Orthogonality, dependency and music: an exploration of the relationships between music facets

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Abstract

The classification of Western art music is a complex area of knowledge organization, yet the reasons for those complexities have not been fully studied. This article dissects the concept of orthogonality, in particular regard to music classification. Orthogonality (antonym: dependency) means that one facet acts independently from another facet. While orthogonality is an assumed quality of facets, it has attracted relatively little attention in knowledge organization discourse. This article utilizes bibliographic classification schemes, musicological writings, and musical works, to analyse orthogonality in music classification. The relationships between the medium, form/genre and function facets are unpicked and a strong dependency is found between these facets. Whether this orthogonality exists as a construct of faceted classification or stems from the domain knowledge is explored.   Furthermore, the analysis initiates new thinking about the general concept of orthogonality. The idea of a spectrum of dependency is proposed. In addition, novel, orthogonality-derived phenomena are discussed – "dynamic facets" and "meta-dependency" – where the boundary between what is and is not a facet are blurred. The concluding model visualizes the chain of dependencies between music facets, ultimately showing how the lack of orthogonality plays a key role in the complexity and issues found in music classification.

Introduction

The classification of music is notably problematic.   A common theme in the music classification discourse is faceting, especially music's eminent suitability to faceting due to its natural ability to be broken down into its component elements. However, a closer examination of faceting reveals that despite the enthusiasm for faceting amongst those writing about music classification and designing classification schemes, faceting breaks down when being applied to music. This article looks at a particular aspect of faceting: orthogonality, which is the independence of one facet from another. The purpose of this article is to examine orthogonality in music classification, so as to better understand music's knowledge organization complexities and to view the role that orthogonality plays in unlocking the mysteries of music's classification.

There is an additional, more general objective. While there are a small number of seminal texts on orthogonality by authors such as Frické (2011, 2012) and Wilson (2006), and discussions about the related topic of differential facets (Satija, 2002; Vickery, 1959, 1975), the knowledge organization canon does not contain a deep or prolific coverage of orthogonality. So, this article will also add to the knowledge organization literature by providing an in-depth analysis of orthogonality as a general

concept, and by using music to generate examples of novel orthogonality-related phenomena for generalized discussion.

The focus of this article is notated Western art music as the issues surrounding orthogonality arose from analysis of classification schemes which are centred upon this type of music. However, it should be borne in mind that the issue of orthogonality in music may be a more general one. This article starts with an analysis of the concept of orthogonality and dependency as well as the related idea of differential facets, and this is followed by an overview of faceting in music. The first exploration of music orthogonality considers the relationship between the medium and form/genre facets. The second analysis of orthogonality explores the relationships between the function and medium, and function and form/genre facets. The third discussion of orthogonality considers the orthogonality inherent within the facets themselves. The article concludes with a model of orthogonality for music, demonstrating the complexities of relationships between music facets.   As the various aspects of music's orthogonality are unpicked, it becomes clear that orthogonality itself is a complex, rich, and hither-to under-explored aspect of knowledge organization discourse.

Methods

In order to analyse orthogonality in music, a number of methods are employed. Conceptual analysis from knowledge organization discourse is used to study the extant literature about orthogonality concepts, while the discussion about the facets of music utilizes music knowledge organization discourse. The examination of orthogonality in music uses two separate analyses: analysis of bibliographic classification scheme; analysis of musical works and musicological writings.

For the bibliographic scheme analysis, examples are drawn from general and special bibliographic classification schemes. The following schemes are utilized: *British Catalogue of Music Classification* (Coates, 1960; shortened to BCMC), *Dickinson Classification* (Dickinson, 1938), *Flexible Classification* (Pethes, 1967), *Dewey Decimal Classification*, 23rd edition (Dewey et al., 2011), *Subject Classification* (Brown 1914) and the *Library of Congress Classification* (Library of Congress, 2019; shortened to LCC).

The analysis of the music domain draws on examples of specific musical works and literature about some of those works. Types of musical works are also used to illustrate phenomena, alongside information elicited from musicological writings which discuss types of music information.

Literature analysis of key concepts

Orthogonality and dependent facets

According to Frické (2012, p. 209) facets have to be orthogonal or independent, and it is assumed that the terms "orthogonal" and "independent" are being treated as synonyms in this instance.[1] So, being orthogonal is necessary to being a facet. This point is made in a slightly different way in Frické (2011, p. 492), where orthogonal facets are part of the definition of a faceted classification. Wilson (2006, p. 1), while discussing orthogonality in the context of a digital setting, states that "faceted classification, at its core, implies orthogonality". Once more, orthogonality is viewed as an elemental aspect of faceting.

The next step is to consider what is meant by the term orthogonality. Frické (2012) defines orthogonal facets as follows: "This means that, when constructing a synthesized value, the choice of a focus from one facet has no repercussions whatsoever for combination with a focus from another facet." (p. 209). In an illustrative example of period and subject facets, Frické (2012) states that orthogonality means that the choice of focus from one facet "neither compels, nor excludes, a particular choice" (p. 209) from the other facet.   (The idea of compelling and excluding are examined in more detail in the next section.) Wilson (2006) takes a different approach to defining orthogonality: "[orthogonality means] that every facet exists at right angles to (i.e. independently of) every other facet axis" (p. 1). The right angles are a metaphor for two sets of information never touching and therefore being independent, and orthogonality being defined by right angles is found in non-facet-related definitions such as in the *Oxford English Dictionary* (Orthogonal, adj., 2004).

The relative lack of discourse about orthogonality within knowledge organization discourse – with the notable exception of Frické's (2011, 2012) work and Wilson's (2006) contribution – is striking. Moreover, when dependency or orthogonality is mentioned, it is not necessarily defined or discussed. For example, when Vickery (2008) discusses faceting in an online environment, he says that "… what we are aiming for is a set of mutually exclusive and independently combinable facets" (p. 150). Yet, Vickery (2008) does not at this juncture give a definition or framework for what is meant by "independently combinable". Furthermore, the main topic of Frické (2011, 2012) and Wilson (2006)'s discussions are about the relationships between foci in the same facet, rather than the orthogonality between facets which is the focus of this paper. So, this article is also contributing to general faceting discourse, by examining in detail a part of faceting that is often assumed but not analysed.

The theory of compelling and excluding

Orthogonality is defined by its compelling and excluding (Frické, 2012, p. 209). In this context, exclusion means that a particular combination of two foci from different facets is not permitted. For example, selecting focus 3 from Facet A means foci a and b are excluded from the choice of focus in Facet B. Figure 1 visualizes an example of exclusion in a pair of non-orthogonal facets. Combinations which are not possible – so, those which are excluded – are depicted by a zero, and those which are permitted are represented by a cross. Note that exclusion is a binary idea, as each combination is either permitted or excluded.

| | | Facet B | | | |
		Focus a	Focus b	Focus c	Focus d
	Focus 1	X	X	X	X
Facet A	Focus 2	X	X	X	X
	Focus 3	0	0	X	X
	Focus 4	X	X	0	0

Figure 1: Orthogonality as exclusion: non-orthogonal facets

Compelling a particular combination of foci is, in some respects, the opposing action to exclusion. However, compelling is also the probability of certain foci being combined. For example, if focus 1 is chosen in Facet A, and it is more likely to also have focus b or d from Facet B than focus a or c, then this would be compelling. Figure 2 visualizes both exclusion and compelling. While the zero or cross depicts exclusion, the size of the cross indicates the strength of the compelling. Therefore, orthogonality, or lack thereof, appears to be both a binary categorization based on exclusion of combinations, and a measure of scale based on compelling combinations.

Facet B

	Focus a	Focus b	Focus c	Focus d
Focus 1	X	X	X	X
Focus 2	X	X	X	X
Focus 3	0	0	X	X
Focus 4	X	X	0	0

Figure 2: Orthogonality as compelling: non-orthogonal facets

Differential facets

Differential facets are an aspect of faceted classification broadly related to orthogonality and dependency. Differential facets are not discussed widely: examples where they are mentioned include Vickery (1959, 1968, 1975), Satija (2002) and a brief appearance in an encyclopaedia entry on facet analysis by Foskett (2010). However, discussions about differential facets do provide useful insights into how orthogonality is perceived.   Foskett (2010) describes differential facets as follows: "… [a differential facet] is a facet of a class in which the terms are secondary to another facet and may differ according to the term to which they are attached in the primary facet" (p. 1820). So, dependency of some description is abundantly clear. Vickery (1959, pp. 36-37) describes differential facets as a possible solution for a classification scheme author. He says (Vickery, 1959) that for a scheme where the first facet is products and the second facet is operations, the differential facet is the second of these two options: "either to make an extended *operations* facet listing all processes for all produces in one sequence, or to make a separate facet for each product" (p. 37, italics from original). So, though sources on differential facets rarely use the terms orthogonality or independence – a comparison of section headings in Vickery (1959, p. 36) and Vickery (1968, p. 34) provides a rare exception which equates "differential" and "dependent" – it can be assumed from the definitions of the terms that differential facets can only occur if there is a lack of orthogonality between two facets. Therefore, we consider commentary on differential facets as part of the review of orthogonality and dependency.

To start, differential facets are certainly used in faceted classification schemes. For instance, Vickery (1960, p. 33) comments that differential facets are widely used in *The Colon Classification*, especially in the areas of medicine and agriculture. This demonstrates the acceptance of differential facets in

the faceted classification canon by being used in Ranganathan's seminal faceted scheme. It also highlights how differential facets – and by extension, orthogonality – are used for some subjects more than others, which is of interest to this study of orthogonality in music. Commentator's remarks show how differential facets are usually viewed as a negative attribute of classification schemes. For example, Sayers and Maltby (1967, p. 237) use the term "problem" when referring to ideas around differential facets; for instance, Satija (2002, p. 87) acknowledges that differential facets are unideal but are needed for detailed classification schemes. Therefore, the knowledge organization discourse about differential facets illuminates that dependency and lack of orthogonality are seen as being problematic.

Ultimately, combining the unequivocal presence of differential facets in the *Colon Classification* (Ranganathan, 1963) with definitions of orthogonality presents a dilemma. Sequentially, the logical series of statements runs aground: Frické (2012, p. 209) defines facets as having to be orthogonal; differential facets are by nature non-orthogonal; however, differential facets are found and accepted in the germinal faceted classification scheme, *Colon Classification*. This ambiguity, where orthogonality is required in theory but not always present in real-life classification schemes, is important context when considering the orthogonality of music.

Facets and music

The important connection between faceting and music can be seen in a number of ways. First, faceting is a prolific topic within music classification discourse (Lee, 2012). Second, it could be argued that music's presence in a number of important developments in faceted classification is a sign of music's embracement of faceting; for example, BCMC was the first fully-faceted classification scheme in Great Britain (Redfern, 1978, p. 24) and BCMC formed the basis of the new version of the music schedules in *Dewey Decimal Classification* (Sweeney, 1976, p. 4), one of the first fully-faceted sections of this scheme. Third, older music classification schemes' use of proto-faceting could suggest an innate susceptibility of music to faceting (Lee, 2017a). Therefore, by examining music's orthogonality and non-orthogonality, we are also contemplating a subject where faceting is perceived as being important, which in actuality does not obey one of faceting's tenets.

This article focuses on relationships between specific facets, as it is not possible to analyse the relationships between all pairs of facets of music within the scope of this article. The relationships between three significant music facets are analysed and unpicked in this article: medium, form/genre and function. While classification schemes and music classification discourse might vary in their total number of music facets, there is some agreement that medium and form/genre are the

two most significant facets for musical works (Elliker, 1994, p. 1317-1318; Smiraglia & Young, 2006, p. 7). Function's position is less assured.   However, it occupies an important place in some music classification writings; for example, ideas akin to function are relatively prominent in the results of Elliker's (1994, p. 1319) analysis of music classification schemes and a function-related facet appears as one of the key facets in BCMC (Coates, 1960, pp. ix-x). So, while three major facets are explored in this article, it is with the understanding that these are not necessarily the only dependencies between music facets.

Knowledge organization literature about music and orthogonality

The final point to consider is any existing literature which considers orthogonality in music classification. Unsurprisingly, there is very little. However, a few theorists writing about music classification briefly acknowledge connections between different aspects of music, without framing these as orthogonality or dependency. For example, Smiraglia (1989, p. 65) observes that musical forms imply a specific medium of performance, while a similar brief comment is provided by Szostak and Smiraglia (2019, p. 4, Footnote 4). These short observations illuminate the gap in the literature for discussion about the relationships between music facets, which this article seeks to fill.

Orthogonality between medium and form/genre

Introduction to the medium facet

Lee and Robinson (2018) show how medium – who is singing or playing the music – is actually a facet made up of different arrays, in sometimes complex sets of interrelationships. This section will focus on two areas of medium which appear to be particularly important to questions of orthogonality, as well as being primordial in the classification of medium. Lee and Robinson (2018, p. 265-266) identified the categorization into vocal and instrumental music as the primary and most significant categorization within musical medium. Lee and Robinson (2018, p. 265) posit that medium foci generally live in either the vocal or instrumental sides of the medium facet.   The characteristic which categorizes between vocal and instrumental foci will be called "sonority" in this article.

A secondary division into broad size of medium is identified as the next most important division (Lee & Robinson, 2018, p. 265). This broad size categorization divides a single violinist from a string quartet, and a string quartet from an orchestra. This usually manifests itself as three implicit or explicit categories within each of the vocal and instrumental categories: solo (for example, flute accompanied by piano), ensemble (for example, string quartet) and group (for example, choir).   See

Lee (2017c) and Lee and Robinson (2018) for discussions about these categories. Therefore, this article will focus on the vocal/instrumental categorization and broad size categorization, and their relationships with other, non-medium facets.

Introduction to the form/genre facet

The form/genre facet is a collective name for one of the most important facets of music. In this context, form/genre refers to categories of specific types of musical works, and examples of foci for this facet include opera, symphony, sonata, mass, opera buffa, toccata, waltz, and so on. Naming and setting boundaries for this facet is complex (see Lee (2017b) for a detailed discussion of the issues), so Elliker's (1994) joint label of form/genre will be adopted and this article will generally take a broad approach to the scope of this facet. As a facet, form/genre behaves quite differently from medium. When classifying musical works, usually only one focus from the form/genre facet is permitted, in contrast to the medium facet. This means that when discussing form/genre and orthogonality, the whole form/genre facet will be discussed rather than specific categorizations.

Dependency between medium and form/genre in bibliographic classification schemes

An analysis of music bibliographic classification schemes show that the selection of a focus in the form/genre facet is very frequently compelled or excluded by the choice of sonority in the medium facet. So, a medium of choir would not be permitted to be combined with a form/genre of symphony; similarly, a medium of orchestra would be excluded from combination with the form/genre of opera. For example, in BCMC (Coates, 1960), only certain combinations of medium and form/genre are permitted, and these are dependent on the vocal/instrumental categorization (for a detailed analysis of BCMC see Lee (2017b)). Not every bibliographic classification scheme excludes specific combinations of sonority and forms/genres. For example, the *Flexible Classification* (Pethes, 1967) does not explicitly exclude the selection of a particular form/genre due to the choice of medium, although it could be argued that the wording and organization of its forms/genres compels the classifier to combine certain forms/genres with certain mediums. In other cases, a bibliographic classification scheme has a form/genre facet which is predominantly dependent on vocal/instrumental categorization, but then shows orthogonality in specific parts of the scheme. In the *Dewey Decimal Classification* (Dewey et al., 2011) the choice of form/genre is mostly dependent on the vocal/instrumental categorization; however, for vocal music, there is a possibility to add a form gleaned from instrumental music, such as a waltz (see Lee (2017b, p. 315) for details). This

highlights how orthogonality between facets is not always as simple as a binary categorization between orthogonal or dependent. Dependency could be considered as a spectrum.

The broad size categorization shows a similar phenomenon. A dependency between broad size and form/genre means that choosing a solo instrument such as a solo violin excludes the classifier from selecting the form/genre of symphony, which is usually associated with a group. For example, the *Dickinson Classification* (Dickinson, 1938) sees the choice of form/genre (called Species facet) governed not just by whether the medium is instrumental or vocal, but also by broad size. Interestingly, the dependency between broad size and form/genre happens less often and is sometimes less pronounced than for sonority (see Lee (2017b, pp. 77-81, 289) for details of the schemes consulted). Consequently, this means some schemes have both dependent and orthogonal relationships between the medium and form/genre facets. The *Subject Classification* (Brown, 1914) provides a useful example: there is dependency between one part of medium (sonority categorization) and form/genre, yet another part of medium (broad size) and form/genre are orthogonal. This asks an interesting question about the essence of orthogonality, and whether a pair of facets being orthogonal only in part can be considered orthogonal at all.

In conclusion, the medium facet is rarely orthogonal with the form/genre facet in bibliographic classification schemes and the form/genre facet is likely to be dependent on one or both of medium's most significant constituents (sonority and broad size). Furthermore, this exploration ascertains that orthogonality between the medium and form/genre facets is not a simple binary attribute. Instead, dependency is a quality that can appear in smaller or larger quantities, on a spectrum of orthogonality.

Dependency in music: the choral symphony

The next part of the analysis considers orthogonality through the lens of a particularly problematic form/genre: the choral symphony. Choral symphonies are types (or subgenres) of the form/genre of symphony. (For a fuller discussion of the choral symphony from a classification perspective, see Lee (2017b)). The major reference work in music, *Grove Music Online* and hereafter abbreviated to Grove, defines a symphony as "a term now normally taken to signify an extended work for orchestra" (Larue, Wolf, Bonds, Walsh, & Wilson, 2006). So, the music domain's definition of a symphony indicates a dependency: the form/genre is defined partly by an aspect of its medium (sonority). Choral symphonies add an extra layer of complexity as they are defined as "a symphony in which a chorus is used at some point" (Choral symphony, 2013; abbreviations expanded from original), and choruses are a type of vocal medium for a vocal group, and thus possess specific values

in the sonority and broad size categorizations. Hence, choral symphonies are defined as having a vocal medium, yet their parent genre is defined by having an instrumental medium.

The choral symphony example raises a number of significant questions about orthogonality. At the simplest level, both symphonies and choral symphonies could be seen as inherently dependent between medium and form/genre, as these dependencies are part of their definitions. Furthermore, choral symphonies illuminate another side to orthogonality which concerns originality. "Unthinkable" and "epoch-changing" are some of the expressions employed by musicologists such as Osborne (1993, p. 105) and Levy (2003, p. 102) to describe the use of voices in Beethoven's Symphony No. 9, the work popularly thought of as being the first choral symphony. Beethoven's Symphony No. 9 upends the norm that the form/genre of symphony is associated with instrumental mediums. So, this makes a strong case for orthogonality's power: orthogonality leaves space for originality and creativity, and this creativity can also dissolve common associations and dependencies between different types of musical knowledge such as medium and form/genre.

It is useful to consider choral symphonies in bibliographic classification schemes. Lee and Robinson (2018, p. 268) analyse the placement of choral symphonies in bibliographic classification schemes, and conclude that these are frequently difficult to classify as it is difficult to represent both the voices and the form/genre of symphony. For example, is not possible to combine a vocal medium with the form/genre of symphony in BCMC, making choral symphonies difficult to classify in this non-orthogonal scheme (Coates, 1960). Consequently, this example demonstrates the impact of the lack of orthogonality on classification practice. It is also a useful lens to contemplate the relationship between the musical works and bibliographic schemes. Choral symphonies have an interesting tangle of relationships between the medium set by their form/genre (choral symphony) and the medium set by their parent genre (symphony); in a parallel classificatory landscape, the bibliographic classification schemes frequently struggle with the classification of choral symphonies. Ultimately, the difficulties of classifying choral symphonies in bibliographic classification schemes could be viewed as an example of causation (Lee, Robinson, & Bawden 2019, pp. 235-236), where the orthogonality issues of the musical works are transformed into bibliographic classification scheme issues.

Orthogonality between function and medium, and function and form/genre

Introduction to the function facet

Introducing the function facet is complex, as its boundaries, name and even its essence are not universally agreed. For example, the IAML meta-facets include a function facet of sorts; yet, it has the compound title of "purpose, occasion, effect/intension" (German original: "Zweck, Anlaß, Inhalt"; Dorfmüller, 1975, p. 48), and is so complex that IAML were compelled to create a thesaurus in order to elicit the facet's meaning (Schneider, 1994). The idea of a third facet after medium and form/genre is found in many different classification schemes, albeit sometimes with a different name (Elliker, 1994). So, this article utilizes a broad idea of the function facet: it is defined as the category relating to the purpose of the musical work, either to the purpose of the music's performance or a more abstract idea of purpose.

The music domain has two different categorizations of function. The first is a binary division between functional music, and its antonym, autonomous music, which is not of interest to this article. The second type of function involves a small number of specific functions, and is utilized in bibliographic classification schemes. Musicological writings discuss these categories. For example, Busoni (1957, p. 1) suggests that opera, church and concert are the three purposes of music; Wolf (2002, p. 579) has a similar list, suggesting that the three traditional functions of music are church, theatre and chamber. Combining and broadening these categories, we can summarize the main functions of music as follows: a religious or liturgical function, a theatre or dramatic function, and a concert category which has no liturgical or dramatic purpose. Bibliographic classification schemes also demonstrate prolificacy of certain functions, albeit also with disagreement about the boundaries and names of these categories, and often not necessarily explicitly labelling the demarcation between functions (for example, BCMC). In this article, three main functions will be used (dramatic, religious and concert) to explore the orthogonality between function and the other facets.

Dependency between function and medium in bibliographic classification schemes

The relationship between function and medium is mediated through the form/genre facet. It is more difficult to track than the other facet combinations, as often function does not appear as a

separate facet in bibliographic classification schemes. Bibliographic classification schemes often treat function differently depending on the sonority selected. For example, in BCMC, if a vocal medium is selected, the classifier is then presented with a categorization between dramatic and non-dramatic music; yet, no such division occurs within the instrumental parts of the schedules.

Furthermore, in rare examples, it can be seen that the desire to keep works with the same function together can even see mediums "misclassified". Ballets are a form/genre of music with a dramatic function and are predominantly for an instrumental medium. However, LCC places ballets within vocal music, which misclassifies their medium (Library of Congress, 2019, p. 37). It is assumed that the reason for this is to ensure that ballets sit with other dramatic works, and most other forms/genres of dramatic works are associated with a vocal medium – see section below for discussion of dependency between function and form/genre. (Although LCC is an enumerative rather than faceted scheme, it is still useful as a reflection on the connections between the function and medium facets.) Possible ramifications of this layout include classifiers and users not being able to locate ballets, or those without expert musical knowledge assuming that ballets have a vocal medium.   The LCC ballet example could be considered as an extreme type of compelling, which could be a termed a "dependence-induced falsity". This is visualized in Figure 3. The function/medium matrixes in this figure show ballet within various structures: orthogonal facets; facets which compel specific combinations of medium/function and where ballets do not conform; a facet structure where ballet (coloured in red) is compelled to reside within the incorrect medium. Figure 3 plots this case of deliberate misclassification of the medium of ballets as the final point in a continuum of compelling, at the end of spectrum which moves from orthogonality to compelling (dependency) through to extreme compelling (high dependency).
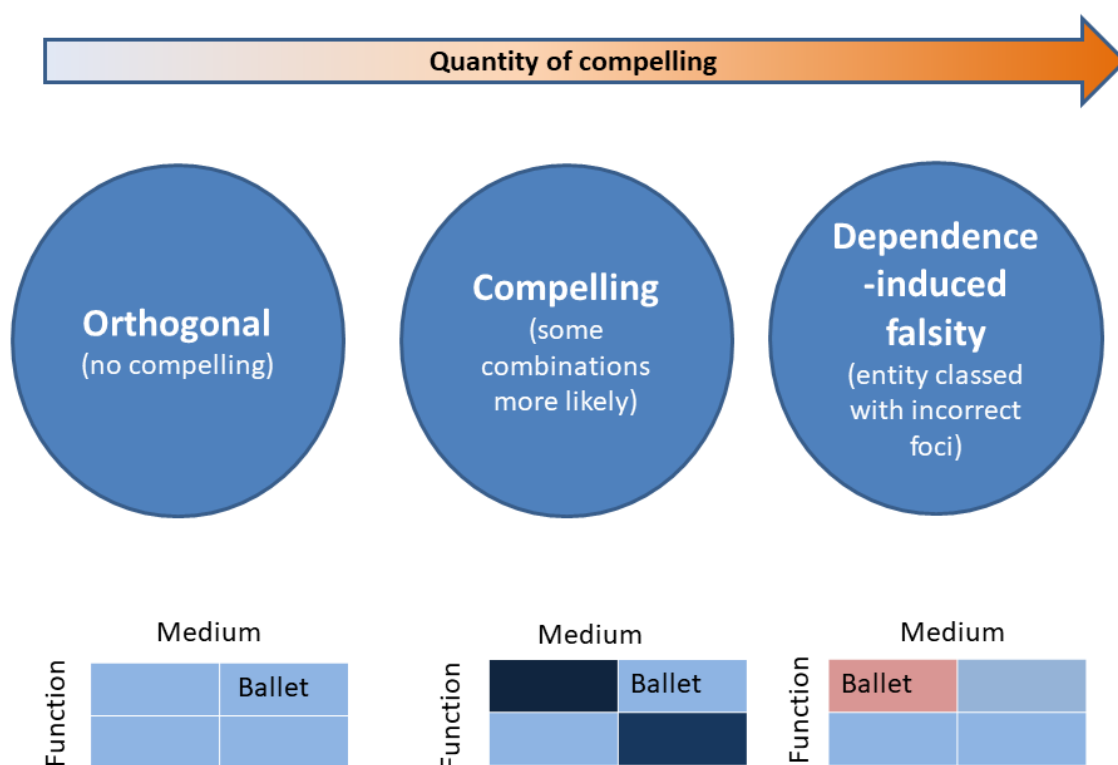
Figure 3: Dependence-induced falsities and a spectrum of compelling

Dependency between function and form/genre in bibliographic classification schemes

Considering whether function and form/genre are orthogonal in bibliographic classification schemes reflects the general nebulous nature of the function facet. The majority of faceted classification schemes have ambiguity about whether function is a facet at all. For example, BCMC treats concepts such as "liturgical" and "dramatic" as an implicit way of categorising various form/genre terms within vocal music, rather than as a separate facet (Coates, 1960, pp. 25-26). However, BCMC (Coates, 1960, pp. 3-4) also has space for the concept of character – for example, dance music, music of occupational groups, military music, childhood – which overlaps with the idea of function, and this is treated as a separate, somewhat orthogonal facet in a different part of the scheme. The *Dickinson Classification* (Dickinson, 1938, pp. 22-25) uses function-type categories such as secular, sacred, "liturgic" and dramatic within its medium tables, showing function not being treated as a facet. Yet, the same classification scheme includes a class for "Occasional" in the form/genre facet, which contains an instruction to add from the Occasion facet (Dickinson, 1938, p. 32). So, the Occasion

facet in *Dickinson Classification* is not orthogonal with form/genre: it can only be used when no other form/genre is used, and is also only applicable for specific ranges of mediums.

These bibliographic classification scheme examples illustrate a number of key issues with how function relates to other facets of music. First, function is not always a facet. It can be a categorization within form/genre. Second, different ideas contained within the IAML combined facet of "purpose, occasion, effect/intension" (Dorfmüller, 1975, p. 48) might co-exist in different parts of the same classification scheme, and these can be treated differently including whether it is treated as a separate facet or not. Third, where there is a function-related facet, the choice of foci might be compelled by the foci from another facet, illuminating the non-orthogonality of function and form/genre facets. Function is clearly a complicated and multi-layered idea within bibliographic classification schemes.

Dependency in music: five musical works

At this juncture it is useful to look at some examples of musical works for examples of how function and form/genre interrelate. Five examples of musical works are given in Table 1, with their corresponding form/genre, their (originally-intended) function and corresponding medium (condensed for brevity).

Example	Work	Medium	Form/genre	Function
A	Schubert*'s Suleika I*, D720	Solo voice with piano accompaniment *(vocal/solo)*	Song	Concert
B	Tallis' *Mihi autem nimis*	5 solo voices *(vocal/ensemble)*	Motet	Liturgical
C	Mozart's Church sonata in D major, K69/41k	2 violins, continuo *(instrumental/ensemble)*	Church sonata	Liturgical
D	Bellini's *Norma*	Orchestra, choir ("chorus"), *6 solo voices (vocal/group)*	Opera	Dramatic
E	Mendelssohn's *Elijah*, Op. 70	Choir, orchestra, 8 solo *voices (vocal/group)*	Oratorio	Concert

Table 1: Examples of functions for five musical works

Example A has a form/genre (song) where any function is technically possible. Therefore, function is a useful type of information here and can be considered orthogonal to the form/genre. In Example B, the function information is also useful as a type of information, as it helps to distinguish this work from the secular motet. This is needed as though motets are normally considered a "sacred polyphonic composition with Latin text" (Sanders et al., 2016), in the Middle Ages some motets were

secular (Sanders et al., 2016) and some later motets contained a combination of sacred and secular texts. This highlights how the relationship between form/genre and function can change over time. However, as certain functions would be highly irregular for motets (for example, dramatic), the form/genre of motet could still be considered to be compelling the choice of function foci and is hence the two facets are not orthogonal in this case. Example C highlights the genre/subgenre relationship and how this can interweave with orthogonality. Sonatas are usually found serving a concert function, yet Example C is an exemplar of a particular subgenre of sonatas, the Sonata da Chiesa, which is designed for liturgical use (Mangsen, 2016). Therefore, in this example, the function is inseparable and part of the definition of the subgenre (Sonata da Chiesa); yet to the parent form/genre (sonata) the function is useful extra information.

Examples D and E have their functions built into the form/genre represented. For example, in Example D, the form/genre of opera is defined in *Grove Music Online* (Brown, 2001) using a non-musical art-form, the drama, which itself is defined by being staged. Example E is an example of an oratorio. The concert function forms part of the definition of oratorios, especially in distinguishing oratorios from operas: "… the normal manner of performance [of an oratorio] is that of a concert" (Smither, 2001). (As the definition suggests, unlike Mendelssohn's *Elijah*, some individual oratorios were created to be staged, thus creating cases where the default function would not hold true.) So, examples D and E move beyond just compelling a specific function: in these instances, it appears that function is enfolded within the form/genre.

So, the different types of relationships between form/genre and function found in the five examples of musical works could be summarized into information about the range of connections between the two facets:

- Function is a separate facet to form/genre, and orthogonal (e.g. songs)
- Function is a separate facet to form/genre, but non-orthogonal as could compel the choice of functions (e.g. motets)
- Function is a separate facet to the parent form/genre, but function is subsumed into the subgenre (e.g. church sonatas)
- Function subsumed within form/genre (e.g. operas, oratorios)

Function as a dynamic facet

From the analysis of a selection of musical works and bibliographic classification scheme examples, an interesting phenomenon emerges: the facet of function acts differently in different situations.

So, if the form/genre is opera, then the function of opera is enfolded within the musical definition of the form/genre; in bibliographic classification schemes, the form/genre of opera is sometimes housed within a broad category of "dramatic" forms/genres within the form/genre facet. Conversely, if the form/genre is church sonatas, then this subgenre is defined by the confluence of its liturgical function and its form/genre of sonata; this is reflected in some faceted bibliographic classification schemes, which permit a liturgical function to be added to any form/genre.

So, we could view the juxtaposition of different treatments of function as a dependency, albeit a very different dependency from traditional ideas about orthogonality and dependency. Normally, dependency refers to the choice of focus in one facet being linked to the choice of focus in another facet. However, the relationship between form/genre and function could be viewed as furthering the boundaries of dependency: whether function acts like a facet or not is dependent on the focus selected in the form/genre facet. This could be named a "meta-dependency". Furthermore, a novel idea is encapsulated by function: it is a "dynamic facet".

The first corollary is that the binary division of relationships between facets into dependent versus orthogonal is broken down. Instead, there is a tripartite set of possibilities when describing the relationship between these music facets: orthogonal, dependent or meta-dependent. So, it is not enough to say "not orthogonal", but these findings suggest that there is a question to be asked in "what sort of dependency". The second corollary is that a new idea about the nature of relationships between facets is brokered. Until now, it is assumed that relationships between facets were static; whereas this discussion shows how the relationships between facets such as form/genre and function might be dynamic. This is a phenomena not previously discussed in discourse about facet analysis theory. The third corollary concerns the relationship between the organization of knowledge in the music domain and bibliographic classification schemes. The nebulous nature of the function facet as exemplified by IAML's work on this facet (Dorfmüller, 1975; Schneider, 1994) and the treatment of function in bibliographic classification schemes, could be viewed as bibliographic schemes responding to function being a dynamic function within the structure of musical knowledge.

Orthogonality as part of music facets

The focus up to this point has been the relationships between foci in different facets of music. However, the discussions about music facets raise an interesting question: when we say that two facets are orthogonal or dependent, are we saying that the facets themselves or orthogonal, or that

orthogonality and dependency are qualities possessed by foci within those facets. So, this section discusses the idea of a dependency between the concepts that are represented as facets. The discussion will centre on genre. The reason for this is that musicological writings suggest that genre is made up of multiple types of music information, which makes genre particularly interesting to consider in terms of orthogonality.

The eminent musicologist Dahlhaus (1987, p. 38) suggests that musical genre is made up of text, function, scoring and formal model. Translated into common bibliographic music classification terms, Dahlhaus is positing that genre is constituted of the following types of information: text, function, medium, and form. The idea of defining genre by medium is amplified by other theorists: for example, Samson (2015) uses instrumentation in his definition of genre for *Grove Music Online*. Hence, genre is defined in the music domain as being constituted of categories of information that are treated as separate facets (medium, function) within bibliographic classification schemes. (As the musicological differences between form and genre are out of scope for this article, form as a constituent of genre will not be considered further.) Orthogonality is defined by the choice of one focus not influencing the choice of focus in another facet; yet, one of music's facets (or part of it, if considered a joint concept with form) is defined by two of its other facets. So, genre is not just dependent on medium, but medium is actually part of genre; similarly, genre is not just dependent on function, but function is actually part of genre. These constituent relationships are visualized in Figure 4. Here, medium appears within genre and also as a separate facet; correspondingly, we could ask, which of these mediums is actually being presented in a classification scheme? A similar question can also be asked for function.
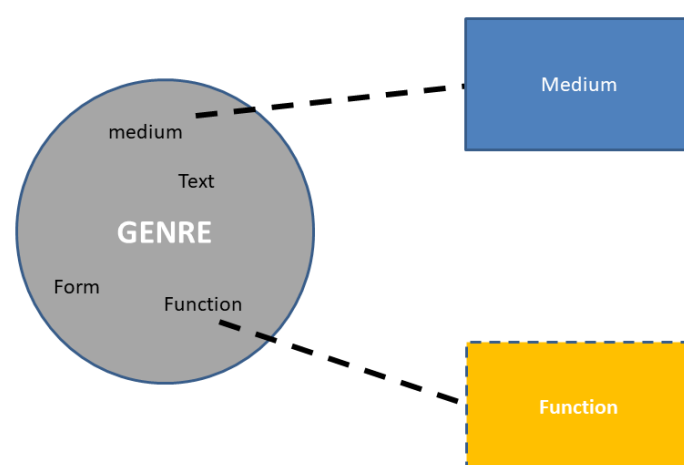

Figure 4: The constituents of genre and the function and medium facets

In the earlier sections of this article, musical works and bibliographic classification schemes repeatedly demonstrated that the choice of foci from one facet in music is often governed by the choice of foci in another. However, considering the idea of genre in writings such as Dahlhaus' (1987), suggests that there is a further orthogonality which is inbuilt at the structural level of the facets themselves. This duality is illustrated in Figure 5, which shows a two-storey dependency between the medium and form/genre facets. The first level represents the dependencies which act at foci level; for example, using the focus Medium 1 from the medium facet then limits the choice of foci in the form/genre facet. The second level illustrates what has been discussed in this section: there is also dependency at the facet level between the medium and form/genre facets, which is built into the fabric of the music information represented by these facets. Moreover, this foci/facet duality of orthogonality also illuminates the intersections between the structures of knowledge in the domain – for example, how music genre is defined by Dahlhaus (1987, p. 38) and others – and the construction of bibliographic classification schemes.
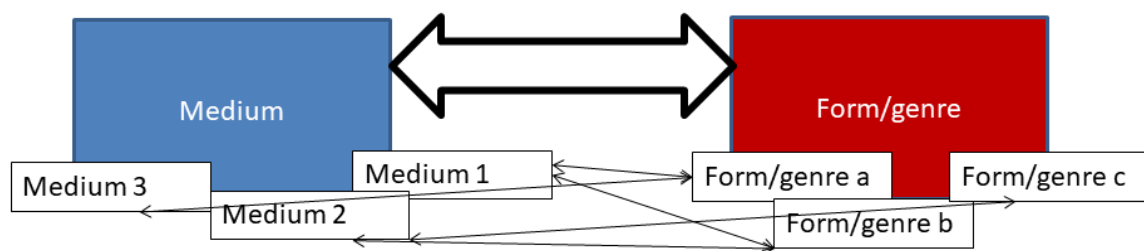

Figure 5: Foci/facet duality of dependency

Conclusion

This article explored the relationships between facets in music. In seeking an understanding of the orthogonality of music classification, it sought to unravel one aspect of music's classificatory complexities. A key finding from this research is that the three primary facets of music are not orthogonal. This is seen in the analysis of bibliographic schemes; moreover, in particular for genre, it is rooted deep within the musical concepts themselves. Music's medium facet (sonority and broad size categorization) and form/genre facet show much dependency. The nebulous facet of function is also dependent on medium and form/genre; in fact, it is argued that function is so dependent on form/genre that even function's status as a facet is dependent on the focus selected from the form/genre facet. Figure 6 presents a model of the relationships between music's three key facets and visualizes their orthogonality/dependency. Regular dependency is depicted using a double-headed arrow. The dynamic facet of function has a dotted outline to show its unstable status, and its

meta-dependency with form/genre is represented by a jagged shape. As the medium and function facets do not share a direct relationship, their dependency is represented by a double-headed arrow with a dotted outline. Therefore, it could be posited that music's strong dependencies between its key facets could be one explanation for the complexities and difficulties of classifying music.
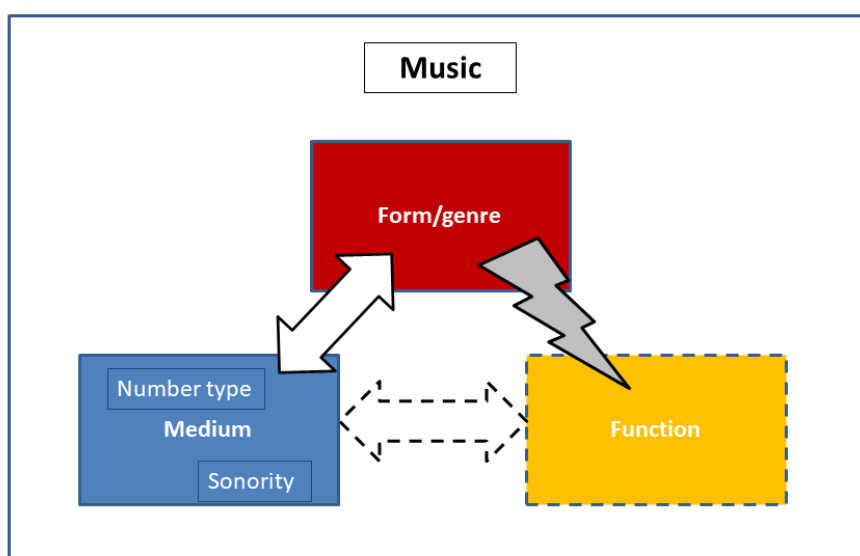

Figure 6: A model of the dependencies between medium, form/genre and function

The general concept of orthogonality (and dependency) has been analysed and unpicked in this article, with a number of novel ideas about orthogonality introduced. Dependency has been shown to be a spectrum, and examples given where a single music classification scheme has instances of both dependency and orthogonality. Through the idea of a "dependence-induced falsity", the discussion has illustrated how strange phenomenon in bibliographic schemes could be folded into an orthogonality/dependency framework. The connection between free choice of foci and the pursuit of originality in music was illuminated, showing how orthogonality is more than just a technical aspect of faceting. Importantly, this article has introduced the concept of dynamic facets and meta-dependency; these novel frameworks for discussing relationships between facets could also be considered for other complex subject areas. Ultimately, this article has demonstrated that orthogonality, which is critical to faceting and the idea of facet-ness, is actually a complex and multi-planed entity.

Discussing music's orthogonality asks an important question: is orthogonality a quality of knowledge organization and faceted structures, or is it inherent in the knowledge from the domain? This article illustrated how musical works themselves can embody a lack of orthogonality – for example, the discussion about choral symphonies or the relationship between function and form/genre in specific

musical works. Furthermore, it was shown how the music domain defines one type of information (genre) in terms of other types of information. Therefore, the lack of orthogonality between music facets could be construed as passing between music knowledge and music bibliographic classification schemes, with this transference of orthogonality illuminating a type of influence (Lee, Robinson, & Bawden, 2019, pp. 238-239) between music scientific classifications and bibliographic classification schemes.

Future research could usefully explore whether a bibliographic classification scheme of music could be built which avoids dependency, and whether it could include music facets which are truly orthogonal. Could dependency within music classification be "designed out"? Another extension to the research would consider other types of music outside of Western art music, to see whether they are similarly non-orthogonal. Future research could take these findings about orthogonality, including ideas such as the spectrum of dependency and meta-dependency, and use them to explore areas of knowledge outside of music. This would help to validate and extend the theories of orthogonality presented in this article, as well as increase understanding of the classification of other subjects.

To conclude, the lack of orthogonality is a major attribute of the classification of notated Western art music, and the complex web of relationships and dependencies between music's three main facets is one reason for the difficulties seen in classifying music. While music is seen to have two main facets (medium and form/genre), and a third important one (function, or a function-type quality), close examination of how medium, form/genre and function interact with each other illuminates how these building blocks of music are actually neither as separate nor as sturdy as it first seems. Through examining music's (lack of) orthogonality, music's classificatory fragility is exposed and better understood. Furthermore, this study also furthers our general knowledge about an assumed yet understudied and critical element of classification. While music has been used as an exemplar in this article, the findings also highlight more generally how the concept of orthogonality is far from a simple and inevitable property of a facet. Ultimately, this study engenders deeper research into the relationships between facets in the universe(s) of knowledge.

Note

1. For simplicity, in this article terms based around orthogonality and independence will always be used interchangeably. The term "independent" has an established antonym of "dependent", see for example Frické (2011). As there appears to be no standardized

antonym for orthogonality in the literature, "non-orthogonal" will be adopted where

necessary.

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