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Music as an Organizing System

Using an Information Architecture Approach to Understand Musical Complexity

Abstract

This article applies elements of information architecture to the analysis of musical works. The intention is to provide an effective and logical way for people with minimal background in music to learn to analyze music. The authors draw on both musical literature and the work of Robert J. Glushko in "The Discipline of Organizing" (2013) to give non-musicians a way to think about music as organized information so that they can add ever-increasing layers of complexity as their skills at applying this approach improve.

Introduction

This article describes an information architecture-based approach used to teach rudimentary musical analysis to people with no background in music theory. It has been used successfully with students who were non-music majors in a university general music history course. This approach to listening and analysis enables non-musicians to view different styles and genres of music as intentional constraints on organized sound. Our approach for describing music applies and extends the ideas about resource organization presented in Robert J. Glushko's 2013 "The Discipline of Organizing" (TDO), which proposes that all "organizing systems" can be understood using a common framework for analyzing how resources are selected, described, and arranged.

The benefit to this approach can be seen by comparing the following three hypothetical analyses:

- **Description 1:** The opening motive is an anacrusis that implies the dominant with a repeating alternate pattern emphasizing the chromatic lower auxiliary to E, creating tension leading to tonic resolution on the downbeat of the first full measure. The A section

begins with alternating tonic and dominant arpeggios, culminating in a drive to the cadence featuring a melodic sequence that emphasizes a descending pattern from the dominant to the tonic.

- **Description 2:** The famous melody opens with an almost static figure that alternates between two adjacent notes before falling to the next melodic figure and chordal accompaniment at 0:02. These two figures alternate to create two symmetrical four-bar phrases until 0:09, returning to the beginning for the repeat. At 0:18, the second figure is broken up and moved around until 0:23, when it is interrupted by a hiccough-like phrase that returns to the original figure to close the first section.

- **Description 3:** This is music for piano and sounds like a sad man walking around looking for the woman he loves. He is frustrated, as he looks everywhere, sometimes madly rechecking places as he gets increasingly frantic and depressed.

All these describe the same piece, Ludwig van Beethoven's "FÃ¼r Elise", but they could not be more different. The first description, which we call Expert Analysis, can be created and understood only by expert musicians because of its specialized concepts and vocabulary. Educated musicians speak to each other this way, but ordinary listeners do not. While this analysis provides the most detail and insight, only music specialists can understand it. Many works of music theory are rich and insightful analyses that are written at this level and are therefore impenetrable for the average reader. The second, which we call Literal Listening, is a description typically found in program notes for a performance or liner notes for a recording, in which the analysis is tied to the progression of the work over time and to specific musical cues. The third description is an Affective Response, a subjective interpretation of what the music conjures for the writer and which is not tied to musical structures or events.

Most descriptions fall into one of these categories, but the Expert and Affective types are not useful to most people for articulating their musical tastes. Literal Listening descriptions are a useful compromise between the extremes of the other descriptions. Their play-by-play is similar to the Expert analysis, but without the specialized jargon or the figurative language of the Affective analysis. However, their subjective impressions conjured by surface-level events provide little detail about how the composer selected and organized the musical material.

Fundamental to our approach is Glushko's description of information architecture as "designing an abstract and effective organization of

information and then exposing that organization to facilitate navigation and information use" (Glushko 2016, p. 114). This is similar to Richard Saul Wurman's definition of information architecture as "the thoughtful making of either artifact, or idea, or policy that informs because it is clear" (Wurman 1997, p. 16). An information architecture is therefore an organizing system that intentionally arranges resources and then facilitates interactions enabled by that arrangement. According to Glushko, information architecture as a practice consists of four critical activities:

- Selection: determines the scope of the organizing system and what to include in it.
- Organizing: determines the rules or constraints for organizing resources.
- Designing: resource-based interactions determine how the resources are made useful.
- Maintaining: manages the resources and the system and adapts to suit different needs (Glushko 2016, p. 92).

TDO views organizing systems as abstract building blocks at the foundation of all organizing activities, including music. Musicians apply these four critical activities as a series of hierarchical constraints that allow them to move from the universe of unbounded musical materials to a complete and identifiable musical work with its own specific information architecture. This perspective is not intended to replace existing theoretical paradigms, but to demonstrate an application of information architecture that is systematic and generative. It allows students to grasp basic ideas of organization from a cross-domain perspective and build on those skills as they encounter different types of music and discover how musicians innovate by challenging existing paradigms.

Literature Review

The study of music in information science is dominated by the concept of the musical work as a bibliographic resource. The pivotal work of Smiraglia (2017; 2017a) provides the fundamental groundwork for the application of library science to the organization and searchability of the Western art music (WAM) repertoire. Research by other scholars such as Adcock (2001), Wu and Shi (2016), Rousi et al (2016; 2016a; 2018) and Abrahamsen (2003) has used a similar approach to consider the musical work as a bibliographical

resource. Lee (2017; 2018; 2019) considers genre, form, and instrumentation as additional facets for consideration in classification of notated WAM, while Weissenberger (2015) and Boutard et al (2012; 2019) address the difficulties of finding classification systems for non-notated music such as folk music and electro-acoustic music. Additional research on music in the field of information studies focuses on music information seeking as the basis of music creativity. Webster (2002), Burnard and Younker (2002), Lavranos et al (2015), and Pohjannoro and Rousi (2018) have looked at the ways in which composers and performers locate existing works of music to inform their own music-making activities. Most recently, Badaloni's (2021) description of the informational atom, informational molecule, and informational macromolecule as representing the hierarchical progression from note to chord to key is an excellent and helpful analogy for understanding music theory as information architecture.

Within musicology and theory, the work of Meyer (1996) and Gjerdingen (2007) are worth noting here. Meyer considers compositional choices made by composers to be limited by both ideological and cognitive constraints on the development of musical material, while Gjerdingen analyzes the music of the Galant period in the mid-eighteenth century by considering it as a series of small, modular musical passages chained together to create larger compositions. Additional work in the field of popular music by Tagg (2001) proposes a semiotic approach to analysis that allows students to apply descriptive labels to musical events and provide a narrative analysis of popular musical works. The approach proposed here is a simpler, more general, and more actionable one that allows people with less expert-level knowledge of music to make rudimentary analyses of pieces from a wide range of musical genres.

The Concept of Musical Constraints

Edgar Varèse famously described music as "organized sound" (VarÃ¨se 1966, p. 18). We propose a definition of music as sound intentionally organized according to a system of constraints that are arbitrary, dynamic, and non-universal [1]. Sounds are the primary resources that composers select and organize. Some composers work with noise and environmental sounds in their compositions, and those sounds might be selected and organized for their aesthetic value or left unadorned. In Western art music, sounds become music when they are intentionally organized to create rhythms, melodies, harmonies, and other musical structures. These structures can be arranged in complex ways using repetition, contrast, transformation, and other compositional processes. As Igor Stravinsky (1882â€“1971) writes:

> *I conclude that tonal elements become music only by virtue of their being organized, and that such organization presupposes a conscious human act" (Stravinsky 1998, p. 23)*

Viewing music as the embodiment of organizing constraints treats styles and genres as sets of socially acceptable design principles or patterns that define the musical organizing system for some community and time period. Composers who work within tonal music, including 18th and 19th century composers like Mozart and Beethoven, generally follow the same constraints of what constitutes good or stylistically acceptable music. Blues or jazz practitioners follow stylistic constraints to be considered effective proponents of the genre, and one often hears "that's good, but it's not jazz!" whenever certain musicians move beyond those stylistic constraints.

Defining music in terms of constraints mitigates the difficulties students face when confronted by specialist analytical language and the non-quantifiable language of "inspiration" and "genius." The conscious human act Stravinsky describes treats musical innovation as taking place when a composer, recognizing that constraints are arbitrary, breaks them and replaces them with others. Stravinsky describes it this way:

> *Now it well may be that I remain for a considerable time within the bounds of the strict order of tonality, even though I may quite consciously break up this order for the purposes of establishing a new one" (Stravinsky 1998, p. 38)*

Consider the design problem composers face. Every note of every musical instrument could be used in a piece of music, which on a piano would be 88 different keys consisting of 12 different notes over 7 Â½ octaves. The possibilities for musical innovation are unbounded, which requires creativity to be constrained to avoid the paralysis created by an overabundance of options. Barry Schwartz calls this the paradox of choice; because of our limited memory and attention capacity, the more viable options we are given, the harder it is to make a rational choice from among them (Schwartz 2004). To avoid this dilemma, musicians rely on design patterns to determine which notes are acceptable within a stylistic context.

The Organization of Music

Organizing systems are defined by the answers to several interdependent design questions about the resources being organized: what, why, how, how much, and when. Organizing systems are designed abstractly to facilitate different realizations by varying the user interface and other aspects of implementation. For example, the organizing system of an income tax form

is logically prior to and separable from its different renderings as a printed document, a web form, or software. These implementations differ in their presentation while remaining equivalent in the information they require.

Similarly, a piece of music is a set of musical resources selected and arranged to create music for performance and listening. Like the tax form, it is an abstract architecture, a logical creation that can be performed in different ways while maintaining its identity as a particular piece of music.

Organizing systems can be described using their organizational principles or constraints, some of which are inherent in the nature of information. For example, catalogs, directories, and other collections of information resources are often organized using logical hierarchies in which coarse categories are subdivided into granular ones until the lowest level categories contain a manageable set. Information is often distinguished logically in terms of its importance, role, or relationship using content labels like title, heading, caption, warning, and example.

Analogously, music follows a set of constraints inherent in the nature of the resources. Our organization of these constraints is hierarchical, beginning with coarse constraints. Subsequent layers of constraints are more refined to generate and describe smaller categories of music. This model recasts the four critical activities of information architecture (selecting, organizing, designing, and maintaining) with new labels and descriptions to demonstrate their application to an information architecture for the creation of music. One might therefore think of these constraints as the critical activities of musical information architecture.

Level 1 (Definitional) constraints are the most fundamental and include the high-level constraints of form, harmony, melody, and rhythm that determine whether we are hearing organized sounds or noise. The basic constraint about notes is that they must be within a human perceivable range. A similar constraint on melody is that the intervals must be in a tuning system that establishes acceptable pitch frequencies. This determines the pitches that are available to the musician and allows them to distinguish between notes that are "in tune" and "out of tune".

Level 2 (Creative) constraints define music within a style or genre. At this level, we can ask, "Is this classical?" or "Is this Jazz?" These constraints are more specific than those at the Definitional level. For example, Harmony is a Definitional constraint that contains the Creative constraint of a grammar that defines the standard ways of moving from one musical event, such as a simultaneous sounding of notes in the form of a chord, to another to make the music interesting for the listener and to give it momentum.

Level 3 (Compositional) defines the arrangement of Creative-level constraints that identify a piece and distinguish it from other pieces. This is where we distinguish the arrangement of constraints that produces FÃ¼r Elise instead of the "Moonlight" Sonata, or observe the distinct styles of Mozart and Bach based on the way they implement similar musical principles. Level 3 is a more complex level, since it requires a greater mastery of specifically musical vocabulary and concepts.

Level 4 (Performance) is the most difficult level to quantify. It defines the variations of elements like tempo, articulation, and dynamics that determine different performances of the same work. These elements can undergo considerable variation without violating any of the previous constraints.

Performance is tied closely to Compositional, as composers frequently dictate these elements in the score. Performers have considerable latitude to interpret these instructions. The instruction Forte, or "loud", will be written in the score, but it is up to the performer to determine what that means in the context of that piece, and it is the variations on the way performance constraints are interpreted that creates different performances of the same work. The Performance level is one in which the personality of the performer creates subtle variations; without them, there would be no need for more than one definitive recording of the same work.

The features we have chosen are not unique or exclusive, and organizing systems retain the bias of their designers. An obvious bias is the choice of features that define each level. Level 1 features like form and rhythm are considered the fundamental parameters of music, but some composers also include naturalistic sounds that cannot be defined within these parameters. We can imagine musical cultures in which sounds created by women are treated as music but not those created by men, and vice versa. At the Performance level, we could include a feature that differentiates between performances on the basis of the different physical gestures the performers made [2].

Most Western music is built on the structure of the Definitional level. This is where we perceive some sound patterns as music or not. Selection and organization of resources occurs at the Creative level, where the constraints of genre and style are found.

Design patterns determine which notes are acceptable within the stylistic context, which limits the number of options the musician must process. The constraints are, perhaps paradoxically from the perspective of the non-musician, the basis of the musician's creative freedom. These design patterns become the bridge between the musician and the listener. The listener's

understanding of the music depends on their familiarity with the shared design pattern vocabulary. These configurations also provide the vocabulary for interaction and improvisation by the musicians. Blues musicians can collectively improvise music with a simple 12-bar blues, in which an established series of harmonic events occur over the course of 12 bars, which is then repeated with variations based on stylistically determined melodic figures.

We can now examine how musicians apply constraints when composing. This will help us to describe music in a way that is accessible to the listener with minimal understanding of music theory. Composers navigate the Definitional and Creative levels simultaneously, which fulfills the expectations of style and genre. The Compositional level is where the composer works within the constraints to create an original piece that fulfills the expectations of the Definitional and Creative constraints without copying an existing piece of music. Every style of music has a repertoire of existing pieces by many different composers, and the abstractions of their elements constitute the design patterns for new pieces. A composer's relationship to this repertoire will determine their artistic vision: if they have a close relationship with this repertoire, they might become a skilled practitioner of the genre; if they have an antagonistic relationship with that genre, they might become an iconoclast; if their relationship to the repertoire is so close that they rely too heavily on the pieces themselves and not the abstractions of their design patterns, you get a musical plagiarist, which is where today's legal woes over musical copyright infringement have their origins [3].

The Performance level has a vast range of musical subtleties. This is where many performers, especially classical performers, spend their entire lives, for while the composer might provide interpretive markings, performers have considerable leeway in those instructions, and the different ways in which musicians interpret them can produce very different interpretations. This is why there are hundreds of interpretations of J.S. Bach's Goldberg Variations on YouTube. None of those interpretations alter the design patterns of the Definitional, Creative, or Compositional levels. Instead, performers explore opportunities for interpretation at the Performance level.

Finally, it is important to address the way in which composers like John Cage have challenged traditional concepts of what constitutes the materials of music. Cage's philosophy is based on the intentional obfuscation of the distinction between music and noise. For Cage, the composer is an "organizer of sound" (Cage 1973, p. 5) who is increasingly faced with the breakdown of the definition of musical materials. As Cage writes:

> *Whereas in the past, the point of disagreement has been between dissonance*

> *and consonance, it will be, in the immediate future, between noise and so-called musical sounds. The present methods of writing music, principally those which employ harmony and its reference to particular steps in the field of sound, will be inadequate for the composer, who will be faced with the entire field of sound" (Cage 1973, p. 4).*

This "entire field of sound", from traffic to rain to radio static, could be the material out of which music could be intentionally constructed. At the same time, Cage saw music in the non-intentional reception of sound in nature:

> *And what is the purpose of writing music? One is, of course, not dealing with purposes but dealing with sounds. Or the answer must take the form of paradox: a purposeful purposelessness or a purposeless play. This play, however, is an affirmation of life--not an attempt to bring order out of chaos nor to suggest improvements in creation, but simply a way of waking up to the very life we're living, which is so excellent once one gets one's mind and one's desires out of its way and lets it act of its own accord." (Cage 1973, p. 12)*

Cage's broad and divisive definition of music challenges our assumptions of what constitutes music and noise, embracing as it does both intentional and unintentional sound that does away with traditional musical materials. For our purposes, we will work with a more traditional concept of music as the intentional arrangement of musical materials, though with the understanding that this framework could be expanded to incorporate Cage's non-musical materials as well.

A Potential Implementation

This approach produces a workable rudimentary analysis for non-musicians. It is a simple, repeatable, and generative perspective that students can use outside of the classroom to analyze a wide variety of music that uses the different levels of constraints defined above. We have tried numerous representations for teaching this approach. A table presentation allows students to analyze by starting with the broad strokes of Level 1 and moving to the particularity of Level 4. They can break the music into its constituent blocks and say simple things about each, which serves as a rudimentary analysis or as the foundation of a more advanced analysis as students advance.

Table 1 shows an application to FÃ¼r Elise. While this is not an analysis a theorist would create, it is an insightful first step for non-musicians. It is not a map of musical events, but a taxonomy that summarizes the elements in an understandable way and moves from the general to the specific, with a narrative summary. It is a model for effective analytical listening and writing for non-musicians. Any of the constraints could be removed or expanded,

and new ones could be introduced for different musical contexts. This is general enough for Beethoven, but other genres might require amendment. The content in the performance column is hypothetical and not specific to any particular performance.

Table 1. Für Elise

Definitional	Creative	Compositional	Performance
Pitch	Consonance - Dissonance	Consonant intervals provide stability. Dissonant intervals interpolated between consonant combinations provide tension that resolves to stable consonance.	Emphasizes tension-filled passages and dissonant chords to heighten resolution to consonant chords and familiar themes.
	Melody	Simple eight-bar melody built on repetition and sequential treatment of two primary ideas.	
		Motive from intro returns throughout.	
	Harmony	Minor key. Harmonic stability generated by establishing a consonant harmonic simultaneity as the tonal centre. Harmonic variety generated by interpolating unstable harmonic simultaneities between consonant ones and resolving to the tonal centre.	
Duration	Pulse	Triple time.	Frequently slows down and speeds up to emphasize points of tension.
	Tempo	Moderate and energetic.	
	Surface Rhythm	Consistent surface rhythmic activity in both hands with an increase in activity in the B section.	
Timbre	Instrumentation	Solo piano.	Frequent use of the pedal provides sustain in the A sections.
Dynamics	Intensity of Sound	Moderate variety of intensity from soft to loud.	Emphasis on smooth articulation in A and B sections. Increased use of short, sharp articulation in C section.
Form	Repetition	Repetition of material in first section. Contrasting material in the second section. Return to material from the first section. New contrasting material in the third section. Return to material from the first section. Form is ABACA.	Takes all indicated repeats.
	Thematic Development	Motive from intro returns throughout.	
Narrative Summary			
Für Elise, for solo piano, represents a typical example of Western art music practices from the late 18th and early 19th centuries. The opening section uses two motives: the famous opening motive that returns throughout and provides a landmark at the beginning of new sections, and; a disjunct motive that is subject to repetition and sequential treatment. The point of harmonic stability is a minor key, and harmonic variety and interest are created by dissonant intervals and unstable harmonic simultaneities that eventually resolve to the consonant tonal centre, with the pianist emphasizing moments of tension and resolution by adjusting the tempo and using heightened dynamics. The tempo is moderate and there is an energetic triple-time meter with consistent surface rhythmic activity among both the right and left hands. There is an emphasis on smooth articulation throughout with a moderate dynamic variety moving from piano ("soft") to forte ("loud"). The piece features repetition and development of the two themes in the A section and contrasting material in the B and C sections.			

This effective rudimentary analysis is a reasonable goal for a non-musician to achieve to become a more insightful listener or for students to reach in a semester. While the lack of analytical detail means that this analysis would be very similar for other works by Beethoven, highlighting that FÃ¼r Elise is a typical example of Beethoven's style is a useful observation for the non-musician and provides a good abstract of some simple elements of Beethoven's style for comparing his music to that of other composers.

This approach to analysis makes explicit the levels of organization that musicians often take for granted and that prove difficult for non-musicians to understand. It provides an at-a-glance format that students can use to

compare and contrast this analysis to others or provide the basis for more in-depth analysis of the piece as their analytical skills improve.

Scope

As with any pedagogical approach that uses modeling, this is not a universal solution to every analytical problem a music student might encounter. In this section, we present some limitations and potential avenues for future development and research.

First, while this approach can provide assistance to non-musicians with no understanding of music theory, those with at least some background in the fundamentals of music theory, such as the concepts of pitch, rhythm, basic ideas about harmony, and a rudimentary understanding of basic musical terms such as consonance, dissonance, and timbre, are likely to get more from this approach then students with no musical education or experience. However, in our experience using this approach to teach non-musical college students in introductory music appreciation classes, we have had considerable success helping students achieve a respectable level of rudimentary analytical skill. This has particularly been the case when using this approach in an online teaching environment, which requires extensive architecture of learning resources in the online platform and detailed editorial feedback from the instructor on multiple progressive analysis assignments.

Second, this approach is not primarily concerned with the psychology of music or the acquisition of musical judgement. While there is a rich literature on the topic of how human cognition navigates musical events (Huron 2006), this systematic approach is built on the premise of musical materials as information resources that are organized and manipulated to create large-scale structures in the same way we might build digital information architectures or documentation sets.

Third, while this approach is fundamentally agnostic in terms of style and genre, its genesis, as well as our classroom application of it, are based on the principles of Western art music. This is a reflection of nothing other than the primary research orientation of the authors and should not in any way be seen as a value judgment of the applicability of the method to other musical genres, styles, and traditions. Indeed, a primary motivation for developing this method is to provide analytical approaches that cross these boundaries and encourage students to make connections between the ways in which various musical traditions manipulate musical materials.

Finally, and perhaps most egregiously in the eyes of musicologists or music

theorists, this approach largely excludes considerations of aesthetics and musical meaning. This is not an attempt to devalue them or suggest that they are not primary elements in the decision-making processes in which composers and improvisors engage regularly. It is, however, an attempt to avoid distilling the rich, subjective, and nearly infinite variety of aesthetically based musical decisions into a rudimentary model. Musical art, of course, is an endless series of aesthetic judgments that deny musical expectations and innovate or invent above and beyond the baseline of the fundamental manipulation of musical materials. Attempting to model the endless variety of musical aesthetic decisions would be futile, especially when the purpose of this approach is to provide a model that allows students to determine the fundamental baseline of how musicians use musical information and to use that as the basis for subsequent analyses that consider additional aesthetically based decision-making processes that composers use to move from information organization to art.

Conclusions

The language of musical analysis is highly specialized and requires years of training to apply properly. Considering the wide popular appeal of music, the exclusivity of musical analysis alienates a significant audience of non-musicians who might wish to understand how to listen critically to music without having to resort to programmatic or descriptive metaphors that highlight emotive or subjective ideas about the musical narrative. Analyzing music as an organizing system allows listeners to focus on abstract organizing principles using accessible language. Applying the TDO concept of information architecture to musical thinking is a useful framework for helping people with no musical background develop proficiency in critical listening. The reviewed framework offers an alternative to more advanced approaches of critique by viewing music as an organizing system of information and making advanced musical analysis conceptually accessible. Further, students can focus on granular elements of a musical work to provide effective musical analysis and the groundwork for additional development and learning.

Acknowledgments

The authors would like to thank the following scholars for their kind assistance in the preparation of this manuscript: John McDowell, Andy Gass, Ray Jackendoff, Stephanie Conn, and Polina Dessiatnitchenko.

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Footnotes

[1] The concept of constraints in music has been taken up most vigorously by those working with computer-and-AI-generated composition. Constraint programming (CP) is a flourishing field in both scholarly and industrial practices. The concept of constraint used in this paper relates strictly to the way in which a human composer intentionally organizes, selects, and manipulates musical material for the purpose of creating a musical work.

[2] The idea that performers have a distinctive gestural style is addressed in

Hospelhorn and Radinsky (2017).

[3] See, for example, Althea Legaspi. Blurred Linesâ€™ Copyright Suit Against Robin Thicke, Pharrell Ends in $5M Judgment. https://www.rollingstone.com/music/music-news/robin-thicke-pharrell-williams-blurred-lines-copyright-suit-final-5-million-dollar-judgment-768508/.

Cite as

Glushko, R. J. and Freeman, G. (2021) Music as an Organizing System – Using an Information Architecture Approach to Understand Musical Complexity. Journal of Information Architecture. Vol. 06. Iss. 02. Pp. 9–24. http://journalofia.org/volume6/issue2/02-glushko/. doi: 10.55135/1015060901/212.010/2.042.

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