**Dynamic Systems, Ecological Systems and a Praxis-Centered Account of Western Music: A New Possibility for an Embodied Music Theory**

**An abstract by:**

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## Summary

The working concepts of music theory are characterized by a top-down, retrofitted perspective that classifies musical structures using approaches often totally divorced from the situations and practices that gave rise to those structures. For example, standard theoretical concepts such as sonata form or the figures of modern harmonic analysis are used to explain musical works and events from cultures and periods which functioned in conditions likely unreceptive or uncomprehending of these theories. To be most relevant and useful, theoretical musical concepts must be viewed as aggregates of individual performance practices that self-assemble dynamically in response to history, utility and social context. This behavior is bounded by the horizon of consciousness of the practical improviser, which delimits parameters of musical meaning even for notated and replicated music. In a dynamically assembled theory music's phylogeny recapitulates its ontogeny as the progression of theoretical understanding flushes with both the progression of music education and training and the progression of music history. Such an approach reveals new directions to explore in the interaction between music, movement, cognition, and therapy.

## Dynamic Systems Theory

Like much scientific inquiry, traditional music theory has sought linearly oriented solutions, broad theories divorced from the specifics and "noise" of a system that apply regardless of scale, history, or external dynamics. In recent academic research, another paradigm has been spreading into diverse territories from its origins in physics and mathematics: dynamic systems. Also called nonlinear systems or "chaotic" systems, dynamic systems study phenomena that show non-linear responses to input. Though the input into the system is linear, the system often acts in terms of discrete and radical shifts at specific points that are not controlled by any one variable.

Because they thwart large, uniform generalities, the large-scale properties of dynamic systems cannot be explained with an equation or other broad account. Rather, they are looked upon as the aggregate results of many small actors, each of which have a specific limited behavior. This is where the major paradigm shift occurs with dynamic systems: they are better accounted for as algorithms than equations. While an equation accounts for a system regardless of position, scale, context, or time, an algorithmic account

requires knowledge of the micro-level behavior, a starting-state, and a history. The state of a dynamic system is better rendered through computation than through solution. While an equation describes an end-state, an algorithmic account describes the process or means of the system. Process and context become the bedrock of understanding the system.

Large-scale trends are viewed not as principles which guide the system, but as “attractors”, the way that the fork in a river that gets more water deepens, or the path more traveled gets more trampled. However, each system that passes through a state that falls within an attractor has its own history and context and its behavior is thus not determined by that particular attractor. The macro-scale “attractors” show trends of behavior rather than being the fundamental behavior itself.

Macro states in dynamic systems are described as “soft assembled”, meaning the particular large-scale manifestation of the system is a fluid phenomenon tied to context and history, and not the “underlying” information that guides the system. A shift in one of the contextual elements can cause a system to change linearly, unpredictably, or not at all.

Dynamic systems theory is considered by its advocates to be the first account to reconcile the messy, stepwise, small-scale actions of a system with its larger trends and characteristics. It is this fundamental aspect of dynamic systems that I consider so important for music theory. Large-scale musical behaviors can be viewed as “attractors” built out of the fundamental behavior that guides musical activity: that which I have termed “practical improvisation”.

**Textbook Theory: Stasis and Fragmentation**

The standard conventions of music theory fall to the same prejudices as traditional theories of many disciplines: theories for musical praxes are invented decades after the fact, derived from abstract principles divorced from the real, practical, day-to-day activity of musicians creating and performing music. Theory teachers hedge by teaching that creative minds "break the rules". Dynamic systems theory gives us the tools to craft more fluid and relevant principles.

The textbook musical theory studied today was codified by Hugo Riemann (1849-1919), a German musicologist with negligible creative output. Riemann asserted that music’s identity rested not on the structure upon which music had been composed and improvised for millennia – the scale – but rather had shifted into a tripartite harmonic structure of tonic, dominant, and subdominant chordal functions. Combining the notes in these three functions gave the notes of the scale, but the discrete, vertical harmonies were the primary musical phenomenon. This theory displaced the original harmonic theories of the French master composer and improviser Jean-Philippe Rameau (1683-1764) and the Belgian composer and writer Francois Joseph Fétis (1784-1871). While those and other competing harmonic theories viewed music in terms of tendencies, movements, and gravitational pulls, Riemann’s system allowed the music to be chopped up into discrete units measurable from an absolute standpoint.

The ability to divorce analysis from performance allowed the discipline of theory to free itself from creation and performance, subsisting merely on activity within its own domain, creating an industry interested in sustaining it in its self-contained form. It also enabled the treatment of musical works as crystallized, formal entities bounded by the notation on the page, rather than the traditional view of the notated music as one pole in a creative ecology, the essence of which lay in creation and improvisation in the act of performance.

Riemannian analysis even proceeds in a different sequence than the act of musical creation – left to right, like reading a book – while improvisational music making requires leaps in time and thought, establishing directional targets towards which the musician proceeds on a path that stretches backward as the music rolls forward. Chord analysis breaks into numerous discrete parts what is best described as incidental stops on a path between only two points. While the cadence points form discretely in the mind of the performer, the intermediate stages are felt as process, path, and quality. It is simply not a feasible model to assume that in what can be described as a gentle meander from one tonal area to another, the performer has left in his wake nuggets of great conceptual complexity that require multiple levels of analysis. The elaborate pointillist explanations devised by Riemannian analysis do violence to the fluid nature of improvisational musical conception.

**Glimpsing A Dynamic Alternative**

A meaningful music theory must be grounded in the acts of individuals making and performing music, in a time, for a purpose. Through the interactions of these countless musical individuals broader patterns - “attractors” - start to emerge. However, broader musical conventions must be viewed as “soft-assembled” - coagulations of individual practices that tread the same path because certain solutions resolve a variety of situations, not because any such solution contains an inherent truth, or is in itself any sort of teleological marking point. Change in such a system must be viewed not as proceeding along a linear, orderly progression, but as a nonlinear, dynamic system, driven as much by context and history as the physics of sounds or theories of cognition.

The diatonic Western scale that became the universal standard in European music is itself a product of layered activity over time in response to culture, technology, and history. Each development of the scale, through addition of notes, shifts of intervals, or alteration of tuning, gave up some previous advantages for a greater number of new advantages, in what game theorists would call a non-zero-sum process, until it reached a balance that has endured as the overall most favorable for musical creation in the Western idiom. Viewing musical invention from the point of view of algorithmic development creates a narrative that views the cornerstones of harmony as more efficient solutions made possible by slight shifts in underlying historical context. When viewed as a layered, dynamic progression of practical solutions, the standard array of musical progressions at the center of the classical canon prove stable and enduring functions from their

emergence in stripped-down form in early vocal counterpoint to thickly decorated but fundamentally similar behaviors in jazz.

**The Dynamic Nexus: The Horizon of Consciousness of the "Practical Improviser"**

The key behavioral variable in the development of Western music – and likely all musical traditions – is the horizon of consciousness of "practical improvisation", or someone spontaneously creating music in response to a need. Improvisation stands far above composition in importance to the understanding of music, because it unifies creation of music with enactment of the music in a real time situation. The scope of activity of a musician spontaneously creating music to satisfy an external need is the boundary of what is meaningful in music, directing the algorithm of the dynamic musical system. Composition may work within that scope of activity, with the added benefit of reflection, but it cannot transcend its boundaries.

People have persistently invented new technologies to further their musical goals, and notation is among the most primary. A through-composed piece, however, has been the exception to the rule. The overwhelming majority of the usage of musical notation through the history of music has been as a technology to enable musicians to improvise practically. Whether it contains the bare outline of a chord progression, or a mixture of obbligato and free sections, musicians traditionally used notation to help them spontaneously create and improvise music, and did not view themselves as replicators. With a broader eye to the developments of music history, then, composition is not the dominant influence and never has been, but is rather a subservient function to improvisation.

This is not only true for the musical creator but for the listener: the ideal listener is not someone who has memorized the twists and turns of a piece, or studied a score, but who is able to both absorb the score's complexities and also react to the developments anew, hearing surprises as surprises, delays as delays, and recapitulations as reminders. Performers, even solely replicating performers, are cognizant of presenting and feeling the music as if it were being discovered or created for the first time.

This horizon of musical consciousness is by no means a fixed quantity: the scope and direction of an improvising musician's consciousness depends on the performer's history and training, cultural ecology, and congenital gifts. Equally important, an effective musical solution also takes the needs of the occasion into account, creating music that collaborators and audience can use to whatever ends brought them into the musical event. Earlier Western music was explicitly for sacred worship, or for folk activities such as dance. Music began to intersect more deeply with drama and poetry, become a vehicle for storytelling, and eventually become the story itself. These many different needs call for music that responds to them within a phenomenologically comprehensible framework, and the qualities of such music will be as varied, vast and nuanced as the infinite social situations that have such a need in the first place, despite commonality of small-scale intention.

However, a set of solutions can be infinite but still lie within boundaries. The *Augenmusik* coming from the academy in the twentieth century, music built on elaborate conceptual foundations derived rationalistically, rather than empirically as aggregates of performance practice, begins outside the window of improvisational consciousness and often does not intersect it at all. As a result, the "mainstream" academic music of the twentieth century only becomes meaningful to an audience incidentally.

This problem did not arise with the onset of atonality: as greater specialization began to flower around the turn of the century, creating specialized composers, performers, and conductors, artists no longer necessarily had the resources to spontaneously create music in response to outside needs, reducing the vitality of the musical conception. Many things improve in society with increasing division of labor, but not all. An artist who has not been trained with a broad enough span of musical tools to spontaneously create music in response to a need is left with a fragment of an organism that cannot survive on its own. As any art form becomes overspecialized, and removed from the horizons of conscious experience, it yields in the popular imagination to art forms that preserve that quality of immediacy and spontaneous, flexible creativity. Wordsworth's description of poetry as "spontaneous emotion recollected in tranquility" applies equally to music. If music does not begin from spontaneous action, it will not hold our interest as listeners when transcribed.

It is difficult today to get a sense of the way in which improvisation was once the central binding force of the classical tradition, but a look at the historical record confirms this. Bach's compositions were only known to specialists in his day, but he was renowned as the greatest organ improviser alive. Mozart was described by a biographer as most famous "first as improviser, second as pianist, and third as composer". During Beethoven's one meeting with Mozart, having only one chance to impress him, Beethoven did not play one of his compositions, but asked Mozart to give him themes to improvise upon. Schubert improvised dances almost every night with his friends throughout his younger years. Beethoven was famous in Vienna as an "astounding improviser" for years before he gained fame as a composer. According to his lover George Sand, Chopin's compositions were "but a pale shadow" of his improvisations. Debussy improvised constantly and particularly liked to improvise on out of tune pianos to hear the different overtones. Schumann, Brahms, Bruckner were all accomplished improvisers.

As classical music became more specialized at the turn of the century, popular music that had room for improvisational traditions captured the popular imagination: jazz, blues, rock and roll, and on to hip hop. When any of these traditions become too self-conscious or ideological, another movement embracing practical, improvisational creativity rises to take its place.

Improvisation is now all but excluded from classical music education and analysis. Its reinstatement as the central aspect of musical creativity is at the crux of the classical dilemma.

**Elements of a Dynamic Theory**

Dynamic systems theory has penetrated some corners of academic and computer-based musical composition. However, dynamic systems are not a catchy gimmick to be grafted onto the Western music corpus we know it. The beauty of research like that of Thelen and Edelman is their demonstration that dynamic systems have always been all around us and fundamental to every aspect of our being. Dynamic systems theory does what great scientific paradigms have always done: it allows us to construct a more accurate model of the reality already passing before us, and its applications to the history of Western music are as full of potential as any other field. A dynamic systems theory of music will be a novel synthesis that unifies contemporary ideas in systems theory, information theory, cognition, and economics with a revised look at the developments of Western musical history, composition, and education.

Once the foundational ideas of dynamic systems have been established in such a study, the methodology for applying them to cultural problems has to be developed. For this we start with the enormously successful application of dynamic systems thinking to biology (Edelman) and child development (Thelen). From this the broad strokes of a biological account of our reaction to music is needed, informed by recent development in the neurobiology of emotion (Damasio, Edelman) and movement (Berthoz) and ecological views of the human organism (Bateson, Reed). Based on this biologically informed account we can begin to view the traditional musical theories of affect (Mattheson, Schubart, Rameau) and recent contributions (Leonard Meyer, Edward Cone, Deryck Cooke, W.A. Mathieu) and integrate these perspectives with updated views on the human organism.

A dynamic theory of music proceeds in step with the narrative of music history and the conceptual process of music education. Rhythm is the most obvious and palpable bridge between the movement of sound and the functioning of the human organism. Biological and cognitive foundations of rhythm are introduced by looking at rhythm in simple life, ecosystems, and its indispensable role in the functioning of the human physiological and nervous system. Phrase, meter, and period are shown as fundamentally rhythmic phenomena, as they can be expressed in purely rhythmic contexts, and the basic rules of accent and nuance can be shown as intertwined with the fundamental properties of rhythmic forces.

Tone relations are the rhythmic interplay of pitched sounds, and based on the previous groundwork we are in a conceptually strong position to revisit the basic assumptions of Western tonal music. The study of Western tonal phenomena best begins with the establishment of Western vocal counterpoint (Palestrina) and informed contemporary analysis thereof (Jeppesen) (medieval music being more accurately characterized, we are now informed by current liturgical and musical history, as more of an outpost of Byzantine and Syriac Christian traditions). The critical step of the relation between single line and mode, studied in only the Dalcroze method, is established (Fetis, Rameau, Dalcroze) before looking at two-voice relations, which allows us to heavily critique Hindemith. Bach rather than Fux is held as the model for two-voice relations as his work

integrates the scalar relationships of pitch with intervallic relationships, and our study of pitch takes on two dimensions. Rules of accent and nuance can be reviewed and expanded dramatically to include the forces of pitch, providing guidelines for tasteful interpretation based objectively in formal musical properties.

With the advent of modern tuning and improved musical technology and training, three voices present a new solution to traditional problems of concord and discord that proves more efficient and wide-ranging than its predecessors, namely movement by fifth (Rameau), providing the modern conception of harmony and its building blocks of triad and seventh. Through some analysis it will be shown that movement by fifth, as accounted by Rameau, is an empirically accurate description of the music of the great Western composers, and that the rival theory of Riemann, labeling the subdominant as a pre-dominant chord, has no empirical basis in composition. The establishment of fifth-movement as a fundamental factor creates an additional field of influence on pitch, causing our understanding of pitch to grow to three dimensions – scale, interval and function. Rules of phrasing, accent and nuance can now be viewed in three dimensions and expanded to develop principles of interpretation that create taste and subtlety while staying within the music's formal substance and leaving room for interpretation.

Combined, the musical experience is described to run along an imposing seven dimensions – beat, gesture, meter, phrase, scale, harmony, and function, as well as considerations of genre or psychological development. The musical experience is revealed not as a journey of tortuous linear complexity but as an often simple movement of great dimensional depth, requiring depth of attention to absorb more than ornate reflection. It is this multi-dimensional depth of attention that is required for practical improvisation, and is not cultivated in our music schools, but is cultivated explicitly in many Eastern methods of attention.

Having covered harmonic movement, the discussion turns to the overall craft of musical creation, through improvisation and composition, in which dynamic systems has a great deal to say. Broader forms such as sonata and fugue can be shown not to be fixed forms imposed from outside, but emergent properties driven from a smaller activity, with commonalities in form delineating "attractors" of common psychological necessity. An approach of practical improvisation gives us behavior descriptions that yield classical forms naturally, rather than something organized and imposed from the outset. Other common musical phenomena, such as peaking at phi, are explored as emergent properties based on smaller-scale algorithms rather than anything explicitly orchestrated.

With that in mind, two broader conclusions can be drawn about the craft of musical composition. One, more formal, is that the larger-scale musical formations, in contrast to the predominant structural theories, can be seen as epiphenomena of psychological information distribution, operating in forms characteristic of the way information is distributed in systems (Wiener, von Neumann, Bonabeau, Eberhart) and societies (F.A. Hayek, Steven Levitt, Robert Wright). Once this understanding of long-form musical models are adapted, the composer by necessity abandons a centralized God's-eye-view approach to compositional planning and views compositions more as subtly guided

through-composed episodes of improvisation, an approach documented by many of the great composers in their letters, and in others' accounts of their musical process. The compositional craft of the great composers can be viewed as the incomparably subtle regulation of information.

The other, broader conclusion is that the workings of music parallel the workings of consciousness, and in this we finally see the inner appeal of the great science of counterpoint, as well as the meaning behind the structure of sonatas and musical forms that optimally blend dramatic development and architectural symmetry. Just as Damasio describes film, with all of its discontinuities and selective reproduction, as the best reflection to date of the human consciousness at work, so too might the balance of concord and discord, independence and unity, balance and asymmetry, repetition and development within the musical art be the most analogous model we currently have to the operation of the human inner psyche.

The concepts of dynamic systems can be our key to unlocking these many disparate elements of music and the self, and developing a framework that unifies biology with music theory, history, culture, and education in a fluid and relevant way that sits flush with the moment of practical improvisation that is the vital wellspring of the great art form of music.