. 197). Within the FRBR framework, there are Works, Expressions, Manifestations, and Items (Tillett, 2005b). There are efforts to adapt FRBR concepts to music, such as the Yale library's guide to using FRBR and WEMI for music cataloging. FRBR's model is designed for musics that are to be housed within repositories in formats such as music scores, media (CDs, DVDs, LPs), reference texts, and periodicals. As the FRBR model relies upon physicality or tangibility of objects (at certain levels) and defined relationships between people and objects, as well as between objects, it is limited in how well it can serve musics that do not fit these expectations.

Two aspects of the FRBR model that prove problematic for accommodating all musics are the ideas of relationship(s) and authorship. In the case of authorship or composer, the example of the Flathead and Plains Indians' visions referenced earlier is one of music cultures which do not share the same notion of ownership or creator of musical works as the idea of a composer. Another example problematizing the idea

of strict relationships is the ill-defined boundary between variation and composition across music cultures. For example, it is hard to express exactly when an Irish traditional tune's melodic variation becomes a new tune composition instead, and who is in the privileged position to determine this point? The practice of renowned Irish traditional musicians like whistle player Micho Russell or Clare fiddle and concertina player John Kelly Sr creating personalized versions of well-known tunes is still viewed by other traditional musicians as the "same" tune; the tune title might be slightly modified to allow personal references, such as "Micho Russell's Mason's Apron" instead of "The Mason's Apron" (Weissenberger, 2014). This new title is synonymous with the non-named title, however the musical content is slightly different. Including the musician's name within the title, in this case, does not ascribe composer status to the musician – it is a reflection of the older style of melodic variation that could replace large sections of tune melodies with personalized interpretations.

Instead of adopting FRBR concepts that do not neatly accommodate a primarily non-textual and representationally diverse phenomenon such as music, this paper puts forth a new term to describe the music phenomenon used in MIR and related research: the MIO – an abstract concept because music is neither a exclusively physical, cognitive, or socio-cultural phenomenon. The term attempts to encompass all the ways in which music can be perceived – either as a concrete or abstract "object." A holistic view of music encompasses physical, cognitive, and socio-cultural manifestations of perhaps a higher-level abstract idea of a complete object.

Unlike Downie's (2003) concept of "representational completeness" within MIR systems, the MIO cannot be considered complete at any point in time, because the object is not static, but dynamic. Music, when viewed from the perspective of a practitioner of a musical tradition outside western classical music, is a living and evolving process. The practitioner has authority to both learn from and alter the course of the tradition over time. The complete MIO contains all conceivable representations of music as we know today, and leaves room for those not yet created.

Central to the concept of this higher-level MIO is that no MIO will ever achieve full completeness. MIOs are not finite creations, but inherently dynamic and continually evolving as we create and discover new aspects of the music phenomenon. Downie's implication that the MIO is stable enough at any one point in time, space, and context denies the diversity and immensity of the music information phenomenon. It could be argued that for some musics, the physical, cognitive, and socio-cultural paradigms are inseparable (Merriam, 1964, pp. 262-263), thus making a complete representation of a MIO at any point impossible. Consensus from the academic community as well as the field – in the anthropological sense of "field" – on the aboutness and scope of what constitutes music is unlikely to happen, so theories must have both broad scope to accommodate differences and an appropriate level of specificity to aid further comparisons, insights, and discoveries.

Downie's theoretical foundation for MIR

Though Downie (2003) does not explicitly state that his seven facets, five challenges, and theory of representational completeness were intended to be a theory for MIR research, his statements are decidedly theoretical in construction. They are "[…] an articulation and communication of a mental image of a certain order that exists in the world, of the important components of that order, and of the way in which those components are connected" (Meleis, 1991, p. 183). This is the closest MIR has to a native, formal theoretical framework, and Downie's terminology and theoretical concepts have been largely embraced by researchers in this area.

His first proposition, Downie conceives of music information as "consisting of seven facets" that, together, define the MIR domain (p. 297). The seven facets are: pitch (fundamental frequency), temporal (duration), harmonic (involving more than one pitch at a time), timbral (tone color), editorial (performance instructions and differences in editions or versions of a musical work), textual (lyrics), and bibliographic (metadata). Information within the bibliographic facet is "music metadata" – the only information not derived directly from the content of the score (Downie, 2003, p. 301).

Downie's facets are flexible and not rigid in construction. He notes that there are musical elements that could be placed in more than one facet depending on context – a noteworthy acknowledgment of music's representation challenges, given how complex a phenomenon music is (Downie, 2004). The facets are intended to articulate the various aspects of music information that could be extracted from a musical work, either by machine or by a human, and used to organize the work for retrieval purposes.

Next, he proposes the idea of representational completeness, defining the degree of completeness by the "number of music information facets (and their subfacets) included in the representation of a musical work, or corpus of works" (Downie, 2003, p. 308). To that end, the theoretical proposition of representational completeness comprises of a system that includes "all the music information facets (and their subfacets), in both audio and symbolic forms" (Downie, 2003, p. 308).

Downie (2003) describes a high degree of representational completeness as depth and the number of musical works (within a system) to be breadth. The extent to which a system can accommodate representational completeness of music information depends upon several factors, but Downie divides MIR systems into analytic/production and locating systems. Analytic/production systems tend to have representational depth at the expense of breadth, whereas locating systems have breadth at the expense of depth (Downie, 2003).

Again, the idea of representational completeness is grounded in the physical paradigm, where a musical work would possess as many (or all) of the elements within each facet in order to maximize its retrieval potential. Many information retrieval researchers are either primarily or exclusively grounded in this systems-centered approach (Jansen and Reih, 2010). Theoretical concepts are often tied in some way to a physical application within a system environment – what is termed "practical problems and issues" in these contexts (Jansen and Reih, 2010, p. 1519). Music objects represented in many forms, along with related objects and information about those objects, can be organized and retrieved within various environments (Beghtol, 2003).

Downie's concept of representational completeness does not seem to leave room for new developments not yet imagined, but instead remains grounded in the physical paradigm that views the music object as a collection of various types of tangible and extractable data – a finite and concrete concept. This is not an unusual view within information retrieval; information is viewed as being "inherently concrete, definable, and encodable" (Jansen and Reih, 2010, p. 1524). Within Downie's framework, if all seven facets and their subfacets are represented, he argues the musical work is representationally complete.

Theory of representational incompleteness

The multicultural, multi-experiential, and multidomain challenges Downie (2003) articulates – in the way he describes them – contradict his assertion that the musical work can be representationally complete. Although music can be experienced, conceptualized, and created so differently among individuals, cultures, and societal

groups, these diverse and conflicting perceptions are not supported within Downie's facets of music representation. Downie's five challenges do not provide adequate arguments for – in fact, they seem to argue against – the idea that MIOs can ever be stable enough to be seen as representationally complete.

It could also be argued that any of Downie's five challenges is, at heart, a representation challenge. Researchers must be able to account for all of the variability in conceiving of the MIO, as described in the five challenges, and be able to represent them sufficiently for the purposes of music information seeking and retrieval. With that in mind, the following statements lead to an alternate theoretical proposition to the one Downie (2003) previously put forth:

(1) The MIO is inherently unstable and must be treated as such.

(2) All "challenges" are ultimately a challenge of representation.

(3) Thus, we are left with a theory of representational incompleteness: an acknowledgement that MIOs can never be truly complete if we approach their representation from the physical, cognitive, socio-cultural, and domain perspectives. There is always a piece of the MIO yet to be discovered, articulated, and manifest within human expression. If we acknowledge this viewpoint, we must also acknowledge that the idea of "completeness" is unattainable, and based upon an assumption confined to the systems-centered approach.

Three meta-classes for MIO representation

MIR research at large must focus on solving disciplinary issues in several key areas, namely a lack of: commonality in research vocabulary, diversity of research directions and aims, and theoretical frameworks from which to choose. The following attempts to further the theoretical frameworks available to music researchers by focussing on the ways in which the MIO can be represented. Instead of working to make non-western musical traditions fit into western classical musical constructs, it is helpful to create an organization system that is large enough to be flexible and moldable according to the needs of specific musical traditions. Flexibility is essential; it has been noted that "the challenge is to build classification systems that are "flexible and can accommodate new phenomena (Kwasnik, 1999, p. 39). To this end, the three meta-classes for MIO representation were developed.

The creation of meta-classes for MIO representation serves to re-conceptualize the traditional ways in which classification and organization is used by MIR systems. A system that groups representations of MIOs according to the three meta-classes allows for greater interaction and connectivity between the various representations. It would allow the user to have similar types of information together, and would allow users from many diverse backgrounds and domains to participate in knowledge creation. The meta-classes function to connect MIO representations via a "meaningful clustering of experience" (Kwasnik, 1999, p. 24), in this case, a collection of experiences.

The three meta-classes contain all representations articulated in Downie's facets and allow for a more culturally diverse conceptualization of which components might comprise a MIO. Importantly, the classes do not group representations according to format, such as physical digital; or function, such as intended actual use, as these are unstable assumptions that will change both over time and according to cultural space – both from a culture redefining itself, or from those on the outside defining use according to a different set of cultural assumptions (Merriam, 1964, pp. 209-211).

Any classification structure must remain open and flexible to accommodate new knowledge and new interpretations (Kwasnik, 1999), as the meta-classes do with MIOs.

The classes are broad enough to be useful in describing MIOs from a wide variety of musical traditions, intentions, practices, and uses. They also are not confined to any single paradigm or approach, but instead are broad enough to accommodate the physical, cognitive, and socio-cultural paradigms and derive from domain-specific knowledge of music. This classification structure is intended to join those classifications from "emic" experts (music practitioners) as well as scholars from the MIR, computer science, information science, musicology/ethnomusicology, and anthropology communities by accommodating differences in classification that occur within the same meta structure.

To visualize how the meta-classes might lead to new knowledge creation between many diverse communities of knowledge, data might be displayed using aggregated topic maps to show relationships between which representations belong to which meta-classes or subclasses. Another approach would amass information from many users' classifications and display this information as data points dispersed throughout the meta-classes diagram. The last approach is based upon White's (2007) idea of co-citation pennant diagrams, but expanded using the relationship principle of co-citations to describe information relationships in other areas.

However, as Jörgensen (2004) keenly points out, the process of "unlocking" objects or documents currently inaccessible to those outside specific institutions is an immense challenge. It should be our obligation to allow practitioners and those with indigenous knowledge to participate in their description (Jörgensen, 2004). While the logistics of such availability may become more promising with the increased interest in linked open data – something Jörgensen might have foreshadowed with her call to action – there remains the problem of a theoretical structure that can house and organize the resulting music information, while serving as a framework from which comparisons and new understandings may take place.

The three meta-classes

The symbolic class contains all types of character or image representations of the MIO, such as those using ASCII characters, marks, and symbols that have applied meaning, images of music objects such as sheet music, tablature, shapenotes, and others. Song lyrics could belong with the other symbols within the score, making it a part of the symbolic class, or could be placed within the intersection of both the symbolic and derivative classes. The two subclasses are character-based or image-based MIOs.

Next, the interpretive class includes any MIO that is an actualization of the abstract music object through sound creation, such as a performance. The two subclasses are human-generated manifestations such as studio or field recordings or live performances, and machine-generated manifestations using MIDI or other tools that do not require human participation at the moment of sound creation.

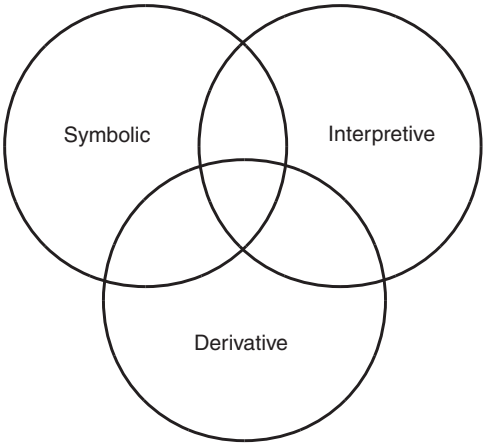
Last, the derivative class includes any representation that places the MIO in time and space. Fundamental to this class is the idea that each object does not exist without a context – a point of origin, such as a composer, or in the case of traditional musics, the type of tradition into which the music object falls, prominent musicians and performers associated with the object, contextual information, and performance instruction. The derivative class also includes aspects of "music metadata" such as style or specific type of music, historical contexts, socio-cultural contexts, and other

MIOs that share a relationship. Derivative representations include user-generated tags, metadata, descriptions, emotional content, and mood feedback, along with other types of descriptors. It also includes works that reinvent or re-imagine the original object, if there can be one authoritative version. As is the case with traditional Irish music, there are many versions of tunes and not a single "authoritative" version, meaning all settings have equal status as an authoritative version.

The three subclasses of the derivative class are participatory, experiential, and descriptive. The participatory subclass contains those MIOs where audience and performer boundaries are blurred or do not exist, or when the work is re-imagined or re-interpreted. Examples include settings of tunes, covers of songs, sampling, and remixing. Experiential MIOs are the time and space identifiers such as socio-cultural contexts, historical influences, political influences, geographical influences, and user mood/emotion perception. Descriptive MIOs contain both formally structured and user-created information such as metadata, tags, crowdsourced knowledge, formal vocabularies, and folksonomies (Figure 1).

Floridi's (2004) three types of information roughly correspond to the three meta-classes: information as reality/ecological information (interpretive class), information for reality/instructional (symbolic class), and information about reality (derivative class). There is also a loose relationship to Buckland's (1991) information meanings, namely: information-as-process (interpretive class), information-as-knowledge (derivative class), and information-as-thing (symbolic class). Although the meta-classes were not conceived based upon Floridi's information types, nor on Buckland's information meanings, these comparisons demonstrate how the model can accommodate the diverse approaches to the nature of information and how it can be represented.

An example of how the meta-classes model can accommodate representation of African MIOs derives from Agawu's (1992) own classification into what he terms iconographic, metalinguistic, and metamusical forms: "pictorial illustrations of music-making found in anthropological and historical documents, verbal accounts



Notes: Symbolic: character-based MIO, image-based MIO; interpretive: human-generated MIO, machine-generated MIO; derivative: participatory MIO, experiential MIO, descriptive MIO

Figure 1.
The three meta-classes for music information object representation

of music-making found in the same or similar sources, and – especially in the modern period – musical works based on existing 'traditional' musics" (p. 247). The pictorial illustrations are likely symbolic MIOs (image-based subclass), verbal accounts likely derivative MIOs (descriptive subclass), and musical works based on existing traditional works also derivative MIOs (participatory). Performance or recordings of those works could be deemed interpretive.

Future research

The meta-classes allow multidisciplinary research in MIR to use the same structure for comparison, as well as accommodate research using a wide range of musics. Comparisons using the same model are extremely helpful, as this might contribute to the creation of new knowledge. An example of this is ethnomusicologists' desire for a musical instrument classification system that "makes possible intercultural comparisons, and [the] wish to study the classification of each society in order to see what it tells […] about the relationship of fundamental guiding principles of the culture and musical values" (Nettl, 2005, p. 383). Though Nettl wrote of instrument classification and the importance of accommodating many music cultures, the same applies for the three meta-classes model.

Future research might examine which representation classes are most frequently used as the subject or basis for research in MIR. An examination of research projects using the meta-classes as a framework might discover where research spanning several classes overlap, and if there are frequent overlaps between meta-classes and even within classes. It would be helpful to discover if certain subclasses are more frequently the subject of MIR research, and if there are subclasses from different meta-classes that are used for MIR research more frequently. Results could be displayed as a visual model that best illustrates how MIR research is dispersed based upon the representation classes, and subclasses that are the foci of the individual research streams. Having this information would show dominant research areas and those that are under developed.

Another stream might take a task-based approach, examining which representation classes and subclasses are searched for during which types of tasks. Still another research stream might take a domain-based approach, examining how the domain of the user (LIS, CS, musicology, ethnomusicology) effects the types of representation classes searched for. The same research question might be asked using the profession of the user – such as a performer, conductor, music scholar, or MIR system-developer – and desired outcome, such as performance of a musical work as a performer, interpretation as a conductor, or research as a scholar, as a consumer of music/non-performing outcome, or as a MIR system-developer. Ultimately, with the information on user searching behavior according to desired outcome, domain, type of task, and profession, this would lead to the creation of a theoretical framework for music information seeking according to these various contexts.

To inform future MIR research involving non-western music, there is a need for research that focusses on the differences in how music cultures value various representation formats, along with information seeking practices and intended use with music information representations. Relevant research to this end might focus on various musical traditions and their practitioners to discover: if practitioners of different musical traditions seek different combinations of representation classes and subclasses; and which classes or subclasses the practitioners perceive are most relevant to their tradition and to their needs as individual musicians. Information seeking practices of western classical

musicians and non-western traditional musicians from different backgrounds could be compared to determine what different combinations of classes and subclasses each seek. After determining which classes and subclasses are more heavily sought after by musicians from different traditions, this could lead to future research into their information values.

Conclusion

It could be argued that disciplinary progress is "measured by the scope and quality of its theories and the extent to which its community of scholars is engaged in theory development" (Meleis, 1991, p. 182). MIR research is currently focussed on directed problem solving with little room in most research streams for over-arching conceptual frameworks. Research in MIR has taken a variety of diverse directions, yet the lack of theoretical frameworks remains (Lee *et al.*, 2009). Downie's theoretical constructs provided the basis for theory in MIR, however the field's recent interest in non-western music research necessitates further advancement.

When using non-western music in MIR research, it is critical that researchers approach the task in a way that does not compromise the music's cultural context(s). These contexts are dynamic and vary widely, but ultimately the challenge is one of MIO representation. By focussing on defining theoretical phenomena and classifying music representations, future MIR research that uses these meta-classes as a framework will be easier to interpret across disciplines and domains. This will prove particularly useful in system development projects, which are typically focussed on smaller scale tasks. System developers would have a common framework from which to base and discuss their work, hopefully facilitating new developments and new collaborative efforts. Theoretical frameworks are "fundamental elements that drive a field's research" (Jansen and Reih, 2010, p. 1519) and are essential for disciplinary and domain advancement – a philosophy researchers in music classification and retrieval must embrace.

References

Abrahamsen, K. (2003), "Indexing of musical genres. An epistemological perspective", *Knowledge Organization*, Vol. 30 Nos 3-4, pp. 144-169.

Adcock, L. (2001), "Building a virtual music library: towards a convergence of classification within internet-based catalogues", *Knowledge Organization*, Vol. 28 No. 2, pp. 66-74.

Agawu, K. (1992), "Representing African music", *Critical Inquiry*, Vol. 18 No. 2, pp. 245-266.

Beghtol, C. (2002), "A proposed ethical warrant for global knowledge representation and organization systems", *Journal of Documentation*, Vol. 58 No. 5 pp. 507-532

Beghtol, C. (2003), "Classification for information retrieval and classification for knowledge discovery: relationships between professional and naive classifications", *Knowledge Organization*, Vol. 30 No. 2, pp. 64-73.

Blacking, J. (1973), *How Musical is Man?*, University of Washington Press, Seattle, WA.

Bohlman, P.V. (1991), "Representation and cultural critique in the history of ethnomusicology", in Nettl, B. and Bohlman, P.V. (Eds), *Comparative Musicology and Anthropology of Music: Essays on the History of Ethnomusicology*, The University of Chicago Press, Chicago and London pp. 131-151.

Born, G. and Hesmondhalgh, D. (Eds) (2000), *Western Music and its Others: Difference, Representation and Appropriation in Music*, University of California Press, Berkeley, CA.

Bowen, J.A. (1993), "The history of remembered innovation: tradition and its role in the relationship between musical works and their performances", *The Journal of Musicology*, Vol. 11 No. 2, pp. 139-173.

Buckland, M. (1991), "Information as thing", *Journal of American Society for Information Science*, Vol. 42 No. 5, pp. 351-360.

Buckland, M.K. (1997), "What is a 'document'?", *Journal of the American Society for Information Science*, Vol. 48 No. 9, pp. 804-809.

Butterfield, M. (2002), "The musical object revisited", *Music Analysis*, Vol. 21 No. 3, pp. 327-380.

Dervin, B. (1999), "Chaos, order and sense-making: a proposed theory for information design", in Jacobson, R.E. (Ed.), *Information Design*, MIT Press, Cambridge, MA, pp. 35-57.

Dick, A.L. (2006), "Whose model, what context? Cultural bias and the nested model of context stratification for information seeking and retrieval", paper presented at the World Library and Information Congress: 72nd IFLA General Conference and Council, Seoul, 20-24 August.

Downie, J.S. (2003), "Music information retrieval", in Cronin, B. (Ed.), *Annual Review of Information Science and Technology*, Vol. 37, Information Today, Medford, NJ, pp. 295-340.

Downie, J.S. (2004), "A sample of music information retrieval approaches", *Journal of the American Society for Information Science and Technology*, Vol. 55 No. 12, pp. 1033-1036.

Fabian, J. (1990), "Presence and representation: the other and anthropological writing", *Critical Inquiry*, Vol. 16 No. 4, pp. 753-772.

Fabian, J. (2002), *Time and the Other: How Anthropology Makes its Object*, Columbia University Press, New York, NY.

Floridi, L. (2004), "Open problems in the philosophy of information", *Metaphilosophy*, Vol. 35 No. 4, pp. 554-582.

Goehr, L. (1992), *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music*, Oxford University Press, Oxford.

Hjørland, B. (2007), "Information: objective or subjective/situational?", *Journal of the American Society for Information Science and Technology*, Vol. 58 No. 10, pp. 1448-1456.

Hjørland, B. and Pedersen, K. (2005), "A substantive theory of classification for information retrieval", *Journal of Documentation*, Vol. 61 No. 5, pp. 582-597.

Ingarden, R. (1986), *The Work of Music and the Problem of its Identity*, University of California Press, Berkeley, CA.

Jacob, E.K. (2004), "Classification and categorization: a difference that makes a difference", *Library Trends*, Vol. 52 No. 3, pp. 515-540.

Jacob, E.K. and Shaw, D. (1998), "Sociocognitive perspectives on representation", *Annual Review of Information Science and Technology (ARIST)*, Vol. 33, pp. 131-185.

Jansen, B. and Reih, S. (2010), "The seventeen theoretical constructs of information searching and information retrieval", *Journal of the American Society for Information Science and Technology*, Vol. 61 No. 8, pp. 1517-1534.

Jörgensen, C. (2004), "Unlocking the museum: a manifesto", *Journal of the American Society for Information Science and Technology*, Vol. 55 No. 5, pp. 462-464.

Krummel, D.W. (1970), "Music as vibrations and as flyspecks: observations of a music bibliographer on the unfamiliar effects and inherent perniciousness of his chosen objects of research", *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters*, Vol. 58, pp. 15-26.

Kwaśnik, B. (1999), "The role of classification in knowledge representation and discovery", *Library Trends*, Vol. 48 No. 1, pp. 22-47.

Kwaśnik, B. and Rubin, V. (2003), "Stretching conceptual structures in classifications across languages and cultures", *Cataloging & Classification Quarterly*, Vol. 37 Nos 1-2, pp. 33-47.

Lakoff, G. (1987), *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind*, University of Chicago Press, Chicago, IL.

Lee, J., Jones, M. and Downie, J.S. (2009), "An analysis of ISMIR proceedings: patterns of authorship, topic, and citation", *Proceedings of the 10th International Society for Music Information Retrieval Conference, Kobe, October 26-30*, pp. 57-62.

Levinson, J. (1980), "What a musical work is", *Journal of Philosophy*, Vol. 77 No. 1, pp. 5-28.

Lidy, T., Silla, C., Cornelis, O., Gouyon, F., Rauber, A., Kaestner, C. and Koerich, A. (2010), "On the suitability of state-of-the-art music information retrieval methods for analyzing, categorizing and accessing non-western and ethnic music collections", *Signal Processing*, Vol. 90 No. 4, pp. 1032-1048.

Liem, C., Müller, M., Eck, D., Tzanetakis, G. and Hanjalic, A. (2011), "The need for music information retrieval with user-centered and multimodal strategies", *Proceedings of the 1st International ACM Workshop on Music Information Retrieval with User-Centered and Multimodal Strategies, ACM*, pp. 1-6.

Lippman, E.A. (1977), *A Humanistic Philosophy of Music*, New York University Press, New York, NY.

Lippman, E.A. (1981), "The dilemma of musical meaning", *International Review of the Aesthetics and Sociology of Music*, Vol. 12 No. 2, pp. 181-189.

McCollum, J. (2007), "Preface", in Nercessian, A. (Ed.), *Defining Music: An Ethnomusicological and Philosophical Approach*, Edwin Mellen Press, Lewiston, NY, pp. xiii-xix.

Maconie, R. (1990), *The Concept of Music*, Oxford University Press, Oxford.

Meleis, A. (1991), *Theoretical Nursing: Development and Progress*, 2nd ed., Lippincott, New York, NY.

Merriam, A.P. (1964), *The Anthropology of Music*, Northwestern University Press, Evanston, IL.

Nettl, B. (2005), *The Study of Ethnomusicology: Thirty-One Issues and Concepts*, University of Illinois Press, Evanston, IL.

Olson, H. (1998), "Mapping beyond Dewey's boundaries: constructing classificatory space for marginalized knowledge domains", *Library Trends*, Vol. 47 No. 2, pp. 233-254.

Raber, D. (2003), *The Problem of Information: An Introduction to Information Science*, Scarecrow Press, Lanham, MD.

Small, C. (1998), *Musicking: The Meanings of Performing and Listening*, Wesleyan University Press, Middletown, CT.

Smiraglia, R.P. (2001a), "Musical works as information retrieval entities: epistemological perspectives", *Proceedings of the 1st International Society for Music Information Retrieval Conference*, *Plymouth, MA*, pp. 85-91.

Smiraglia, R.P. (2001b), "Works as signs, symbols, and canons: the epistemology of the work", *Knowledge Organization*, Vol. 28 No. 4, pp. 192-202.

Smiraglia, R.P. (2002), "Musical works and information retrieval", *Notes*, Vol. 58 No. 4, pp. 747-764.

Su, N.M. (2013), "The social life of tunes: representing the aesthetics of reception", *Proceedings of the 13th European Conference on Computer Supported Cooperative Work*, *Paphos, September 21-25*, pp. 207-228.

Talbot, M. (2000), *The Musical Work*, Liverpool University Press, Liverpool.

Tillett, B.B. (2005a), "FRBR and cataloging for the future", *Cataloging & Classification Quarterly*, Vol. 39 Nos 3-4, pp. 197-205.

Tillett, B.B. (2005b), "What is FRBR? A conceptual model for the bibliographic universe", *The Australian Library Journal*, Vol. 54 No. 1, pp. 24-30.

Weissenberger, L.K. (2014), "When 'everything' is information: Irish traditional music and information retrieval", *iConference 2014 Proceedings*, pp. 496-507.

White, H.D. (2007), "Combining bibliometrics, information retrieval, and relevance theory, part 1: first examples of a synthesis", *Journal of the American Society for Information Science and Technology*, Vol. 58 No. 4, pp. 536-559.

Further reading

Grover, R. and Glazier, J. (1986), "A conceptual framework for theory building in library and information science", *Library and Information Science Research*, Vol. 8 No. 3, pp. 227-242.

Typke, R., Wiering, F. and Veltkamp, R. (2005), "A survey of music information retrieval systems", *Proceedings of the 6th International Society for Music Information Retrieval Conference, London, September 11-15*, pp. 153-160.

Yale University Libraries (2013), "FRBR, WEMI, and music", available at: www.library.yale.edu/cataloging/music/frbrwemi.htm (accessed July 6, 2013).

About the author

Lynnsey Weissenberger is a Doctoral Candidate at the Florida State University, College of Communication and Information, School of Information. She also holds an appointment as an Adjunct Assistant Professor in the College of Music, where she directs the Irish Music Ensemble. Her research interests include theory in information science, music information retrieval, and the classification and representation of music information. Lynnsey Weissenberger can be contacted at: lynnsey.weissenberger@cci.fsu.edu