
Jazz and Emergence (Part One)

From Calculus to Cage, and from Charlie Parker to Ornette Coleman:
Complexity and the Aesthetics and Politics of Emergent Form in Jazz

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Introduction

This two-part essay inquires into the history of jazz from Be-Bop composing practices of the 1940's, to the development of Free Jazz in the 1960's, in terms of the concepts of "complexity" and "emergence" in physics and cognitive science.¹ Thus, it continues my past attempts at cross-disciplinary investigations, which drift from the relationship between complex systems and art into the realm of philosophy, by addressing the transgressive and yet inevitably complicitous nature of avant-garde art and its posture towards dominant cultural formations.²

I define this concern with the relationship between aesthetics and philosophy for this essay in the following way: How can we link the concept of "nomad art," as defined by Gilles Deleuze and Félix Guattari (1987: 614-24), to a historically-specific instance of "minortarian art" --African-American classical music or "jazz" -- an art which has a micro-political, and political-economical, as well as an aesthetic context? I would like to begin to interrogate Be-Bop as a musical genre so as to illustrate the relationship between nomadology as a theory of complex behavior of individuals and collectives within human social systems, and micro-political, transgressive aesthetics. In other words, how can we understand the relationship between a central concern with contingent and emergent aesthetic

Martin E. Rosenberg. "Jazz and Emergence (Part One)." *Inflexions* 4, "Transversal Fields of Experience" (December 2010). 183-277. www.inflexions.org 183

form, and the marginal status of the culture or group producing that aesthetic within a dominant social system? While I might want to finesse the distinction between what is dominant (in the cultural studies sense of “hegemonic”) with Deleuze and Guattari’s machineries of “control” and processes of “becoming,” I think we are too quick to efface the continued conditions of suppression with respect to the complex intertwinings of political, economic and social forces—especially where the condition of African-Americans in the United States is concerned.³

Now, I will have recourse to the work of Gilles Deleuze and his collaborator Félix Guattari (with reference to other fine thinkers like Jacques Attali), as well as cite a number of Deleuzean scholars writing on music (such as Ronald Bogue, Eugene Holland, Aden Evans, Charles Stivale and Greg Siegworth), in order to address a number of these concepts (such as nomadology, minoritarian), with reference to jazz performance.⁴ While Deleuze and Guattari use these concepts largely to describe classical music, we will see that these concepts have particular resonance with the study of jazz performance and composition.⁵ I will refer as well to recent (and remarkable) scholarship on jazz so as to straddle the distinct discourses of music theory, philosophy and science with some specificity. Trans-disciplinary research often enables certain questions to emerge that do not get asked within a single discipline. Deleuze and Guattari speak to this when they exhort us to “forge alliances” (1994: “Preface” xix), amongst the three main arenas of our conceptualization of the world: science, philosophy and the arts.⁶ But one must draw these alliances carefully.

Much of my early work on the avant-garde demonstrates how Deleuze and Guattari ground the concepts of nomadology and micro-political aesthetics to a great extent in the discourses of complex systems in physics and cognitive science, as those discourses have evolved throughout this century, but especially since the 1960’s. Since the late 1980’s, I have argued, along with Manuel Delanda, that many other concepts such as the refrain, multiplicities, territorialization and de-territorialization, difference and repetition—recently

discussed by Deleuzian scholars with reference to music--also share these grounds. We need to justify this venture into the careful forging of alliances among scientific disciplines, the philosophy of science and contemporary aesthetic philosophy, in order to reflect on the following five main lines of inquiry (or what Deleuze and Guattari would call "lines of [conceptual] flight") traversing the realms of science, philosophy and jazz aesthetics:

How do assumptions about duration or time shape the very different creative processes in classical and jazz music? I refer specifically to the western tendency to spatialize time since the 17th Century when both calculus, and standard music notation with even temperament and bars and time signatures, emerged. Examining these assumptions may also help to explain why jazz musicians often have the capability to master the principles of classical performance at the highest levels, but that the reverse cannot often be said.

How dependent are John Cage's compositions, by foregrounding the interdependence of music and noise, upon a carefully considered deconstruction (in the Derridean sense) of the calculus of music notation dominant since those 17th Century innovations in contrapuntal composition. We will then notice how he adopts models of music notation that look uncannily similar to phase space diagrams of such complex irreversible processes as attractor states in thermodynamics. Cage's transgressive aesthetics force a shift in the epistemological assumptions about the nature of duration. Yet, because of his subject position as "auteur" for these events, exerting top-down control despite the inherently contingent nature of those performances, Cage demonstrates complicity with respect to top-down European aesthetic sensibilities.

How did the Be-Bop composing practices of Charlie Parker and others engage directly in the calculated yet spontaneous deconstruction of spatialized time, in order for new, hybrid processes of musical expression to emerge? Reminiscent of Bergson's stages of "creative evolution," these processes, in turn, extend to involve an evolving, iterative pattern of improvisation, recording, transcription,

then followed by re-composition and then further improvisations – what Deleuze and Guattari might call aural-visual de-territorializations and re-territorializations. These processes enable song structures, as the vehicles for improvisation, as well as the conceptual/linguistic musical content (harmony, melody and rhythm) of those songs, to evolve into increasingly subtle and abstract forms at breath-taking speed.

How we may identify processes of de-territorialization and re-territorialization, and the iterative, emergent or self-organizing nature of the refrain (and of harmonic rhythm generally), as central to an understanding of the micro-political motivations of an aesthetic? We will also see how a shift from the model of calculus to the model of phase space in conceptualizing the nature of duration enables us to theorize, and visualize, the crucial role of systemic bifurcations: in both complex processes from physics (and cognitive science in Part Two), and in jazz. We will be able to locate systemic bifurcations with reference to melodic resources, the adaptive nature of harmonic structures with respect to tonality, and the rhythms of harmonic progressions as well as percussive rhythms.

How one might define Ornette Coleman's theorization of "Free Jazz," in terms of a distributed form of musical expression (called "Harmelodics"), as an evolutionary extension of the line of conceptual flight opened up by Be-Bop composing practices. Other artists also embraced the distributed nature of jazz performances, involving the maximum freedom in juxtaposing independent and sometimes contrasting melodic, harmonic and rhythmic materials, so that those associated with John Coltrane (for example McCoy Tyner and Pharaoh Sanders), Miles Davis (for example John Scofield, Jack DeJohnette, and Dave Holland), and the Art Ensemble of Chicago (for example Roscoe Mitchell and Lester Bowie), were enabled to reach for a full realization of performative freedom.

Given the 17th Century invention of infinitesimal calculus by Newton and Leibniz, and the concurrent invention of even temperament and standardized musical notation (with regulated time signatures and bars on staves dividing

time into discrete units according to laws implied by those time signatures), the questions posed by models of duration in physics and music share a common heritage, and often raise similar questions with respect to their epistemological and ideological consequences.⁷ These questions seem to lie at the heart of John Cage's experimentations with "prepared piano"; compositions subverting both even temperament and linear time underlying the laws of musical cause and effect.

We will discover that the laws governing the expression of musical thoughts in the irreversible duration of jazz performance, as they are capable of representation in music notation, resonate with those laws governing the behavior of complex systems.⁸ While the concern with embodied and distributed cognition constitutes Part Two of this study, what I wish to address here are the aural and visual manifestations of performance, rooted in a minortarian apprehension of time or duration that embrace both contingency and emergent aesthetic form through iterative acts of jazz improvisation and then composition. I consider it minortarian because of the subject positions of those who create the art form with respect to dominant culture. In other words, I will insist on the African-American, and, later, the post-colonial cultural bases for jazz aesthetics precisely because of the logic of the minor as spelled out by Deleuze and Guattari. A serious problem with current jazz performance and research has to do with its dependence upon largely affluent white instructors and students in academic institutions, which takes the music out of its cultural context. Many contemporary jazz educators such as Dr. Nelson Harrison complain that academic jazz performance programs in particular have engaged in reductionist formulas for mimicking the melodic, harmonic and rhythmic content of jazz without having any sense of the "life" of the music as it emanates from the culture, which produces it.⁹

Reductionism becomes possible, however, simply through the problematic role of European music notation in "representing" the sonic textures of jazz. The embrace of contingency, and a consequent emergent aesthetics, occurs in

opposition to the dominant tradition of what I call the calculus of western classical musical notation, with the primacy of the pre-determined map for musical performance under the control of the composer at the peak of the performative pyramid. Yet, jazz music has had recourse to the standards of western classical music notation since its inception. This “complicity” with the sign systems and cognitive schema of the dominant musical tradition occurs in part out of the pragmatic necessity for establishing what cognitive scientists call a “consensual realm” which will enable the initial conditions for contingent, spontaneously emergent performance.¹⁰ In other words, while Foucault points out in *The Archeology of Knowledge* that “the map is not the territory,” following Alfred Korzybski, music notation constitutes a limited but useful map of an interior world largely inaccessible to us. While this map reveals only a glimpse of cognitive processes involving sensory, proprioceptive, memory and conceptual/linguistic integration, that glimpse remains sufficient to make certain initial claims about the subjectivity of jazz performers, empirically observed, that will be elaborated in Part Two. This becomes especially significant when we glimpse, through the matrix of western classical music notation, musical processes of contingency and emergence that short-circuit the very assumptions which structure music notation to begin with.

We confront here as well the assumptions underpinning the efficacy of analogy formations across disciplines.¹¹ Reasons for both skepticism in, and enthusiasm for, trans-disciplinary investigations are manifest, but the pragmatic value for such analogy formations remains hard to ignore. That both physical processes and human thought (as translated into signals and then projected through an electronic medium) may obey analogous laws (expressed precisely through mathematics as in cybernetics or information theory), presents us with a most unnerving challenge to our conventional understanding of the status of human cognition and behavior as it finds itself in Nature.¹² This is one context for understanding Jacques Attali’s investigation into the relationship between noise and musical art from a political/economic perspective (and which addresses “Free Jazz” among other topics), as we also recall William R. Paulson’s often

neglected volume *The Noise of Culture*. Paulson's work remains particularly apt, since, by following the work of Michel Serres' explorations of noise in cybernetics, and Serres' fascination with the relationship between "noise" and "emergence," Paulson argues that all of literary aesthetics (and by implication, all artistic expression) emerges spontaneously from the noise/entropy of modern, technologically-driven cultural (and therefore informational) cacophony.¹³ Since the large literature on emergence or self-organization now spans the disciplines of physics, chemistry, biology, cybernetics, computer science, cognitive science to name a few, we may find such analogy formations extremely useful in understanding the complex nature of spontaneous creativity expressed through African-American classical music and find analogies between jazz performance and the behavior of emergent systems compelling.

For jazz musicians, ability often becomes defined by how a performer can maintain the presence of mind to cognize and then fulfill artistically a few of the musical promises that emerge in a single instant of the contingently complex sonic field of performance, as that field is distributed cognitively amongst the collective performers (and audience) sharing that moment in real time. For some new initiates into that sonic field, especially those accustomed to the ordered trajectories of classical musical expression, Jazz can seem not much different from noise. But as we examine those sonic field layers of order, as well as contingently emergent orderings, become readily apparent.¹⁴ By musical promises, I refer to the material content of music as both information and affect, which, with respect to melody, harmony and rhythm, obeys laws comparable (up to a point) with the rules governing grammar and syntax in linguistics, or with the rules of any code for that matter. (Here I defer the question of affect, defined as the range of embodied cognitive responses to internal and external stimuli—from the senses, to proprioceptive activity originating from the muscles, sinews and nerves, to the cognitive loops by which sensory and proprioceptive activity engages short and long-term memory, to the diversity of emotions that define our humanity—which will be addressed in Part Two).

I argue that the intuition of contingent and irreversible time of even mediocre jazz musicians (such as myself) becomes implicated in a profound argument with the history and philosophy of science, as well as social philosophy, over the origins and consequences of particular models of duration in physical and cognitive systems, and in intellectual and organizational systems. This argument, in turn, may have much to say about how creativity and invention can be construed as generally as possible (effacing the boundary between birds and humans as originators of creative expression through sound, for example, as Deleuze and Guattari seem to argue).¹⁵

In his “Jazz Improvisation: Music of the People to Come”, Eugene Holland begins with a crucial observation that poses the pertinent question that this two-part study seeks to address: “One of the truly remarkable things about Deleuze and Guattari’s treatment of music is the way they consider it in relation to nature, and as one of the most creative parts of nature” (2006:196). To what extent does the epistemological and ideological distinction between (irreversible) human and (reversible) in-human time also help to define the creative and destructive forces in human society?¹⁶ While much of my earlier work concerns how this drama plays out in other disciplines as well as the arts, here I wish to ask this question: Can we use the history and the micro-political aesthetics of jazz as a way to illustrate the play of those forces on a much broader canvas? By addressing in some detail jazz theories of chord-scale relationships, harmonic progressions and their harmonic rhythms, as well as percussive rhythms as the basis for improvisation, and the role of time in complexity theory (Part One); and then as the emergent nature of both embodied and distributed cognition within an individual jazz musician and amongst jazz performers (Part Two)--this study seeks to make good on a claim to confront what Deleuze and Guattari mean by Nature, and the place of human cognition and action within it. What I seek are symptoms, in the life of jazz performance, of a material, rather than metaphysical vitalism. Jazz and Emergence: together they may reveal something pragmatic about life itself as an emergent phenomenon.

Bergson, Poincaré, Prigogine and Deleuze: Calculus, Reversible Time and the Irreversibility of Becoming

Complexity theory embraces a broad range of disciplines that share an interest in the relationship between disorder and order—especially how order emerges from chaotic conditions. The emergence of order or the appearance of disorder highlights the problem of time's directional arrow, and this problem appears as a paradox for scientists in the act of observing. It makes visible the problem of cognition's role in epistemology, even in the so-called hard sciences. On the one hand, the mind intuits that events occur contingently in an irreversible way. On the other hand, in order for the mind to exert operational control over external physical events, it structures these events in a formal system, premised on geometry, which enables the mind to identify simple, immutable laws that are *reversible* with respect to time. These laws, in turn, enable the spatial representation of physical events, as exemplified by clock time and calculus.

Winner of the Nobel Prize in 1977, chemist and physicist Ilya Prigogine describes this paradox in terms of the philosophical categories "being" and "becoming," in a number of works written (one with a student of Gilles Deleuze, Isabelle Stengers) for a general audience. Prigogine defines "being" as the static representation of events as fundamentally reversible from a postulated frame transcendental to time and space, such as the way calculus computes movements of planets in a solar system, the trajectory of a cannon ball, the interaction of sub-atomic particles mapped on a Feynman diagram) into the future OR into the past. Being is the inhuman time of mass, energy and gravity. Prigogine defines "becoming" as the *irreversible* and contingent temporal experience irreducible to such a frame, with the possibility for spontaneous emergent orderings in turbulent fluids: such as Bénard cells that emerge as heat dissipates through a viscous fluid, or the appearance of vortices during the Belousov-Zhabotinski reaction; the production of complex chemicals from simpler ones (as in linear and non-linear catalysis), the spontaneous emergence of coherent states within metals and fluids close to the temperature of absolute zero (Kelvin); or the

uniting of unicellular organisms into aggregations (as in slime mold, or rhizomatic grasses). While most associate this with subjective, lived human time, Prigogine wants to claim objective reality for that time as a way to justify the integration of “dead” and “living” systems in nature: “the reversible time of being and “the irreversible time of becoming.”

This distinction between time-reversible and time-irreversible systems is important for two reasons: First, the distinction itself results from how scientists observe the natural world, so that it is implicated in *cognition*. In terms of the reversible perspective, all events are assumed to be reducible to a geometric map of causality that can be replicated precisely. From the irreversible perspective, the event is understood from the beginning as involved in so many randomly variable factors that an event’s exact mapping into the geometry of strict temporal causality (one way to define calculus) becomes impossible. Second, this distinction plays itself out institutionally in a social milieu, because an embrace of one or the other perspective determines decisions concerning the disciplinary procedures for knowing in physics or in cognitive science. In other words, this distinction has *ideological* weight, which affects how knowledge gets made in individual disciplines, including that of computer science and artificial intelligence, but which, I have argued, has implications for understanding the relationship between aesthetics and politics as well. I am proposing that this distinction performs powerful work in understanding the avant-garde posture generally, and the history of jazz as artistic expression of a minortarian culture, specifically.

Ilya Prigogine's crucial distinction between reversible and irreversible processes follows the critique of duration as time’s arrow accomplished by the process philosopher Henri Bergson (ninety years earlier). In *Time and Free Will* and *Matter and Memory*, Bergson critiques the experience of duration, looking to confront the ideological function of the calculus of Leibniz and Newton, as manifest in Immanuel Kant’s *a priori* or transcendental categories of time and space. For Kant, time and space exist in a relational grid that is superimposed

onto sensory data by the Imagination, which receives that data. Kant admits that this superimposition results from the need of the human mind to exert control over its environment. Yet, he attributes transcendental status to these categories, but never questions that status. Bergson's critique goes further in his magnum opus *Creative Evolution* to postulate a theory of cognitive freedom parallel to a model of evolution at work in physical systems. This theory has had enormous influence on painters, novelists, poets as well as philosophers, theologians, and scientists—especially the Nobel Laureate Ilya Prigogine.

Bergson's major source for the mathematical underpinnings to this line of inquiry can be traced in part to Henri Poincaré, his colleague at the Académie Française, whose work on the conventional or social nature of all geometrical constructions foregrounds the ways in which human beings have forgotten that they themselves are the authors of their own schema systems: the mind seems trapped by "a latent geometry, immanent in our idea of space, which is the main spring of our intellect and the cause of its working" (1911: 210). Bergson demonstrates that the domination of human lived experience by clock time and by calculus characterizes habitual human cognition since the birth of the Industrial Revolution. He argues that while this domination leads to greater control over the natural environment, it also closes off human cognition to always-already alternatives to the future moment, an awareness of the condition of contingency that enables not only the apprehension, but, as I will argue, the active deployment of bifurcations or "forks-in-the-road" in the history of physical as well as cultural systems.

Bergson defines the awareness capable of cognizing those alternative futures as *the virtual*, the quality of this awareness enabling the capacity to generate difference(s) as *creativity*, the enactment of that awareness as *intuition*. When Bergson writes that "all the operations of our intellect tend to geometry" (210), he offers us a profound understanding of the tactics required for mastery over the conditions of historical contingency, precisely because he also identifies its costs, cognitively and socially: "The more consciousness is intellectualized, the more

matter is spatialized" (189), and as soon as consciousness accepts condition where duration is spatialized, "its fate is sealed" (196). In other words, in cognition as well as in the reversible perspective of dynamics in physics, in social formations as well as in aesthetic expression, in order to determine outcomes in the future, operational control occurs only through the loss of the intuition of every moment's emergent potential. Bergson's theory of "creative evolution" as an iterative process involving *duré*, *memoire* and *élan vital*, helps underpin both the process movement in philosophy and the stream-of-consciousness movement in fiction and poetry exemplified by Marcel Proust, James Joyce, T.S. Eliot, Gertrude Stein and Virginia Woolf. It will serve us well, again, to initiate our grasp of how irreversible duration gives birth to contingent form through the mediation of memory, and how the calculus of music notation serves a limited but salutary role in jazz improvisation and composition, but only for those already capable of allowing irreversible duration to dominate cognition, from the "bottom--up."¹⁷

By reference to the terms creativity and intuition, and drawing by analogy on the language of irreversible systems in equilibrium thermodynamics, Bergson offers two crucial contributions to an understanding of evolving systems:

1. He formalizes the principle of contingency in physical systems, human subjectivity and cultural systems of signification; and, he demonstrates why contingent processes are "invisible" to human cognition as it currently functions, dominated as it is by clock time and calculus (30).
2. He defines the role that contingency may play in enabling order to emerge of its own accord – as the initial conditions for what he calls, in his master work, "creative evolution." He further argues that the formal processes of "creative evolution" may be observed in physical, cultural and even intellectual systems (like music) (22-3).

Seventy years before Ilya Prigogine's efforts to describe how irreversible thermodynamic processes far-from-equilibrium reveal order emerging out of

chaos, and the birth of trans-disciplinary self-aggregating hybrid formations called complexity studies and cognitive science, we find Bergson describing emergence or self-organization in a way that his mentor, the last renaissance mathematician Henri Poincaré, in his widely influential autobiographical work inquiring into the nature of creativity, "On Mathematical Discovery", finds compelling.

Bergson theorized his way to an irreversible, self-organizing model of physical (and human intellectual) systems from his sense of the irreducible subjective experience of irreversible time, largely due to the influence that the mathematician Henri Poincaré had on his understanding of how trapped Westerners had become by first buying into the transcendental model of mathematics inherited from Greek and Islamic cultures, and then surrendering to the dominance of clock time and calculus since the dawn of the Industrial Revolution. Furthermore, this relationship between the older and younger minds proves reversible. While Poincaré eventually rejects strenuously the extreme positions on conventionalism adopted by Bergson's student Le Roy, and even engages in debates with Le Roy, he finds much compelling about Bergson's philosophical work on contingent time and creativity.¹⁸ Poincaré moves from his conventionalist critique of the social rather than transcendental nature of geometrical models of physical processes, to a deepening appreciation of internally subjective processes of contingently emergent thought when he begins to think about how creativity manifests in the sciences and mathematics.¹⁹ This appreciation, in part due to the influence of his much younger colleague's work on intuition and "creative evolution", compels him to theorize about creativity as analogous to thermodynamic processes modeled in the N-dimensional geometry of phase space that he helped to invent. Poincaré's concept of ensembles, and his description of their behavior through N-Dimensional geometry, helps us to understand Deleuze's concepts of multiplicities and singularities, with *multiplicities* comparable to a cluster of points representing the range of possible futures for a system; and *singularities* now understood as vital moments of bifurcation leading to drastic change for a system.²⁰ Here we have an analogy as

significant to the history of science as that constructed by Shannon from Boltzmann's Order Principle (see Note 12).

Poincaré invents what becomes a widely-cited behaviorist model for creativity: Preparation—Incubation—Illumination—Verification. In this model he refers to *illumination* as the “Ah Ha!” stage of creativity when original insight occurs. He describes this moment by analogy to the classical philosopher Epicurus and his description of hooked atoms: “during a period of apparent repose, but of unconscious work, some of them are detached from the wall and set in motion. They plough through space in all directions ... like the gaseous molecules in the kinetic theory of gases” (1910: 61). Poincaré describes habitual thoughts in terms of entities anchored in an inertial frame represented by the spatial metaphor of walls to which thoughts are hooked. He describes liberated thoughts in terms of entropic processes (once those thoughts are unhooked). Thus, he characterizes the *materiality* of thought in terms of the physics of reversible and irreversible systems. More to the point, in this passage we find the first serious attempt by a scientist to suggest that the tendency toward disorder that we associate with the “endgame” of thermodynamic equilibrium might also give rise to processes by which order emerges out of chaos. Poincaré describes, autobiographically, a bifurcation, in effect (and in Deleuzian terms) a singularity in his thought processes moving toward the spontaneous emergence of his monumental insight. He speaks of his greatest discovery, which forged an alliance between two disparate fields, ensembles and N-dimensional geometry (an alliance, by the way, that eventually enables the representation of bifurcations in phase space!). As Poincaré states of this correspondence: “My comparison is very crude, but I cannot well see how I could explain my thought in any other way” (62).²¹

We may be able to see how easily it would be to slide these terms from reversible and irreversible systems over to the activity of an accomplished classical musician, who might be wedded to the striated space of musical notation, and therefore limited to the affective articulation of someone else's musical cognition, or to that of a jazz musician cognitively capable of generating coherent musical

thought spontaneously, in response to the smooth space of the contingent moment, merely guided by the map of music notation which, for that jazz performer, will not only never be the entire territory, but which can be altered irreversibly during the performance itself, much in the way that Poincaré describes the dissolving and the reforming of the very walls to which Epicurius's atoms had been hooked.²²

Profoundly influenced by both Poincaré and Bergson, Ilya Prigogine suggests that the spatialization of duration in our representation of physical processes--not only the calculus of Newton and Leibniz that Poincaré and Bergson critique, but also the reversible perspective within quantum mechanics, special and general relativity, quantum electro-dynamics and so forth--actually interferes with our ability to perceive contingent processes in the natural world. They interfere because contingency necessarily lies beyond the procedural limits of observation in a deterministic epistemology. These procedures depend upon the freezing of duration into an infinite series of still frames, like calculus, like the endless chain of still frames of a recorded event in cinema (prior to the juxtaposition of montage), like the spatialization of time and pitch in music notation, for the purposes of operational control.

While paying heed to the history of research on entropy in terms of the endgame of thermodynamic equilibrium, Prigogine seeks to *include* those processes that involve a movement toward greater orderliness and complexity. The result of his work in statistical mechanics to formalize non-equilibrium thermodynamics (or as the physicist Erwin Schrödinger coined it in *What Is Life?* twenty years earlier, *negentropy* [negative entropy]) can be called the first sophisticated theory of self-organization. The differences between the deterministic cast of Western classical music and the celebratory contingency of African-American classical music, finds a tentative meeting place in what I am calling the "calculus" of standard music notation. Furthermore the problems reconciling these two aural worlds bear a striking relationship to what Prigogine and Stengers call "The Clash" of the cultures of time. We will see that the connection between calculus

and music notation is a rich and important one, and it will be worthwhile to pursue that connection through what might be called the rhetoric of renaissance counterpoint. This rhetoric has its roots in both the classical tradition traced back to Aristotle's work on schemes, topoi and tropes, as well as in the recent discovery through calculus of a way to spatialize time into an infinite series of still points in order to exert control over physical processes in what we now call classical mechanics.

Calculus and Renaissance Contrapuntal Practices

In Renaissance counterpoint, the composer constructs painstakingly precise juxtapositions of voices according to strict rules governing acceptable melodic figures and harmonic textures involving acceptable and forbidden intervals between notes and strict rules for melodic shapes involving contrary (vertical) motion of distinct melodies, in terms of pitch intervals. While the rules governing those textures become relaxed and more sophisticated as we move through Bach, Beethoven and Mahler, to Stravinsky, Ives, Schoenberg and Bartok, in every case, these compositions are written with the experience of duration-- lived in a continuous flow during a performance--as frozen, in suspension, for the purposes of operational control over the behavior of the musical system represented by the composed score.

Here it will be useful to trace historically the precise relations between the tropes and topoi of classical rhetoric, and the compositional techniques employed in Renaissance counterpoint (Palestrina style), specifically, tactics associated with *formal invention*: 1) imitation at the octave; 2) imitation at the third, fourth, fifth, and sixth degrees of a scale; 3) imitation by diminution or elongation of the melodic line; 4) imitation by retrograde or inversion. Here the connection to jazz not only lies with the seeming autonomy of individual voices, but with the standardization of the Pythagorean modes which remain crucial to an understanding of the basic chord-scale vocabulary for improvisation: if such and such chord gets played, a certain scale becomes implied as a resource for melodic

invention in harmony with that chord. That these tactics have their origins not only in the four master tropes of Aristotle (as we will see in more detail), but in particular geometrical forms as well as in cognitive schema, makes the reference to classical rhetoric fruitful, but in a way hitherto unsuspected. After all, because of the properties of musical notation since the 17th Century as a kind of *calculus* (even temperament; bars, staves and time signatures), which in effect freezes time, the composer can have operational control over the duration as well as the melodic and harmonic textures of his work and the instruments that play it.

Recourse to traditional contrapuntal analysis to describe the circumstances of Be-Bop improvisation may seem fruitful at first, simply by suggesting a fixed structure comprised of autonomous parts. This enables us to think of distinct melodic lines, within contrapuntal textures, as models for understanding how it is possible for jazz melody to diverge, develop and then interweave unpredictably in the contingencies of collective performance. Yet, this is in contradistinction from what we understand about Jazz.

Be-Bop becomes significant in terms of this discussion because historically, this particular form of jazz enables for the first time fully independent and creative voices (and therefore musical roles in the performance) to every instrument performing: piano, bass, horns, drums. The calculations for juxtaposing independent voices over a given harmony, necessarily performed on blank music composition paper transcendental to the deterministic, spatialized vision of time represented by the music notation on that paper for the purposes of composing a two, three or four-part invention, suggest an altogether different kind of environment than the contingencies of jazz performance in the real time of lived duration. This view of music notation as a form of calculus involving the geometric spatialization of time, can be contrasted with the contingent, improvised feel of often hilarious juxtapositions of contrary “rhetorical” intent (from the music notation of the song being performed) during a Be-Bop jam session, and then the fixed recordings of those juxtapositions in recorded archives and transcripts, which provide the further basis for both composition

and more sophisticated improvisation, from one iteration to the next.²³

A way to reconcile the contingent “feel” of Be-Bop musical performance, with the geometrical and rhetorical resources dominating the textures of renaissance contrapuntal technique, is by recourse to the ways in which those contrapuntal techniques become appropriated by sophisticated jazz composers interested in the rigors of larger scale musical forms involving multiple structures while preserving the contingent, spontaneous and unpremeditated nature of jazz musical expression. It is this synthesis of contrapuntal composition with a jazz improvisational context that will point toward a peak achievement of collaborative invention, made possible by structures introduced in Be-Bop, and partially achieved by Ornette Coleman, John Coltrane and his bandmates McCoy Tyner and Pharaoh Sanders, Miles Davis and his band members Dave Holland, Jack DeJohnette and John Scofield, and the Art Ensemble of Chicago, especially Roscoe Mitchell and Lester Bowie, to name just a few masters of the avant-garde strains of jazz.²⁴ In this sense, the principles of jazz improvisation and composition of jazz Be-Bop musicians not only apply to the distributed, consensual circumstances for radically liberated “free” jazz performance, but in fact I will argue that the conceptual and intuitive conditions enabling “free jazz” evolve organically out of those Be-Bop innovations. But we should explore a little more deeply how top-down geometric superimpositions typical of classical physics are also applied to the control of musical textures in the earliest periods of western music notation, so we can understand by contrast just how profound the influence of jazz has been.

Classical Rhetoric and Renaissance Counterpoint

The classical rhetoric of Aristotle requires, through stasis theory, the assumption of a transcendental model of time that enables the rhetor to seek the *kairos* of the moment in order to contemplate the contending forces within the rhetorical situation from a privileged, transcendental stance outside of time and history. The relationship between transcendence and geometry, of course dates to

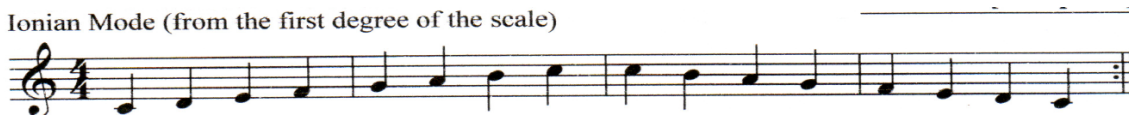
Pythagoras. Furthermore, the Four Master Tropes from Aristotle which have structured our understanding of figurative language are, in turn, structured themselves by geometrical relationships: metaphor and identity, with reference to congruent forms like isosceles triangles; metonymy, and contiguity with reference to the matrix of time and space (displacement in space or deferral in time); synecdoche, and part-whole relationships between forms, with reference to scales of order; irony, or relations emphasizing conceptual distance, and, geometrically through inversion, with reference to mirror symmetry.

Renaissance counterpoint pedagogy becomes organized by reference to these very same Four Master Tropes. The Renaissance musical world borrowed the term Invention from classical rhetoric to aid compositional practices in pursuing the range of expression circumscribed by the logic of the Pythagorean modes (these rhetorical allusions persist past Palestrina from the 17th Century to the most sophisticated contemporary classical techniques). The reason for this borrowing came from the capacity of standard music notation to freeze time, and to allow for the contemplation and design of increasingly complex and sophisticated aural textures enabled by the weaving of multiple distinct melodic voices constrained by harmonic conventions, which are derived from a notational vocabulary, and which have shape in the striated space of bars, staves and standard time signatures: I refer to standard pitch, timbre, rhythm, harmony--all of which come from the possibilities inherent in the sonic "flavors" of particular modes.²⁵

These aural "flavors" are determined by the location of half-steps in the scale. If one were to listen to one melodic shape beginning on the same note, such as "Do," or the first degree or note of the "C" scale, as that shape becomes altered by the shifting location of the half-steps between notes of the mode, we would notice a profound difference in the sound, timbre, and even the emotional "feel" of that melody. The Pythagorean modes are as follows:²⁶

1. *Ionian* (Do: the major scale), where the half steps occur between the 3 & 4 and 7 & 8 notes;

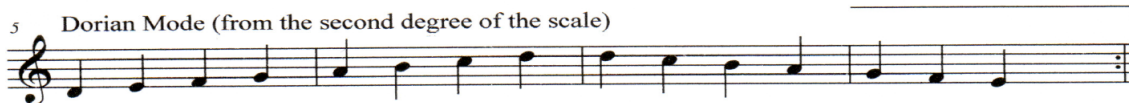
Ionian Mode (from the first degree of the scale)



Figs. 1-7 Pythagorean Modes in Renaissance contrapuntal textures.

2. *Dorian* (Re), where those half steps occur between the 2 & 3 and the 6 & 7 notes;

5 Dorian Mode (from the second degree of the scale)



3. *Phrygian* (Me), where half steps occur between 1 & 2 and 6 & 7 notes;

9 Phrygian Mode (from the third degree of the scale)



4. *Lydian* (Fa), where half steps occur between the 4 & 5 and 7 & 8 notes;

13 Lydian Mode (from the fourth degree of the scale)

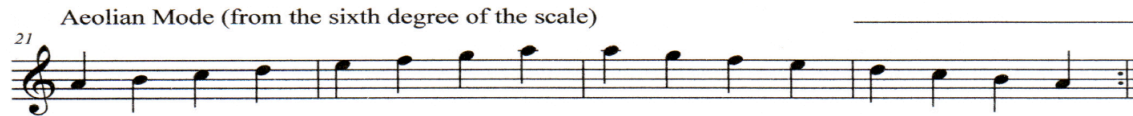


5. *Mixolydian* (So), where half steps occur between the 3 & 4 and 6 & 7 notes;

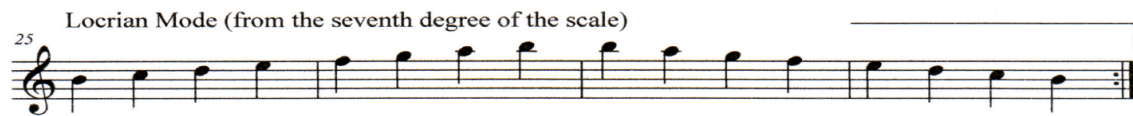
17 Mixolydian Mode (from the fifth degree of the scale)



6. *Aeolian* (La: the relative minor scale), where the half steps occur between the 2 & 3 and 5 & 6 notes;



7. *Locrian* (Ti), where the half steps occur between the 1 & 2 and 4 & 5 notes.



In each case, the displacement of the half step contributes to a profound displacement of the melodic feel or “flavor”, harmonic logic and emotional content. For example, the earlier the placement of a half step in the scale, the more emotionally dark the musical expression: Ionian (Do), Lydian (Fa), Mixolydian (So) modes, which have the initial half step between the 3rd and 4th notes or above, tend to brighten the affect; conversely, Dorian (Re), Phrygian (Me), Aeolian (La) and Locrian (Ti) modes, which have the initial half-step between the 2nd and 3rd, or below between the 1st and 2nd notes, tend to darken the affect. Rather than simply argue that the sound emerging out of the darkness of silence initiates, in the language of philosopher Brian Massumi “an incipient affective potential” (2002: 30), I suggest that scales with $\frac{1}{2}$ step intervals early in the scale move beyond to evoke a more somber emotive response as well, which, within a long western musical tradition, becomes a learned response by both performers and audience (but much more on this in Part Two).

The names of the seven modes apply as well to the 7 degrees of other scales, such as melodic minor. Even though the modes start from the same degree of the scale, because of the different formation of the scales, and especially because of the different location of those $\frac{1}{2}$ step intervals, the aural texture or flavor of melodic minor scales, and their function as melodic resources for the improviser, differ profoundly from modes derived from major scales. A Locrian mode (from the 7th degree) of a major scale sounds quite different from a Locrian mode derived from a Melodic Minor scale. I raise this to suggest the myriad possible

ways that musicians might produce very different aural textures, even given a structurally similar harmonic movement. To simplify my analysis, I will skip discussion of “symmetrical” forms such as chromatic, diminished and whole tone scales.

To anticipate my argument, the rules governing the “flavors” of sound apply as much to jazz as they do to Renaissance, Baroque, Classical, Romantic, Impressionist and more modern styles of western music. For, not only do these half-steps (usually but not always two to an octave scale) determine the “flavors” but also the forms of chordal colorings that can be built from each degree of any given mode or scale. Here it would be useful to remember that chords are built by playing at least three notes related to each other--in the simpler forms of chords--because chords are built from the root note upwards in 3rd intervals (or every other note from within the same scale or mode): C-E-G; D-F-A; E-G-B; F-A-C, and so forth. For extended harmonies, such as 7th Chords, which continue the 3rd intervallic jump: C-E-G-B; D-F-A-C, and so forth, until one may construct chords consisting of five, six or more independent “voices.” Furthermore, there are three essential harmonic targets framed by a ii-V-I progressions popular in Be-Bop, with the ii (and the IV) representing a *sub-dominant* harmonic center of gravity (perceived as a tentative resting place), a V (and the vii) representing the *dominant* harmonic center of gravity (often perceived as an unstable moment of dissonance), and the I (and the iii and vi) representing the strongest harmonic center of gravity, the *tonic* (perceived largely as “home”).

Jazz composer and theorist George Russell of New England Conservatory achieved, in his *Lydian Chromatic Concept*, a conceptual recasting of the “flavors” available to jazz musicians (and which in raw, un-theorized form had been available for classical musicians through Slonimsky's *Thesaurus* of musical scales), in order to account both for the more dense, and dissonant harmonies favored by jazz composers, and the range of melodic resources available to improvisers in response to any given chord.²⁷ In this landmark work of music theory, Russell dropped the standard major (Ionian) and relative minor (Aeolian)

modes which dominate classical scale theory, in favor of the peculiar sound of the Lydian, and then built a system of scale construction based on this one scale emphasizing the raised 4th degree of the scale, creating a half-step not between the 3rd and 4th notes, but the 4th and 5th notes. First designed in the 1940's, first published in the 1953, and widely disseminated in the early 1960's, at a time when experimentation with contrapuntal textures reflecting poly-rhythms and poly-tonality had reached saturation in the jazz world, this system is now the standard among training jazz performers. It proved not just influential but central for the compositional and improvisational practices of Miles Davis in his classic *Kind of Blue*, and John Coltrane's equally respected collection *Giant Steps*:

C Mixolydian derived from F Melodic Minor

[Composer]



Figs. 8-10 Jazz Modes – George Russell's Lydian Chromatic Concept with Melodic Minor Scales from the Mixolydian (Sol), Lydian (Fa) and Locrian (Ti) Positions played over a Dominant 7th Chord

Here we have a scale played over a C dominant 7 chord, whose melodic and implied harmonic resources derive from the F Melodic minor scale, with one altered note (b13) among otherwise “naturally” occurring upper harmonic resources for a dominant (Mixolydian) scale from the 5th degree of the expected F Major scale.²⁸

C Lydian Derived from G Melodic Minor

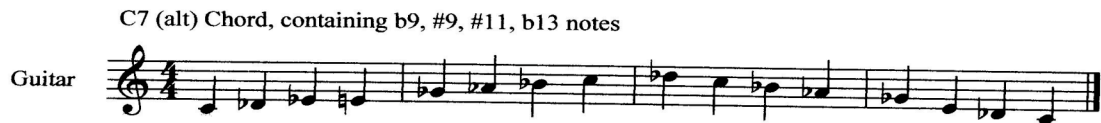
[Composer]



Here we have a scale played over a C dominant 7 chord, whose melodic and implied harmonic resources derive from the G Melodic Minor scale, with one altered (#11 or Lydian) note among otherwise naturally occurring harmonic resources for a sub-dominant (Lydian) scale, but which has a b7 note, and thus contributes to the melodic resources of dominant 7 chords.

C Locrian derived from Db Melodic Minor

McCoy Tyner first popularized this scale



Here we have a scale played over a C dominant 7 chord, whose melodic and implied harmonic resources derive from the G Melodic Minor scale, with one altered (#11 or Lydian) note among otherwise naturally occurring harmonic resources for a sub-dominant (Lydian) scale, but which has a b7 note, and thus contributes to the melodic resources of dominant 7 chords. Here, we have a scale played over a C dominant 7 chord, whose melodic and implied harmonic resources derive from the Db Melodic Minor scale, with no less than four altered notes (b9, #9, #11, b13) among the resources in this very dissonant (1/2 step away) tonal center away from the actual chord, and a minor third interval from the targeted tonal center (F).

This Lydian mode (containing a #11), derived from the Melodic Minor scale instead of a major scale, and available from either the 4th (Lydian) degree, or the

7th (Locrian) degree of the Melodic Minor scale, enables jazz improvisers and composers to use often a range of particularly pungent notes beyond the b7 (or Bb in a scale beginning with C). It will be useful here to recall basic harmony, where in a simple F (1 flat) Major scale, the notes E and Bb (3rd and b7 notes of a C7 chord), form a tritone, called an altered 4th interval, which is profoundly dissonant, and which cries out for resolution to a consonant 3rd interval F and A. This movement towards a dissonant tritone, and then away towards a consonant 3rd interval, constitutes the primary drama inherent in both classical music and earlier jazz music, particularly early (pre-Russell) Be-Bop, with the proliferation of ii-7 to V7 (in the key of F: G-7 [Dorian] to C7 [Mixolydian]) harmonic rhythms often juxtaposed without any final resolution to the I chord (C maj 7) until the end of the song.

Variations of this mode, this time a Mixolydian mode for an altered blues dominant C7b9#11b13 chord (in the key of F), has available within its harmony the notes of its antagonist chord a tritone interval or #4th degree away, which in this case would be a dominant Gb7 chord (in the key of B), which could resolve consonantly equally to the key of B as well as to the key of F. In this case, we have a single chord containing two dissonant tritones, with both chords' dissonant tritones wanting to resolve consonantly to a harmonious F major 7 chord. Here a polytonal texture becomes available WITHIN a single chord and a single, but now complex and ambiguous mode implying more than one tonal center. In other words, jazz musicians have the melodic resources, within these relatively simple ambiguous harmonic contexts, to imply one harmonic trajectory while pursuing a second one.

More on this will become clear, when we make analogies between bifurcations in complex systems, and target chords as the contingent harmonic “forks-in-the-road” —or what Deleuze would call “singularities”--available to both improvisers and composers, which are enabled by the complex ambiguities of these hybrid polytonal chords. Let’s simply refer to George Russell’s intention to propose a theory of harmonic “gravity” towards which particular modes feel

impelled to resolve (according to the laws of dissonance and consonance), and through which he proposes polytonal textures, or coexisting centers of gravity for the jazz improviser to choose, or not choose, to resolve or not to resolve to equilibrium, his line of melodic (and harmonic) flight. The relationship between these choices and the principles of harmonic gravity, as exemplified by tonic, subdominant and dominant targets within a tonality such as “C major,” seem to bear striking resemblance to moments of bifurcation and systemic attractor states (in the sense of equilibrium or non-equilibrium steady states, the references are to “equilibrium,” “periodic” and chaotic or “strange” attractors). We will come back to this point, of the need to conceptualize jazz harmonic cadences as equilibrium, periodic or strange attractors, when addressing the modeling of bifurcations in harmonic progressions and in physical systems modeled in phase space a form of N-dimensional geometry used specifically to model attractor states in both the physical and cognitive sciences.

But we must not forget the blues basis for much of this theorizing by jazz musicians. What we find are a celebration of contingency and ambiguity with respect to exploring the melodic resources available for the Dominant 7th chord, in the context of a I7, IV7, V7 progression of the 12 bar blues. Given the work of Be-Bop musicians, as well as the influence of the music theorist George Russell, jazz musicians were able to draw on a multitude of “flavors,” each implying either a distinct or ambiguous harmony and a range of resolutions beyond the standard movement from one dominant 7th chord to the next, and enabling a range of substitutions and re-harmonizations. So, even within a so-called simple 12 bar blues, every harmonic sequence poses numerous forks-in-the-road for improvisers to choose, or deliberately allow through ambiguous phrasing, multiple modes each with distinct flavor :

Scales for Improvising Over a Dominant C7 Chord

[Composer]

Guitar

1 C Major Pentatonic

5 C Major Pentatonic with added Blues Notes

9 C Minor Pentatonic (Derived from the C Relative Minor of Eb)

13 D Minor Pentatonic (from C) Over a C7 Chord

17 G Minor Pentatonic (from C) Over a C7 Chord

21 Eb Minor/F# Major Pentatonic Over a C7 Chord (Hits all Altered Chord notes but does not contain C)

25 C Mixolydian Mode (5th Degree of F Major Scale Corresponds to Dominant 7 Position)

29 C Dorian Mode (Derived from Bb Major) containing naturally occurring #9 and b7)

33 C Mixolydian derived from F Melodic Minor (with 9, #11, b13 altered notes)

37 C Locrian Derived from Db Melodic Minor (with b9, #9, #11, b13 altered notes)

Fig 11 An Incomplete List of Scales for Playing over any Blues Dominant 7th Chord

I have organized the scales found above so that they move from the most consonant aural textures inside the core harmony, to those most dissonant outside the core harmony – first with pentatonic scales, and then with modes.²⁹

The range of modal and pentatonic scales available to play coherently over a single Dominant 7th Chord is astonishing in the diversity of their implied harmonic structures, “flavors” and melodic potential, with improvisers quite consciously drawing on any of these resources as they search for novel materials through which they might express themselves to delight in novelty and provoke incipient affective activity, extending eventually to the full range of emotions, from each other and their audience. Given the role of surprise (from the perspective of the listener’s expectations for melodic coherence) in jazz aesthetics, one can hear how conceptually sophisticated improvisation can become over a single chord such as C7, how many implied harmonic progressions might be constructed, how many foreign-sounding target notes for a melodic line can find through these resources. When John Coltrane once said in response to a question of how he is able to improvise with such astonishing creativity and fluidity, he said “First learn everything you have to learn about the laws of music, and then forget everything and just play,” it was to these resources that he referred. This understanding provides as well a context for understanding how jazz musicians often comment that any note can be a correct note to play if you have a coherent way to approach, and leave that note in the shaping of a melody over a given chordal sequence.

With John Coltrane’s *A Love Supreme*, we have a body of work that exemplifies the bewildering range of materials, sounds, and conceptual structures that can be brought to bear with successful aesthetic results over the simplest harmonic contexts, using George Russell’s system. During his solos, Coltrane performs constant modulations through a series of harmonic targets or, what avant-garde architects Arakawa and Gins would call tentative “landing sites” (2002: 10) that become deployed sonically over a simple harmonic “home” through the use of centered and then increasingly distant pentatonic scales from that home. In

doing so, Coltrane seeks to widen what I call “the bandwidth” of melodic, harmonic and rhythmic relationships possible. He does so as he maintains the coherence of the melodic line (or narrative) through the aurally comfortable shapes (from the perspective of the audience especially) enabled by those very pentatonic scales, despite the juxtaposition of distant and dissonant tonal centers implied by this method. Many have experienced this recording as one of the most beautiful and spiritual performances in the history of jazz. I will wish to return to this point in Part Two of this study, as I explore the relationship between the embrace of polyphonic, polytonal, polyrhythmic textures, and the sense of the “spiritual,” which I will argue has a direct correlation with the emergence of distributed cognition of players and their auditors. But we have jumped ahead of ourselves, with respect to contrapuntal textures.

When Renaissance composers had the benefit of standard music notation to freeze time and to plan out complex contrapuntal textures in advance of the actual performance, then it was no wonder that they turned to rhetoric, and more specifically stasis theory (which after all is about the freezing of time for the purposes of establishing the circumstances for argument), the four master tropes, in the form of musical “figures,” (or “riffs” as jazz musicians call them). There is so much to say about this correspondence between classical rhetoric and Renaissance contrapuntal tactics that I will restrict this discussion just to the relationship between the Four Master Tropes and the four main forms of contrapuntal Invention. Remembering the importance of the placement of the half-steps in the mode for determining the “flavor” of a particular melody, let’s examine these four examples.³⁰

- 1) Metaphor refers to exact repetition of melodic form at the octave.
Geometrical Principle of Congruency of Forms

Renaissance Contrapuntal Invention:

[Composer]

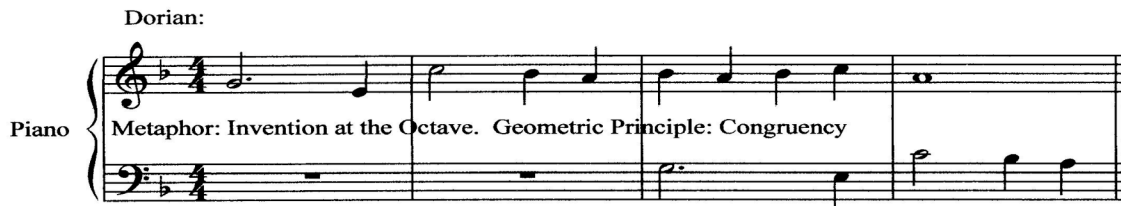


Fig. 12 Forms of Renaissance Contrapuntal Invention

In a strict invention sequence of a single melody, repeated after two bars in the second voice from exactly the same pitch, the “flavor” is identical or almost so, with only the distraction of the first voice beginning a new melodic figure or scheme, as well as the temporal difference in the initiation of the musical phrase, to keep the voices from seeming identical. Here, the spatialization of time and pitch enables us to refer to the geometric principle of congruency to refer to the identical shape of that melodic line. But other possible forms of melodic invention involving the creation of increasingly “independent” (non identical) secondary “voices” were possible as well.

- 2) Metonymy refers to repetition of the melodic form at the second, third, fifth, sixth or seventh degrees.

Geometrical Principle of Contiguity or Displacement in Time and Space

Renaissance Contrapuntal Invention

[Composer]

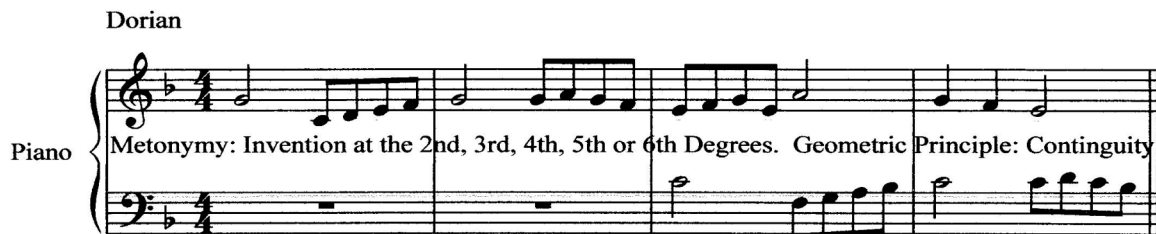


Fig. 13 Forms of Renaissance Contrapuntal Invention

Here a metonymic shift occurs in the location of the half-steps, which makes the melody repeated in the second voice noticeably distinct from the first voice. A second, distinct aural “flavor” occurs due to the displacement of those half-steps, that the listener would pick up on and notice as a reflection of a shift in harmonic orientation. More to the point, that difference in the location of those half-steps signals the “independence” of the second voice or melodic line from the first one. The juxtaposition of two flavors brings greater complexity to the contrapuntal texture.

- 3) Synecdoche refers to diminution or elongation of the melodic line by one-half or by double the duration of the notes.

Geometrical Principle of Scaling with Respect to Size

Renaissssance Contrapuntal Invention

[Composer]

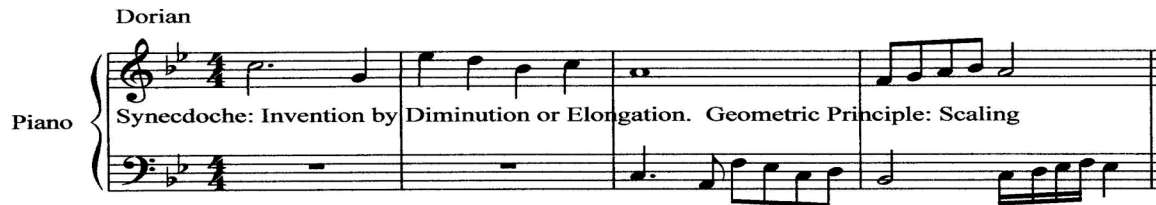


Fig. 14 Forms of Renaissance Contrapuntal Invention

Here we have a repetition of a melody, with a certain “flavor,” in a second voice at twice the speed of the first occurrence (which alters the aesthetic affect in a different way despite the repetition of melodic shape). The opposite was often employed: a melody introduced at the beginning of an invention might be repeated at twice the notational duration. These two tactics create poignant and reflective moments that fix the feel of a particular melody in the listener's mind and enable a whole array of variations for the elaboration of a musical topoi: a classical version of this can be found in the opening sequence of Beethoven's Fifth Symphony.

- 4) Irony might refer to invention by retrograde, a form of composition by which second, third voices are derived from the reversal of the original melodic line as if played backwards in time.

Geometrical Principle of Symmetrical Inversion

Renaissance Contrapuntal Invention

[Composer]

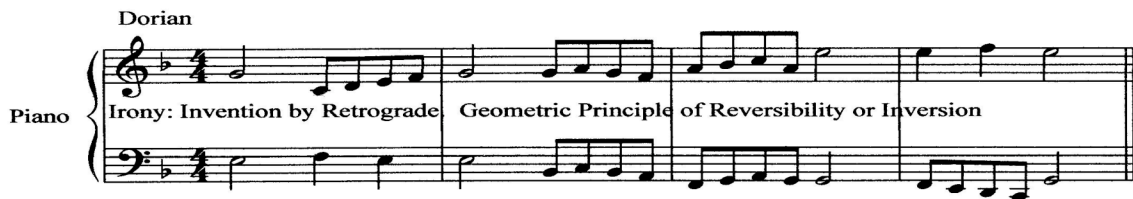


Fig. 15 Forms of Renaissance Contrapuntal Invention

In this last example of retrograde invention, we find the limits to the musical rules governing melodic invention for the purposes of contrapuntal texture. In this case we have the melody of the first voice written as the second voice, but with the durational and pitch orientation occurring backwards, by a strict an inverted movement (this is what the term “retrograde” means) as the location of the half-steps permit. In the first case, the point at which the two voices meet at the middle of the piece provides the opportunity to then recast the voices and their intervallic relationship according to the rules of contrapuntal composition, so to accommodate the already existing voice in a case of forced symmetry. We have here a direct analogy the principles of reversible time, as articulated by Prigogine and Stengers, played out by the rules of calculus which can calculate the motion of the planets, or of the periodic arrival of Hayley’s Comet, forwards or backwards in time. The musical utility, both in terms of the aesthetic creativity of the composer, and aesthetic affect on the audience, as in strict 12 tone composition (now with respect to pitch defined by even-temperament rather than duration defined by regulated meter—as in 4/4 time), finds itself extremely limited by the arbitrariness of the method.

It will be worth it to reflect on the limits to this analogy between classical rhetoric Martin E. Rosenberg. “Jazz and Emergence (Part One).” *Inflexions* 4, “Transversal Fields of Experience” (December 2010). 183-277. www.inflexions.org 215

and renaissance counterpoint as a model for understanding jazz improvisation according to rules, not of geometry and fixed forms, but of contingency and self-organization. But I think that this approach might reveal something much more to the point concerning the spontaneity of invention, and the necessity for recasting the melodic, harmonic and rhythmic forms by which those spontaneous moments allow new thoughts to emerge, new formations of thinking that have profound social and political implications. In other words, we must understand how jazz as an aesthetic bears much scrutiny as a manifestation of the logic of avant-garde resistance, as the avant-garde has come to be understood. Thus, the value of a detour to a conceptual artist, with intimate ties to the avant-garde movements of mid-century, seeking initially to dethrone the tyranny of spatialized time and those deterministic rules governing the production of music: John Cage.

From Calculus to Cage

We can recognize the same emphasis on the representation of mechanism and the threat of contingency in John Cage's prepared piano pieces, as well as in his performances of a musical chess game featuring Marcel Duchamp as one of the players, the first occurring in the 1950's, the last in 1968, the year of Duchamp's death and the discovery of his masterpiece *Étant Donnés (Being Given)*, 1968).³¹ Cage's prepared-piano pieces (1938-1951, including "Music for Marcel Duchamp", 1947),³² involves piano music composed according to conventional modernist techniques (incorporating a variety of modern compositional methods, such as the 20th Century tone-row innovations of Schönberg, and the minimalist structures of Erik Satie). Then the piano would become altered by placing thumb-tacks, rubber bands, leather, nails and other found objects so to affect the strings within the piano for an eccentrically-damping or even startlingly-percussive effect. The overall impression of such works is a synthesis of the subtlety of a Javanese Gamelan with the dramatic equivalence of the theater of the absurd. Written as an accompaniment for Marcel Duchamp's segment which focused on his ocular experiments, in Hans Richter's surrealist

film *Dreams That Money Can Buy*, Cage employs weather stripping to mute tones, while he foregrounds the role of silence to disrupt the melody, in what Cage critic James Pritchett calls “the summit of this style of prepared piano composition” (Pritchett, 26-27).

As a result, the compositional method involves a tone-row sequence reminiscent of Schoenberg, but with one crucial exception. Instead of the fixed pitches of a relativized chromatic half-tone scale, Cage constructs sequential variations upon themes generated out of notes of indeterminate pitch due to the “interference” of competing sound waves (a term analogous to “noise” in information theory) created through the random insertion of thumb tacks and rubber bands among the piano strings. The emphasis for the composer, naturally, becomes the exploration of contingent percussive and rhythmic expression, and more to the point, the exploration of contingent, un-metered duration within the mind of the listener having certain expectations for orderly musical expression according to long-established rules understood or intuitively internalized through cultural conditioning by that listener.

The focus for these alterations lies with the eccentricity of effect, as those aural disruptions contend with both the accomplished skill of the pianist performing on the most mechanized musical instrument in the Western tradition, and the expectations for orderly sound that constitutes the affective response of the audience. A Duchamp-influenced project to disrupt the underlying assumptions of the aesthetic game between artist and onlooker, the result effaces the conceptual boundary between noise and music, between the contingency of aural entropy (often enabled by deliberate musical silence), and the trajectories of mirroring melodic lines propelled by the assumed laws of musical logic governing the dialectical relationship between dissonance and consonance.

While the creative obligation comprising the contract between artist as composer/performer and audience becomes disturbed, something remarkable happens. Given the expectations for order, the audience's exposure to

eccentricity gets translated as noise; one merely recalls the hostile receptions of a number of joint productions Cage made with the choreographer Merce Cunningham.³³ Yet, given the socially acceptable position of the avant-garde artist to disturb expectations, the tension between sound as recognizable aesthetic order and sound as contingency and confusion becomes dissolved.

The noise becomes acceptable, integrates itself into the parameters of expectation, and becomes music—that is, sound with aesthetic potential. This leads to the obligation on the part of the artist to depart from habitual rituals, until departure itself becomes habit. Duchamp made his career on the paradox of departing from obligatory forms of expression while at the same time collapsing the trajectory implied by that departure: in Duchamp, we have the deconstruction of the “new” as a cultural obligation. We have here an incipient critique of “free jazz,” as well, which, by alienating its mass audience through the embrace of an increasingly hermetic complexity, becomes potentially the “self-creating, self-destroying artifact” (a phrase Calvin Thompkins employs to describe a dada piece by the artist Jean Tinguely). It is from this perspective that we should approach the more regressive and minimal structures of creative obligation represented by the game of chess, particularly at endgame, in the works of Duchamp, Beckett and Cage. As I have written elsewhere, the game of chess embodies the epistemological and ideological implications and consequences of the reversible perspective of physics, and underpins conceptually John Cage’s attempts to short-circuit the habitual relationship (and thus the established communications channel) between composer and audience by deconstructing the audience’s expectations for the experience of musical pitch and duration.

John Cage not only played chess, but also became serious enough to have studied chess with Marcel Duchamp, even to the point of reading treatises. There is no direct evidence of Cage reading Duchamp's own work on endgame confrontations (*Opposition et les cases conjuguées sont reconciliées*, 1934), which offers a model of chess at endgame as the terminal attractor state of thermodynamic

equilibrium, or systems-death of the game itself, which both players seek to avoid as long as possible (and it is in fact the “creative obligation” of those players to use the creative ingenuity of their minds to find patterns of avoidance). Yet circumstantial evidence abounds suggesting that he had (see note 22). For example, in the last "chess performance" which included Teeny Duchamp playing chess (Toronto, 1968) within a Cage “event”, each square on the board contained a photoelectric cell, wired to trigger separate tape machines when a chess piece came in contact with the square. Upon the contingent stimulus of deliberated yet unpredictable moves, those tapes would play random selections of compositions by David Tudor, Lowell Cross and other classical composers, as well as by Cage himself. Here determinacy and chance play themselves out non-dialectically on a chessboard dominated by tensions between reversible and irreversible time, with respect to the composer as the aesthetically deterministic “auteur”, and the contingencies of the movements of chess pieces in real time which trigger randomly iterative performances of those determined compositions scripted according to contingent and statistically modeled compositional practices.³⁴

In this work, the precise mechanical movements of chess pieces, though contingently determined by the tactical whims of the players Marcel and Teeny, become undermined by the indeterminate ways in which the machine would be made to trigger musical selections that, while “composed”, were themselves governed by principles of contingency. And yet, the entire "event" was directed, in fact "determined" with some precision by Cage himself. This underscores the play between the contingent eccentricity associated with Duchamp’s concept of *exposure* (analogous to Deleuzean difference), and the dynamic, iterative oppositions associated with Duchamp’s concept of *delay* (analogous to Deleuzean repetition), as this play is integrated into the determined oppositions of formally composed musical sequences at the mercy of the expectations and moods of the audience forced to sit through the meta-musical motives/motifs of the event itself.³⁵

But this is a far cry from the processes by which these same principles of contingency might become applied by analogy to the spontaneous improvisations of Be-Bop musicians. Be-Bop musicians, in effect, deviate from the calculus of music notation in the form of the "lead sheet" containing the chord progressions and melody of an old standard like *How High the Moon*. This deviation becomes the crucial initial condition for the composing processes out of which new, more complex compositional forms like the jazz standard *Ornithology* might emerge, itself then preserved in the calculus of music notation. Here we find the relevancy of research by Charles Stivale, Ronald Bogue and Eugene Holland in particular, who address Gilles Deleuze and Félix Guattari's concepts of "the refrain," filtered as it becomes through Deleuze's earlier work on "difference" and "repetition," as central to an understanding of musical form as a form of repetition. We may think of repetition in terms of what scientists studying complexity call "iterative processes" which may, to a greater or lesser extent, enable differences to emerge through processes of repetition capable of evolving towards greater musical order and complexity. This is the prime difference between the "swing" music of the 1930's and Be-Bop: with swing repetition or iteration enables a framework for spontaneity; with Be-Bop, repetition or iteration becomes embodied in a process of creative evolution which enables differences to emerge that enable greater complexity and sophistication of emergent form. I wish here to up the ante on those discussions by bringing to bear details from both music theory and theories of complexity to fully unpack the significance of Deleuze and Guattari's meditations on the nature of creativity in music as de-territorialized "becoming."

What we will find, is that what becomes de-territorialized from the perspective of aesthetics also becomes re-territorialized from the perspective of the micro-politics of the minortarian subject position—of jazz musicians seeking to preserve the integrity from an aesthetic standpoint, and to maintain control from a political economic standpoint (as Jacques Attali, and Gene Holland point out), an art form originating from a minortarian cultural milieu. Here we will find much resonance amongst Deleuze's discussion of the territorialized vocalizations

of birds, the de-territorializations of Messaien's compositions inspired by birds;³⁶ the improvisations and compositions (such as *Ornithology*) by The Bird--Charlie Parker, the collective cacophony of Bird's progeny Ornette Coleman, the layered juxtaposition of seemingly competing harmonic rhythms as well as percussive rhythms, even compositionally in a work like Miles Davis's "It's About That Time" from his pioneering jazz fusion album *In A Silent Way*, and the Sufi-inspired distributed musical event encapsulating poly-tonal and poly-rhythmic counterpoint entitled "Conference of the Birds" by Dave Holland (from the album with the same name), a celebration of the spiritual implications of collective improvisation as a emergent, distributed cognitive event.

Be-Bop I - *Durée*, Memory, Élan Vital, and the Creative Evolution of *Ornithology*

Let us anchor our discussion here with music history, for we will find the actual practices of Be-Bop musicians, as they move from spontaneous improvisation to composition, map precisely onto Bergson's theory of creative evolution. In this case, we use a rather simple harmonic and a complex melodic reworking from a given tune (*How High The Moon*) to a new composition (*Ornithology*). The tune *Ornithology* emerged from a variety of sources. The opening figure can be traced to Parker's solo performance on the tune *Jumpin' Blues* with the Kansas City McShann Orchestra on a few sides recorded July 2 prior to the August 1942 ban on recording (Russell 128; Owens 19-20; 40-41). The bulk of the song is a rewritten and re-harmonized version of the classic standard *How High the Moon* (you can listen to Ella Fitzgerald's later recording of that standard, how she adds the "head" or opening melody from *Ornithology* to the many paraphrases in her own improvised "scatting"). First recorded for Dial Records, March 1946, with Miles Davis on trumpet, Lucky Thompson tenor, Dodo Marmarosa piano, Arv Garrison guitar, Vic McMillan bass, and Roy Porter drums, it was released as a single (Dial 1002) with Dizzy Gillespie's composition *A Night in Tunisia* on the flip or "B" side.³⁷

Top:
How High the Moon
 by Morgan Lewis

The Calculus of Music
Notation and the
Contingencies of Emergent
Form in Be Bop Compositional
Practices

Bottom:
Ornithology
 By Charlie Parker
 (Benny Golson et. al.)

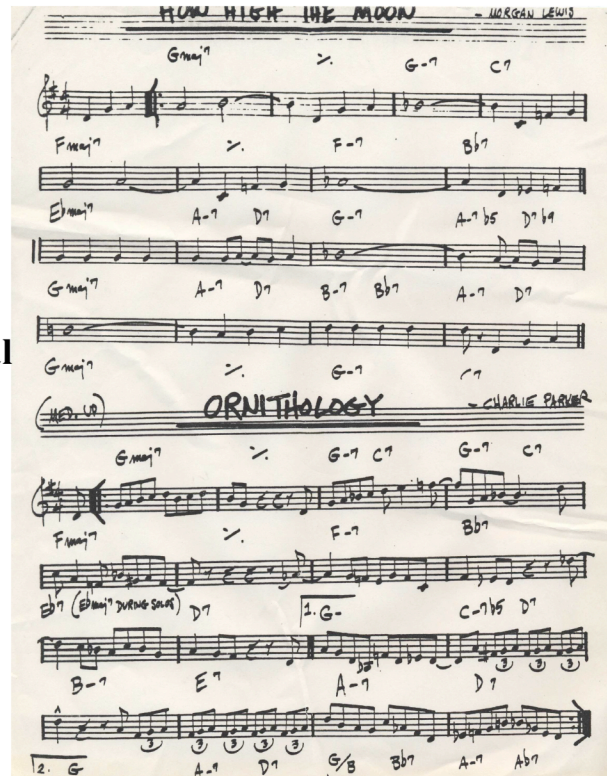


Fig. 16 *How High the Moon* becomes *Ornithology*.

The process of re-harmonization in Be-Bop composition must be discussed in terms of the contingent moment of improvisation, when a musician hears or plays a complex chord, such as the one described earlier, the second of George Russell's scales: a mixolydian mode that is married to an altered dominant 7th b9 #11 blues chord, which is comprised of two distinct and dissonant tritones resolving to the same chord, but capable of resolving to a number of other chords implying other tonalities as well. In other words, when a jazz musician arrives at such a chord, he is at a *bifurcation* point, musical *fork-in-the-road* with a minimum of four distinct harmonies as possible avenues to imply through his melodic line, implications which may be followed or not after the duration of this chord is over. If we can think of music in terms of cause-and-effect (by recourse to the precise analogy of calculus), the tritone dissonance of B and F within the V7 chord of G7, must resolve to C and E of the I chord of C within the Key of C. If there are **two** tritones, then we have a moment of ambiguity in which the music

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is actually compelled equally in two distinct harmonic directions. In this sense one can say by analogy that while the term "bifurcation point" which is applied to turbulent physical systems poised on the threshold of resolution either toward disorder or toward greater orderliness, these musical moments highlight a moment when expectation and surprise are juxtaposed, implying a complex system poised at a bifurcation point between two attractor states.³⁸ While neither of the two harmonic directions is intrinsically more or less ordered than the other, it is the *fact* of the condition of instability and bifurcation, embedded in the new harmonic resources implied by altered chords, that indicates that this innovation constitutes a major evolution in the sophistication of jazz improvisation and composition.³⁹

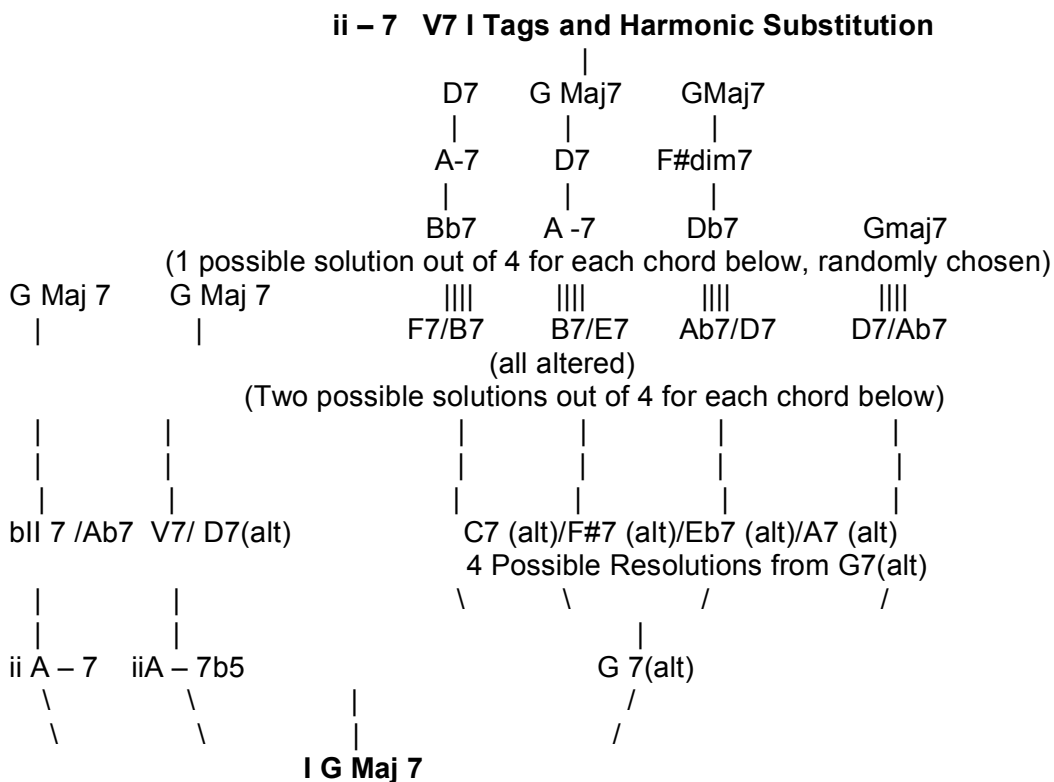


Fig. 17 The Double Tritone as Musical Bifurcation Point.

These are the just some of the deviations that jazz composers since Charlie Parker look for when they listen to the tape of a performance, transcribe that performance, and take note of the harmonic and rhythmic as well as melodic Martin E. Rosenberg. "Jazz and Emergence (Part One)." *Inflexions* 4, "Transversal Fields of Experience" (December 2010). 183-277. www.inflexions.org

riches that these moments imply. If we examine briefly this graphic indicating the range of possible resolutions given the initial ambiguous harmony, we can see the range by which iterations representing the journey through one repetition of a verse, a chorus (a refrain), can generate a range of harmonic deviations or differences available contingently to a creative improviser and composer. Notice as well that we will not, given the space of this essay, address false harmonic cadences which deliberately ignore standard rules for harmonic resolution (with respect to dissonance and consonance) and culminate in a harmonic target that would be as much a surprise to the listener as the most eccentric melodic note.

Beginning with the Tonic (I) G Major 7 chord, the two sequences (moving from the bottom to the top of the page) on the left offer standard resolutions from subdominant (ii-7), to dominant (V7) to tonic (I). The difference is in the dominance chord: an Ab7 (bII7) instead of the D7 (V7). This distinction is easily understood by pointing out that both Ab7 and D7 share the same dissonant tritone (C, Gb/F#), which yearns according to musical logic to resolve to the consonance of G Maj 7 (B, G; or B with the remaining F# as the leading tone or 7th degree implying the tonal center), and so serve as substitutions for each other. So we can call this harmonic sequence a simple fork-in-the-road or bifurcation point in the history of that harmonic progression. The complex trajectories to the right of these two are more difficult to understand. Here the harmonic motion converts the G Maj 7 to a dominant G7, but here with altered extensions of the harmony so that we find two tritones in this G7 chord instead of one. With two tritones we have a possible resolution to a minimum of four distinct harmonic targets: C7 (alt); F#7 (alt); Eb7(alt) and A7 (alt). We could substitute easily a C-7, F#-7, Eb-7 or A-7 as a subdominant target, or C maj7, F# Maj 7, Eb Maj 7 or A Maj 7 as a tonic target. With each following target chord, the number of possible resolutions proliferate, so that, when looking from the vantage point of the original G Maj7 chord, what we see is a cascade of forks in the road leading to a bewildering array of possible harmonic trajectories. In fact, one rarely comes across a continuous proliferation of bifurcations strictly from cascading dominant chords because of how completely alien that line of harmonic flight

would be to the “logic” and thus the sonic “world” of then existing song form (except in certain special cases like the Circle 4 patterns of a bridge or “B” section of a song). Where we do find such cascading bifurcations are in free jazz performances where the improvisers liberate themselves from the “map” of a song form. Furthermore, if we take into account that not only can one chord substitute for another, but the range of modes and scales “in tune” with one chord (The range of those scales and modes varies widely from being comfortably within the harmonic center or attractor state of that chord to quite distant and “outside” that state, depending upon the genre of music being performed.), can be used as melodic resources for the second. We find in effect, endless melodic (and implied harmonic) riches that unfold for the cognitively aware and trained jazz musician from one moment to the next, over any single chord in a harmonic progression.

Here we have bifurcation points or “forks-in-the-road” leading to a range of implied or explicit differences or deviations from the given map in the calculus of music notation of the lead sheet: implied if the jazz improviser seeks to merely “suggest” the foreign harmonic deviation for the purposes of creative melodic de-territorialization; explicit if the jazz improviser wishes to spontaneously re-harmonize the song, to re-territorialize the calculus of music notation to his own harmonic and melodic, and, eventually, compositional purposes, by departing from the song structure entirely. We can compare this again by analogy, to Poincaré’s account (see above) in his dream of dissolving the walls themselves as well as the unmooring of atoms attached by hooks to those walls. How an ensemble of jazz musicians can spontaneously make these decisions in a collective and consensual way, in the contingencies of real-time performance, constitutes one of the topics for Part Two of this essay.

Now it is important to remember that, as far as anyone knows, Charlie Parker did very little writing down in music notation on his own, and some think, for example, that Benny Golson (composer of the standard “I Remember Clifford” and many others) actually wrote the “head” to “Ornithology”--though that

statement is apocryphal.⁴⁰ The fact of the *distributed* nature of the composing process, which occurs through several iterations among several hands, actually strengthens the case that I am trying to make here, but more on that in Part Two. This does *not* mean that Parker was illiterate: far from it. There are numerous recountings of Parker reading through a complex arrangement *once*, not looking at it again for days, and then playing it flawlessly from memory. By all accounts he had a photographic memory, and it remains unfortunate that many still hold that the jazz aesthetic must be somehow “natural” and primitive. While I will finesse the term “natural” here for productive purposes by suggesting that there is an alliance or a common linkage between the minortarian state and an embrace of irreversible duration, I find its use suggests the continual underestimating the intellectual prowess of jazz musicians (as both performers and composers fully cognizant of Western classical music) as part of a history of the patronizing of African-American culture.

Charlie Parker could, in effect, engage the composing process as a form of “creative evolution” involving prior existence of the calculus of music notation, the contingencies of the performance with other musicians, propelled by the creative energies of his own “vital impetus,” the use of technology (tape recording) as a form of memory, leading to a cycle of further performance and composition as the preservation in memory of that performance through the calculus of music notation once again. The fact that he could accomplish this within his head and with his ability to sense what was in the mind of the other players, does not invalidate the model I am suggesting. But, for jazz musicians, this process hardly ever took place in isolation from each other. As I will address in Part Two of this essay, both from the perspective of improvisation and composition, jazz becomes not only an embodied but also a distributed act of aesthetic cognition.

For example, it was the work of Bird worshiper Dean Benedetti, in tape recording endless iterations of Charlie Parker solos, and only Charlie Parker solos, and lending the tapes out to other musicians, that provided the model not

only for students of improvisation, but for jazz improvisers wishing to become composers (Russell 1973, 181-3). So here is the "chorus" for my argument, precisely in the Bergsonian terms underscoring his vitalist model of creative evolution, but here recasting it in materialist terms applying to both physical and cognitive domains. The preserved *memory* enabled by the tape recording of the *contingent* moment, recast in the spatialized time of standard music notation through transcription, enables contingency and memory to become an integral part of the composing and arranging process motivated by the *vital impetus* of the musicians' creativity. Thus, the musical bifurcation point enabled by the ambiguous harmonic resources of the jazz piano player as well as the introduced altered notes of the soloist, makes all future formal innovations in jazz possible, including and especially the fully complex and distributed free jazz events of Ornette Coleman and those followers of the Free Jazz Movement since.

So let us recast this notion of a "fork in the road" enabled by the contingencies of improvisation, in terms of how we understand Be-Bop composition as a self-organizing aesthetic. We may illustrate the usefulness of the concept of self-organization for understanding the rhetorical concept of Invention, by connecting this concept to the process of jazz composition common since Be-Bop. An "ensemble" or collective of jazz musicians begin by performing with the preserved memory of an earlier performance in the form of sheet music of a particular "standard" or original composition, and then improvising in such a way that the structures of melody, harmony and rhythm are all contingent at any point during the performance of that song. That contingency, in turn, depends upon the lively creativity and internal intellectual mastery of music theory by the musicians. Often those musicians will record the performance, note the changes in melody, harmony and rhythm, and then, individually or collectively compose a new song that will become the vehicle for further improvisations also contingent upon the mastery and spontaneity of the performing musician(s) at the next improvisatory event.

A jazz musician's improvisations on a standard such as "How High the Moon,"

recorded with a tape recorder in order to serve as the basis for further adaptations, becomes transcribed, thus committing these improvisations to a collective memory, which then becomes grounds for composing a new song in standard notation. As with "Ornithology" this new song then becomes the vehicle for further improvisations of greater sophistication and complexity. These improvisations, in turn, may or may not become preserved in another, even more advanced jazz composition.

Just as "How High the Moon" became "Ornithology," many other standards became the initial conditions for new compositions. For example, the song "I've Got Rhythm" became at least two dozen distinct, classic jazz Be-Bop tunes, including "Anthropology," "Chasing the Bird," "Cottontail," "Dizzy Atmosphere," "Lester Leaps In," "Meet the Flintstones," "Moose the Mooch," "Oleo," "An Oscar For Treadwell," "Salt Peanuts," "Red Cross," and "Shaw 'Nuff." And, there were tunes written on tunes, and then again written on tunes, with each iteration evolving into more complex melodic, harmonic and rhythmic materials, each more sophisticated than the original, as in John Coltrane's "Fifth House," derived from Tadd Demeron's "Hot House," which originated from Cole Porter's "What is this Thing Called Love." Even complex tunes like Parker's "Confirmation" became the basis for the even more sophisticated "Juicy Lucy" by Horace Silver, and "Striver's Row" by Sonny Rollins; while John Coltrane's monumentally difficult "Giant Steps" became "Dear John" by Freddie Hubbard.

Let's reflect on what those evolving thought structures might look like, by modeling the complex processes of jazz contrapuntal textures in the work of Ornette Coleman, if they become so transformed that the initial conditions for performance insists, from the onset of the performance, that every moment constitutes a sonic field of all possibilities.

Be-Bop II--From Be-Bop to Ornette Coleman: Phase Space, Bifurcations, and the Distributed Grounds for Nomadic Melody, Harmony and Rhythm.

In order to understand bifurcations, we need to understand how the N-dimensional geometrical model “phase space” revolutionized our understanding of complex processes. Phase space diagrams are visual models designed to solve the problem of representing complex systems where the possible origins and futures are too numerous to map through traditional methods. Originating in the work of Poincaré, The Gibbs–Einstein ensemble theory offers a form of geometry modeling points on a matrix of space and time corresponding to a range of contingently possible futures for the history of a system, from one moment to the next.

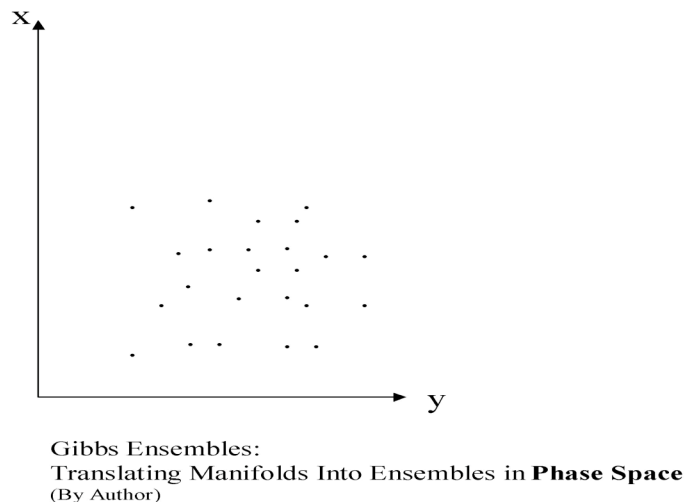
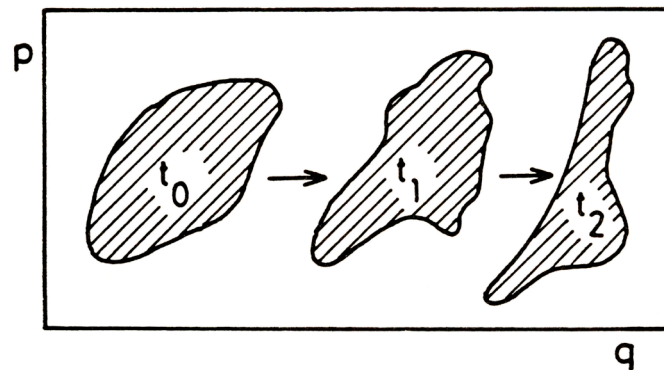


Fig. 18 A Cloud of Possible Futures emerges out of an event (marked by the intersection of x and y/time and space)

Phase space diagrams map the accumulation of a set of points representing a range of locations that can be defined as vicinities that are irreducible to the matrix of the horizontal of space and the vertical of time, with each point/vicinity representing one future for the entire system. This irreducible “set of points” describes the concept of “ensembles” in phase space, which

becomes deployed to describe the large-scale behavior of complex systems *incapable* of being mapped in a precisely deterministic ways--because of the inherent role that contingency plays in the behavior of these systems. When there is a range of possible outcomes in time for the behavior of a system, there is a greater need to represent graphically that range, rather than the actual location and trajectory of every individual element contained by the system itself.

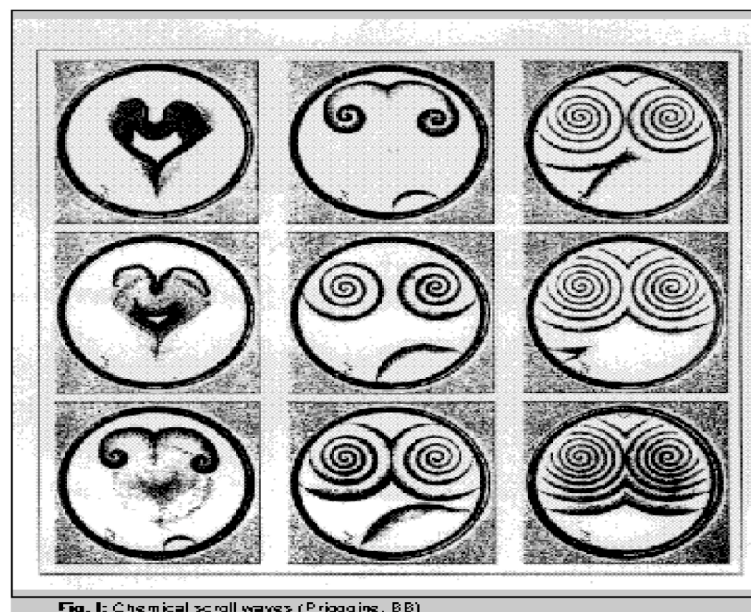


Pg. 249, Figure 28, **OOO: Time Evolution in Phase Space of a Gaseous Volume**

Fig. 19 The range of futures for a complex system (such as a gas) over time.

Calculus cannot accomplish this task, simply because it must assume a cone of causality by which *this* prior event causes *that* successive event. Phase space accounts for a range of possible causes and a range of possible effects, allowing for identifying a statistical probability that this will cause that, while recognizing the impossibility of identifying any such event in the future with absolute certainty. Here we have three shaded shapes representing a system at different points in time, with the content of each shape corresponding to a cloud of possible future conditions for that system. Each dot within those shaded shapes represents one possible outcome out of a myriad of outcomes for the entire system.

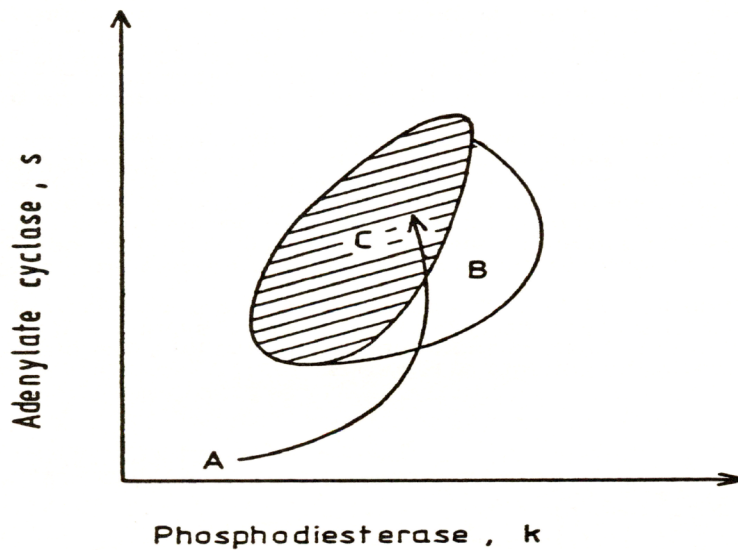
The explanatory power of phase space diagrams has been nothing less than spectacular. It can map the trajectories of pendulums, indicating the range of deviation in the rhythmic repetition of the swing as it becomes affected by gravity. It can map the contrast between pressure and volume in a heat engine, thus indicating the source of power resulting from that contrast, as that power, enabled by irreversible thermodynamic processes, becomes harnessed to impel the reversible movements of an internal combustion engine. It can map as well the evolution in phase space of a cell undergoing Brownian motion, indicating the completely random behavior of a system approaching thermodynamic equilibrium. As an example of a self-organizing, emergent process, the Bromide-Ion concentration in the Belosouv-Zabotinski reaction demonstrates how processes beginning at random in the heat of turbulence may be capable of moving in the direction of greater orderliness, here with actual images of the vortex-like swirls of the chemicals that emerge spontaneously during the chemical reaction “far-from-equilibrium.”



Pg 200, **From Being to Becoming: Chemical Scroll Waves Emerging From the Belousov-Zhabotinski Reaction**

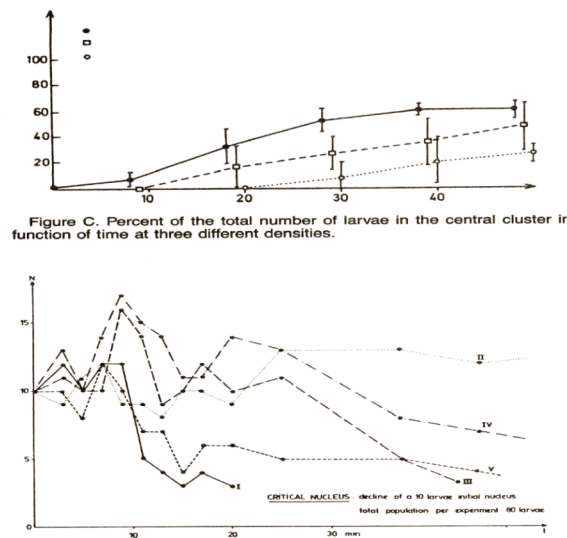
Fig. 20 Chemical Scroll Waves Emerging spontaneously from Belousov-Zhabotinski Reaction.
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Phase space can also offer models of large scale processes in biology and ecology, such as the seemingly random but coherent behavior of entities through time due to a range of variables. The range of possible applications of phase space diagrams to the range of behaviors of large scale as well as a micro-system is thus enormous, from insect morbidity to larvae aggregation, and even to changes in human population density with respect to historical processes of "urbanization" indicating applications of phase space diagrams to problems in sociology and political science. Here are two such examples:



Pg 159 Figure C **OOO: State of Insect Population (Starvation) as Mapped by Levels of Chemicals Adenylate & Phosphodiesterase**

Fig. 21 Mapped state of insect population.

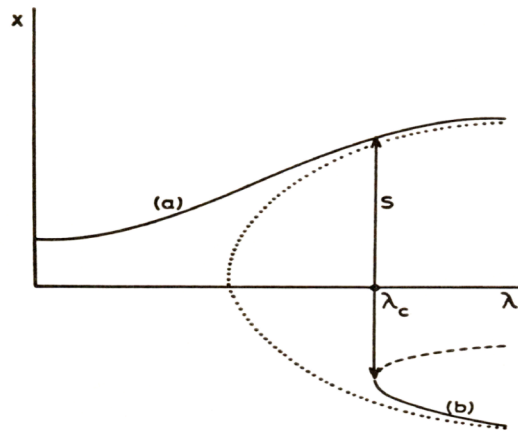


Pg 184 Figures C & D **OOC**: Phase Space Modeling of Larvae Clustering

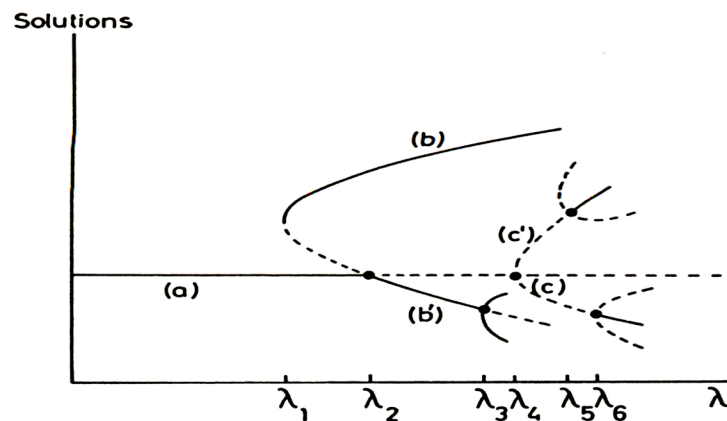
Figs. 22 and 23 Phase Space modeling of larvae clustering.

For these two diagrams, we have representations in phase space of the range of possible outcomes with respect to systemic behavior over time. The first refers to the correlation of the presence of specific chemicals in the environment to the starvation of a specific insect population. The second refers to the aggregating behavior of larvae over time in response to specific stimuli, with aggregation understood as fine example of a self-organizing process applied to biological systems, with other, more familiar examples being the behavior of prairie grasses and slime mold.

The initial conditions for such systemic transformations are mapped in phase space by reference to what are called “bifurcations” and one can see how the metaphor “fork-in-the-road” works as we examine these next two diagrams of bifurcations, the first mapping a simple bifurcation indicating two or three possible outcomes for the history of the system, the second a complex, bifurcation which indicates the instability of cascading branchings pointing to potentially infinite number of outcomes.



Pg 160 Figure 10 QOC: Simple Bifurcation Diagram:
Continuous Lines are Stable; Dotted Lines are Unstable



Pg 170 Figure 17, QOC: Cascading Bifurcation Diagram

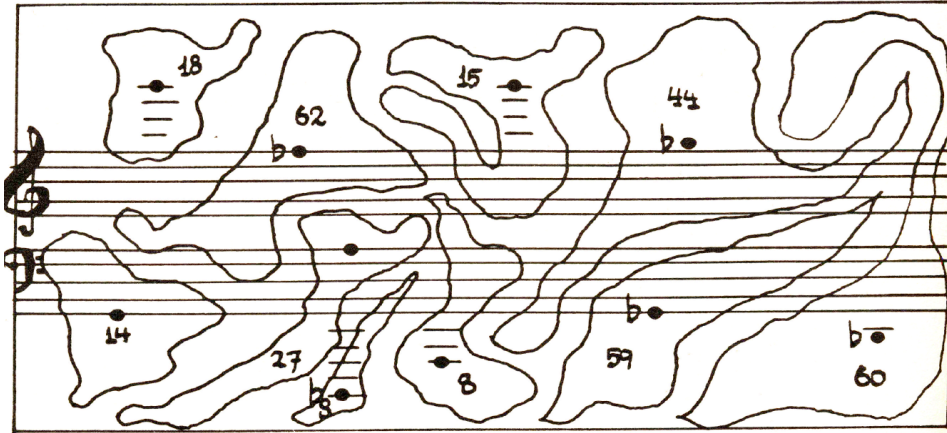
Figs. 24 and 25 Simple and Cascading Bifurcations modeled in Phase Space.

I mention these two diagrams of bifurcations so that we can compare to harmonic “forks-in-the-road.” But let me briefly anticipate by suggesting a correlation between a simple bifurcation with the description of the simple ambiguity represented by possible resolutions of a simple dominant C7 chord

with one (3 or E against the b7 or Bb) or two tri-tones (added b9 or Db against the 5 or G in the C triad C-E-G) in Be Bop; and then the much more complex process involving continual forkings possible in advanced avant-garde ensembles, where the entire ensemble might deviate from a given chord structure and end up very distant or “outside” the initial conditions (indeed), with each instrument capable of its own harmonic and rhythmic trajectory independent of the others. The rules by which these cascading deviations might “work” from the view of jazz harmony are extremely complex and rigorous, and this essay will only hint at how the logics of this complex system of harmonic deviations can succeed as coherent musical expression.

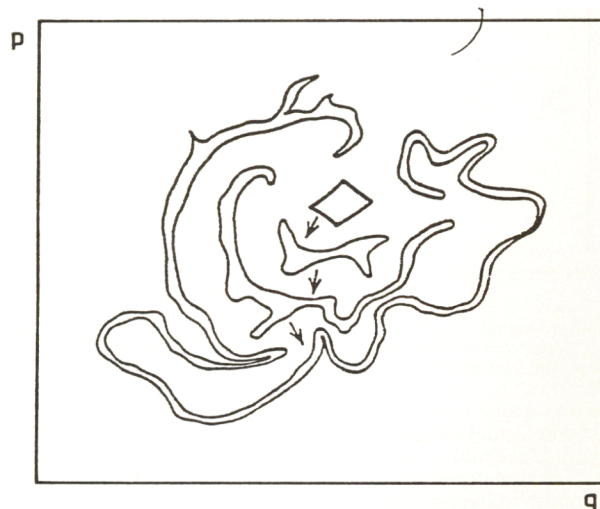
We now return to a simple end-game thermodynamic model, because we can now make a direct connection from the direct rejection of strict causal models of physical behavior exemplified by calculus, to more statistically-oriented models of stochastic complex processes, with John Cage’s rejection of the calculus of music notation established during the Renaissance, and towards a more stochastically-oriented diagrams of musical events modeled on phase space. We can see how prescient Cage was in identifying a need to transform the basis for modeling musical events according to a diagrammatic system capable of accounting for an understanding of duration as contingent and irreversible.

We can find direct echoes of phase space diagrams of thermodynamic processes such as equilibrium and periodic attractors, in the music score of *Concert for Piano and Orchestra* by John Cage. Compare the bizarre revamping of the rules for music notation in this score with the phase space diagram of the Evolution in phase space of a cell corresponding to a mixing system. Again, here is another score of John Cage to compare with a phase space diagram.



Page 116 Example 4-5, The Music of John Cage:
Concert for Piano and Orchestra: Solo for Piano.
 Phase Space Diagram of Musical Performance c.f.
 Phase Space Diagram of Cellular Drift

Fig. 26 Solo for Piano, Concert For Piano and Orchestra by John Cage Notation CC [PP26].



Pg 267 Figure 34, OOC: Typical Evolution in Phase Space of a Cell
 Corresponding to a "Mixing" System. The Volume is Still Conserved but
 No More its Form: The Cell's Material Spreads Through the Whole
 Phase Space.

Fig. 27 PP 25 or 23: Evolution in phase space of a cell corresponding to a mixing system.

Once the double tritone of an altered V7b9#11b13 chord established the condition of ambiguity in the "causal" resolution of dissonance in jazz harmonic progressions and the range of melodic resources, Be-Bop compositions began to

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explore harmonic progressions that celebrate the absence of immediate resolution. In other words, compositions like John Coltrane's "Giant Steps" represent the apotheosis of attempts to offer, within the "logic" of harmonic flow, pivotal dominant chords that not only did not resolve as expected (false cadences), but which did much to explore in extremely abstract ways relationships among distant harmonies that pointed towards hybrid harmony and melody, often presented in dense and complex "sheets" of sound. In these two works, we have an implied phase space model of harmonic movement, with no determined resolution. For example, in "Giant Steps," we have coherent harmonic motion despite symmetrical tonal centers exactly a major third interval apart (G, B, Eb), with no center weighted over the other, nor any compelling musical logic governing that harmonic motion through traditional V7-I dissonance-consonance resolutions. These harmonic progressions might be likened by analogy to non-equilibrium periodic attractor states in thermodynamics, with the musical composition "system" shifting from one attractor state to the next in sequence, and without any final attractor state (such as equilibrium—as in the endgame analogy) achieved, except at the ending, and often, not even then.⁴¹

(FAST) 170. **GIANT STEPS** - COLTRANE

COLTRANE - "GIANT STEPS"

Fig. 28 John Coltrane's "Giant Steps."

These sheets of sound, in turn, generated new kinds of chordal structures based on voicings or intervals emphasizing not 3rds as in more traditional harmonies, but 4ths (as exemplified by the playing of McCoy Tyner), which emphasize the extended and often "altered" or "blues" notes in relation to the root of the chord, and which led to even more ambiguous chord-scale relationships and thus an increase in melodic resources to juxtapose with those ambiguous harmonies. Furthermore, performers and composers move even beyond the ambiguities of

harmonic voicings in 4ths, and begin to use competing triads that juxtapose non-resolving tonal centers, and thus become, through hybridity, ambiguous tonal centers--as exemplified by the playing and compositions of pianist Bill Evans. These ambiguous chordal voicings in 4ths of McCoy Tyner, and upper-structure triads comprised of juxtaposed simple, yet often harmonically distant) triads of Bill Evans such as B/A (Lydian), C#/A (Augmented maj 7), or even the very dissonant A/Bb (diminished), offer ambiguity at a greater level of abstraction, bringing jazz, ironically, back seemingly to the modal simplicities of Renaissance counterpoint and its textures, only with much more complex, George Russell-inspired scales capable of resolving in multiple trajectories, at its basis.

Now, there was a deliberate exploration of all the harmonic and melodic resources available between a tonal center and a target pitch, so that each tonal center becomes a field of all harmonic and melodic possibilities: as exemplified by such early jazz modal compositions as Miles Davis' cool "So What?" and John Coltrane's hot "Impressions," but which become much more richly explored in John Coltrane and Eric Dolphy's *Africa Brass* recordings of "Greensleeves" and John Coltrane and Pharoah Sander's frenetically outrageous *Live in Seattle* recordings. Furthermore, ambiguity becomes embraced not only for the purposes of improvising poly-tonal (more than one key at a time) textures. Jazz composers began to integrate deliberate poly-tonal juxtapositions in actual compositions. One of the most famous and beautiful examples can be found in Herbie Hancock's masterpiece "Tell Me A Bedtime Story," where we find the Introduction in the Key of G Major (with one accidental), while the melody explicitly embraces the notes of an E Major scale (with four accidentals), creating a gorgeous dissonance that also recalls a George Russell scale construction called a Lydian Augmented Mode:⁴²



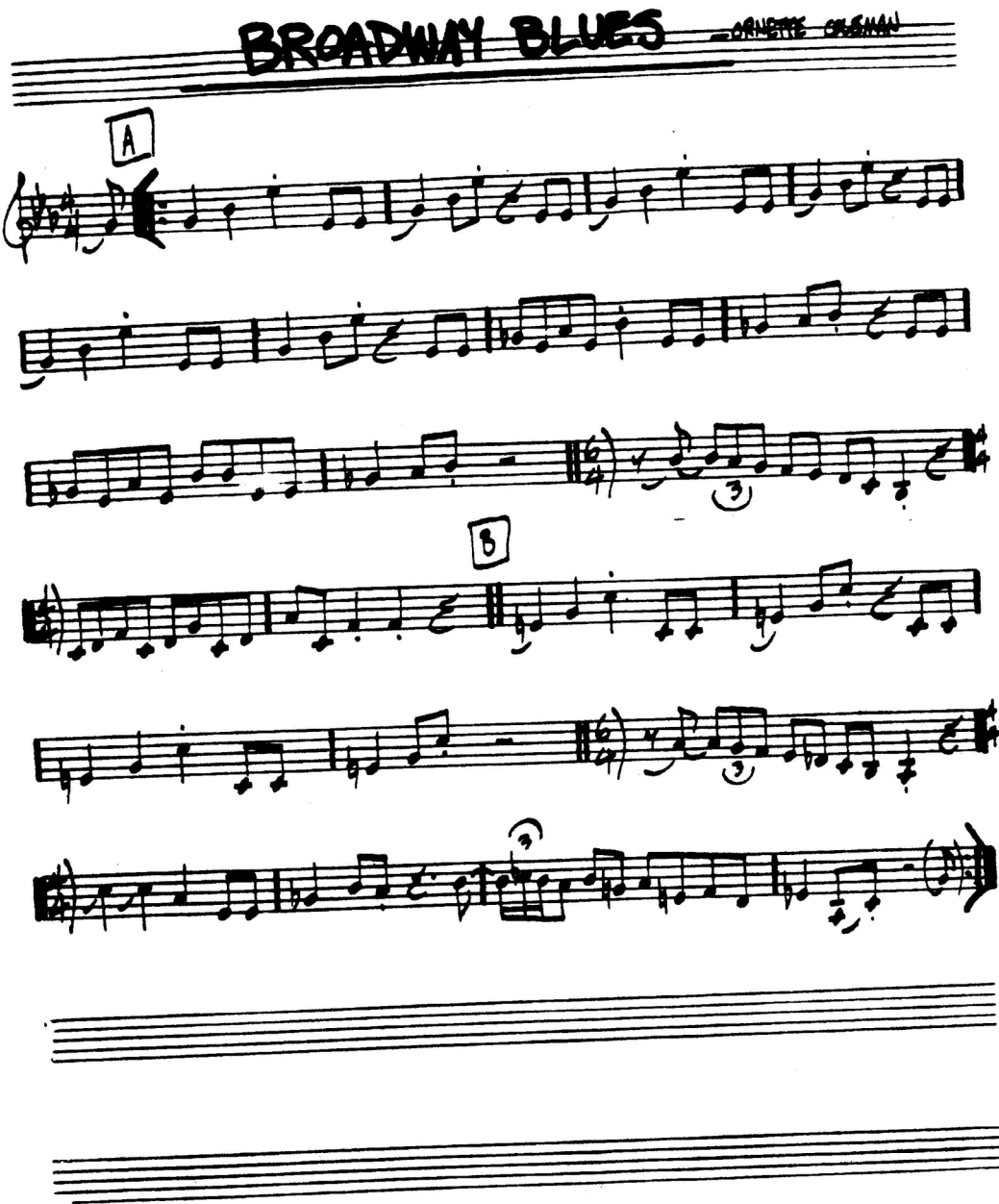


Fig. 30 Ornette Coleman's "Broadway Blues": The Motif and Only the Motif

The simultaneous juxtaposition of competing harmonic textures in “Broadway Blues,” which are implicated in the melodic “lines of flight,” to be employed contingently, and at will, by bass, piano, and horn, over the complex alternating (and implied juxtaposed time signatures) of polyrhythmic drums, makes for difficult listening. This is especially true for those with certain expectations that the specific roles of a melody instrument like the saxophone, the harmony instrument like the piano, and the rhythm instrument of the drums remain consistent and predictable. Yet, if the listener as well as the performer of jazz has learned anything since Be-Bop, it is the celebration of the contingently inter-subjective experience of pure time which structures the heterogeneity of aural textures and provides a unity amidst the diversity of expression.

We find these juxtapositions structuring heterogeneity even in the compositions of jazz musicians having recourse to the same kinds of ambiguity applied to both percussive and harmonic rhythms in a composition. In the Miles Davis composition “Its About That Time,” from the album *In A Silent Way*, we have distinct iterative sequences of harmonic rhythm from both the bass and the piano, with the drums poly-rhythmically supporting both. In the bass, we have a two-measure ostinato or repeating melodic line, with a simple and memorable blues inflection. This line then underlies a three-measure repeating harmonic progression that is extremely complex, with each chord implying a range of melodic resources quite distinct from the following and preceding chords, and suggestive of the difficulties improvising to a Schoenberg Tone Row. The sequences remain distinct and independent, only coming into synchrony every six measures.

Solo Section From "It's About That Time"

Miles Davis

Organ

Chords and measures shown in the score:

- Measure 1: F Maj7 F m11
- Measure 2: F m11 F dim
- Measure 3: C#alt F/G
- Measure 4: F Maj7 F m11
- Measure 5: F m11 F dim
- Measure 6: C#alt F/G
- Measure 7: F Maj7 F m11
- Measure 8: F m11 F dim
- Measure 9: C#alt F/G
- Measure 10: F Maj7 F m11
- Measure 11: F m11 F dim
- Measure 12: C#alt F/G

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Fig. 31 Section of the Miles Davis Composition "Its About That Time" (Transcription by Martin E. Rosenberg).

As the song progresses, the improviser has the option to choose which harmonic rhythm on which to base his solos. Now, in practice the rhythm section does not strictly adhere to the simultaneous performance of both harmonic-rhythmic pulses, but merely imply them amidst other textures. But these two-measure

and three-measure sequences do indeed appear together at certain climatic moments. As a rule, however, the white British guitarist John McLaughlin for solos over the complex “Western” chord sequence, while the African-American soprano saxophonist Wayne Shorter, implying the complexity of those Western chords merely by utilizing to the fullest the blues scale resources, solos over the predominant funky blues bass line. In effect, this song thus straddles the traditions of Western Classical music and the blues basis for African-American classical music (with the concluding solo by Miles both integrating each approach and, as composer and arranger, making the implicit argument as to which tradition is superior!), with the full support of the poly-rhythmic techniques of jazz drummers exemplified by Jack De Johnette on this music track, a disciple of Elvin Jones, the pioneering polyrhythmic performer with John Coltrane.

Furthermore, we find attempts to incorporate as complete a range of textures possible contingently in the performances of Free Jazz by Ornette Coleman, into actual compositions with each instrument (even those conventionally ordained to operate in the distinct realms of melody, harmony and rhythm) having independent melodic, harmonic and rhythmic resources assigned to it as an initial condition for free improvisation. For example, the composition “Conference of the Birds” by Dave Holland contains distinct melodic, harmonic and rhythmic resources, in the form of motifs, notated for each instrument.⁴⁵



**Dave Holland's Sufi Influence, The Conference of the Birds
Phase Space Mapping of Four Dimensions of Cognitive Looping
For Three Voices + Drums**

**See Ron Bogue's Discussion of Messiaen's The Music of the Birds
In Deleuze: On Music, Painting and the Arts, pp 28-31**

Fig. 32 Dave Holland Composition "Conference of the Birds".

Inspired by the Sufi tale by the same name, a tale which plays on the problems of noise and communication and the spiritual quest for harmony amidst the diversity of unique expression, Dave Holland's song embodies both the processes of de-territorialization and re-territorialization with respect to the bird's insistent cry for identity in space and time, and The Bird's (invoking Charlie Parker as the icon of a musical form deconstructing musical notational territory) vital impetus to draw out the contingency of the momentary event to make it new out of the memory of the old. Furthermore, if one listens closely to the timbre with respect to the instrumentation, as well as to the polyphonic

textures, one suspects that Holland is paying tribute to the tradition of Renaissance counterpoint, albeit in a way that violates practically all the strict laws governing Palestrina-style contrapuntal invention so that the calculus of his music notation merely establishes the initial conditions for absolute freedom of expression in the irreversible flow of performance.

I mention poly-rhythms numerous times above, but here I wish to foreground the same potentialities for bifurcations, leading to layers of percussive rhythmic abstraction beneath and supporting the range of performances by each instrument during a session of improvisation. In fact, one might say that poly-rhythms, occurring in all the world cultures that have contributed to the richness of jazz music, constitute the secret key to the nature of the sonic landscape of jazz. For example, a 2/4 rhythm (meaning two beats per measure with every quarter note worth one beat), can be merged contiguously with a 3/4 rhythm, producing a pulse of 5/4 or five beats per measure. Or, one can play a 4/4 rhythm at the same time as a 3/4 rhythm, producing a cycle that comes into synchrony and repeats every 12 beats, which enables the soloist to decide which rhythmic pulse s/he will embrace, and which will be ignored during the solo, or, in a call and response approach, imply each rhythmic pulse alternately.

For, it is through pure rhythm, through textures of independent rhythms coexisting as a field of all possibilities, that most get their first glimpse at the open world of a jazz performer. Thus, to jazz musicians and fans, jazz celebrates an over-arching non-conceptual unity containing the diversity of expressions melodic, harmonic and rhythmic, that has ethical implications for an intolerant world filled with oppressive hierarchies.



Fig. 33 Polyrhythms derived from simpler time signatures.

Conclusion: Race and Nomad Art

One of the consequences of the line of conceptual flight opened up by the exploration of the implications of the bifurcation point with reference to phase space and the science of emergence in improvised musical expression, is that one witnesses jazz evolve in complexity and sophistication during the period beginning with the birth of Be-Bop (early 1940's) at such breakneck speed that major aesthetic transformations became measurable in months rather than decades. The transformations of jazz from Be Bop to Cool to Hard Bop to Free Jazz took place in 15 years, and in such a way that swing jazz musicians less able to innovate were left bewildered if not angry. The problem is that during that stretch of incredible creativity, the evolutionary trajectory of the music left most

of jazz's popular audience in the lurch as well. Some have argued, as I have, that one primary motive for the rich and sophisticated innovations in harmony and melody during the early days of Be-Bop were inspired at least in part by African-American improvisers, arrangers and composers expressing disgust and outrage at the consistent theft not only of songs but of an entire genre by derivative white jazz musicians, as well as by their radio station and record company sponsors, who then shut them out of the economic benefits of commercial artistic expression. This pattern of adoption, appropriation, exploitation and disenfranchisement proved daunting for African-American performers, composers and arrangers in their attempts to earn a decent living in the face of the total control over the political economy of music production.

Many Be-Bop performers gathering at birthplaces like Minton's in New York City deliberately set out to create an art form so difficult that it would take a long time for imitators to develop the technical skills and hearing ability to perform it. For example, instead of playing, and then recording on an old standard such as "How High the Moon," and thus have to pay royalties on it, musicians would at first simply record a reharmonized version with new melodic materials as a vehicle for improvisation. In other words, Swing as a minortarian art originating from the African-American community, became de-territorialized by white band leaders, club owners and record company executives. Be-Bop, while aesthetically enacting micro-politically the processes of aesthetic de-territorialization with respect to the epistemological and ideological investment in a dominant model of reversible time, enacts political-economically a re-territorialization for the purposes of returning the means of musical production and remuneration to the "minors" responsible for creating the art form to begin with. But as more conceptual and cognitive resources were required of the audience to "hear" this aesthetic tradition, the more the audience, largely white, came to drift away from jazz and begin listening to rhythm and blues, rockabilly and then rock and roll. The problem is that these more simple traditions of musical expression also have their roots in the African-American tradition. And so, the same procedures of adoption, appropriation, exploitation and

disenfranchisement occur with the rhythm and blues tradition as it did in the jazz tradition.⁴⁶ By the time Free Jazz emerges, and Ornette Coleman attempts to become a producer to his own musical compositions with respect to live and recorded performances, the capability of jazz musicians to sustain themselves economically had already eroded significantly. Ornette Coleman's efforts at entrepreneurship failed, the jazz listening audience collapsed due to shifting aesthetic allegiances to American roots music and the distraction of television (despite employment opportunities for some) led to the mass migration of jazz musicians to Europe in an attempt to find work.⁴⁷

Thus emerges as well a "down side" to this unboundedly creative aesthetic process, unfortunately. Soon everyone was trying to play Be-Bop; but not everyone wanted to listen to its strange dissonances and its unfamiliar musical logic, especially since that logic increased in complexity and sophistication more quickly than the largely white audience had the capacity to "hear" and enjoy. It became inevitable that a vacuum in the common aesthetic tastes of American concert goers and record buyers would get filled by other forms of music, also originating out of the African-American community, but eventually becoming appropriated and exploited by white performers and record company owner sponsors, only to lead to the very disenfranchisement of the originally ethnic creators of the genre--just as had occurred in jazz.

Only with the ownership of the means of production by African-American entrepreneurs, first attempted by Sam Cooke, and then with more sustained efforts by those like Berry Gordy of Motown, music producers like Quincy Jones, and extremely wealthy performers like Michael Jackson, who were eventually to develop the economic clout capable of buying the catalogues of white musicians like the Beatles as well as those of African-American performers, did the cycle of appropriation, exploitation and disenfranchisement come, at least to a certain extent, to an end.

Acknowledgements

The audio files for this essay were recorded at Martin Thomas Studios, New Kensington, PA. I would like to express my appreciation for Martin Thomas's assistance in shaping audio files from pre-existing tracks, as well as performing piano for the renaissance counterpoint examples, as well as providing accompaniment for the demonstrations of various chord/scale relationships. The quality of the demonstration audio files of chord-scale relationships is my responsibility alone. When I was finishing this essay, I began playing guitar regularly for the first time since the 1970's, and I wish I might have waited another year before recording them. In any case, the process of re-learning how to perform jazz on guitar becomes part of the narrative of Part II of "Jazz and Emergence" in order to replicate the prescient work of David Sudnow in his landmark phenomenological study of 1970, *Ways of the Hand*, with reference to new knowledges in neuro- and cognitive science. I would also like to thank the drummer and cultural theorist Bob Budny, and jazz educator, trombonist and educator Nelson Harrison, as well as two other Pittsburgh jazz performers – pianist Howard Alexander and bassist Paul Thompson -- for engaging in several interviews that proved useful for both parts of this essay.

Notes

¹ My first presentation on Be-Bop compositional practices occurred while still a graduate student, in a series of lectures for Professor Harold Cruse's Seminars on Twentieth-Century Afro-American Culture, University of Michigan, February 17, 1988; November 30 and December 7, 1988; October 11, 1989, during which time I had volunteered to play guitar for a friend Ed Sarath, who directed the University of Michigan's big band ensemble, "North Coast." I have presented different aspects of the materials on jazz, emergence and cognition: for the Lyrica Society at the Modern Language Association, Dec. 30, 1996; for one of three invited talks at the Escola do Futuro, Universidade de Sao Paulo, Aug. 24-30, 1999; for the Trent Conference on Gilles Deleuze, May 15-18, 2004; for the Conference of the Society for Literature, Science and the Arts, Duke University, October 11-14, 2004; for a National Science Foundation Seminar in honor of Peter Galison's notion of the "Trading Zones", at Arizona State University Center for Nanotechnology, May 20-25, 2006. With reference to the meta-rhetoric of verbal Martin E. Rosenberg. "Jazz and Emergence (Part One)." *Inflexions* 4, "Transversal Fields of Experience" (December 2010). 183-277. www.inflexions.org 250

invention in real-time multi-object-oriented environs as analogous to both jazz improvisation and the science of “emergence”, I have presented several times at the Computers and Writing Conference, including June 1, 1996; Conference on College Composition and Communication, March, 1998. I also created in 1989, with Thomas I. Ellis, an instructional software program called *RHIZOME*, modeling creative and analytic heuristics, based in part on iterative non-linear sequences from complex systems, and in part on the iterative processes of jazz improvisation and composition, and modeled in hypertext for users to emulate, including one called “Jazz Writing.” The results, and its theoretical underpinnings were published in “Physics and Hypertext: Liberation and Complicity in Art and Pedagogy,” *Hyper/Text/Theory*, ed. George W. Landow, Johns Hopkins UP, 1994, 393-443; Contingency, Liberation and the Seduction of Geometry: Hypertext as an Avant-Garde Medium,” *Perforations* 3, Spring-Summer 1992: *After the Book: Special Issue on Hypertext*, ed. Richard Gess, Public Domain, unpaginated.

² This essay constitutes part of Chapter Six of *Fables of Emergence: The Cultural Work of Complexity in the Avant-Garde*, as yet unpublished, but with sections of a number of the other chapters appearing in article form. Among the topics addressing transgressive aesthetics and philosophy that I have published in the past include: Deleuze and Guattari, Richard Feynman and Ilya Prigogine, and novelist Thomas Pynchon (1992); Deleuze and Guattari, Sigmund Freud, and the distinct stages in the history of complex systems as models for human subjectivity (1993); Deleuze and Guattari, Francisco Varela and Edwin Hutchins, and Thomas Pynchon (1994); Deleuze and Guattari, Ilya Prigogine, Francisco Varela and Hypertext Fiction (1992; 1994); Deleuze and Guattari, feminist theorists Helen Cixous and Luce Irigaray, Francisco Varela and the focus on the visceral in the works of artist Kiki Smith (1996); Gilles Deleuze, Humberto Maturana, Francisco Varela, and the avant-garde architecture of Arakawa and Gins (2002; and, forthcoming).

³ Deleuze notes that even Foucault recognized that western “democracies” were moving away from regimes of power based on discipline, as exemplified by institutions, to conditions where “continuous control and communication” enables power to remain immanent, beneath the threshold of awareness (1995: 174). But those within the African-American community would find such models of subtle power networks largely impotent in representing their experiences in any meaningful way. It is important to recognize that many layers of power, in the form of networks, institutions and overt displays of threat and exclusion, coexist: different people with different subject positions experience power differently. That is why the perspective on jazz, and its

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relationship with irreversible time presented in this paper still resonates with an older model of resistance from the dominant cultural perspective of reversible time in a way resonant with Bergson's account of the problematic cognition of metric time with respect to *durée*. This resistance is consonant with what Foucault calls the "insurrection of subjugated knowledges." We are talking about micropolitical resistance that manifests literally as a "becoming imperceptible" (1987: 232-309). Jazz is an oral tradition, whether academic jazz instructors and students recognize that fact. It constitutes a "secret" society, as my friend and jazz educator Nelson Harrison constantly emphasizes. It is secret in the sense that Deleuze and Guattari, writing about something quite different, state: "the more the secret is made into a structuring, organizing form, the thinner and more ubiquitous it becomes, the more its content becomes molecular, at the same time its form dissolves" (TP 289). One could not find a better description of the creative processes of jazz musicians undergoing morphogenesis from Be-Bop to "free" improvisation. While Bergson's critique of cognition seems most applicable to science and aesthetics, and I have spent much of my research demonstrating how this critique is applicable to the tactics of resistance in avant-garde art, the aim of this paper is to insist on the micropolitical implications of this embrace of irreversible time as a tactic of resistance to determination.

⁴ The relevant passages in Deleuze and Guattari's *A Thousand Plateaus*: "1730: Becoming Intense; Becoming Animal; Becoming Imperceptible," esp. "Becoming – Music" 299-309; "1837: Of the Refrain" 310-350; "1440: The Smooth and the Striated," 474-500, with special attention to their discussion of the relationships among "the technological model," "the musical model," "the maritime model," "the mathematical model (multiplicities)," "the physical model," and "aesthetic model (nomad art)." Notice especially the linking of music, complex modeling in phase space, and nomad art. The best book addressing music in Deleuze remains Ronald Bogue's volume *Deleuze on Music, Painting and the Arts*. See especially his discussion of bird songs, and Messiaen, and read through these references to those that I make on "Bird" Parker and Dave Holland's composition "Conference of the Birds." I have read two essays by Eugene Holland recently that are particularly relevant to my work: "Jazz Improvisation: Music of the People to Come", where he also discusses birds and jazz with respect to territorialization and de-territorialization; and "Studies in Applied Nomadology: Jazz Improvisation and Post-Capitalist Markets," especially his discussion of Jacques Attali, which resonates with my own work on Attali. I am indebted to Gene for his conversation and support of this project, especially leading up to my presentation at the Trent Conference in 2005, as well as for his willingness to read an earlier "iteration" of this essay. While Gregory J.

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Seigworth's essay "Fashioning a Stave, Or, Singing Life" does not address music directly except through the allusion to music notation, its link of the "stave" with the dominant epistemological and ideological entrapment in the geometries of cognition, and "singing a life" with strategies of resistance and liberation from those geometries, and linking these oppositions to Freud's life and death drives, is superbly insightful. See also Charlie Stivale's article on Cajun Dance music and the refrain.

⁵ I would like to mention Gregory Siegworth and Eugene Holland in particular. I have also read recently Jeremy Gilbert, "Becoming Music: The Rhizomatic Moment of Improvisation"; Marcel Swiboda, "Cosmic Strategies: The Electric Experiments of Miles Davis" – both from the recent collection *Deleuze and Music* edited by Ian Buchanan and Marcel Swiboda. Both address issues raised in this essay, and especially, note my discussion of Miles Davis's composition "It's About That Time" from the album *In A Silent Way*, with reference to Swiboda's essay. Since I began this study, the jazz saxophonist and musicologist David Borgo has produced a brilliant work on jazz improvisation and complexity theory, *Sync or Swarm: Improvising Music in a Complex Age*. I would like to thank Klas Nevrein, a gifted free jazz pianist from Stockholm, for recently pointing out this study to me. A fine jazz saxophonist in his own right, Borgo has made insightful connections between a large range of scientific practices and jazz performance, and has made an important contribution to understanding contemporary "free" jazz improvisation, exemplified by Sam Rivers, using what his mentor N. Katherine Hayles calls "the figure in the carpet" approach to chaos – that is, finding patterns in disorder. In particular, his use of Rolf Bader's work on the "fractal correlation dimension" to explore the distinction between "sync" and "swarm" or performative synchrony and dispersion amongst jazz musicians (as manifest visually through the analysis of sound waves exterior to the performing musicians), indeed points to the need for further research, research that I address from a different angle in Part Two on embodied and distributed cognition and neuro-anatomy. Where we differ, I suggest, is in the scale of focus and historical context. Borgo raises and discusses briefly just about every "school" of complexity studies, and every figure associated with it from Ralph Abraham, to Edward Lorentz; from Benoit Mandelbrot to Stuart Kauffman, from René Thom to Ilya Prigogine; from Humberto Maturana and Francisco Varela to Heinz von Foerster; from Edwin Hutchins and Antonio Damasio to Varela again. Here I focus on a few key concepts within a particular historical sequence from Charlie Parker to the birth of Free Jazz: the distinction between reversible and irreversible time in the analysis of the problematic role of music notation in classical music and jazz with respect to deterministic and contingent musical trajectories; Bergson's concept of "creative evolution" as a

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proto-theory of emergence in describing the history of the improvisation, transcription and composition practices of Be-Bop musicians ; and the crucial role of bifurcation for emergent systems in physics and chemistry (and the related philosophical concept of individuation from Gilles Deleuze and Gilbert Simondon, which I discuss further in Part Two), and melodic, harmonic, and rhythmic “forks-in-the-road” in the evolution of jazz from Parker to Coleman--particularly with reference to the monumental contributions of George Russell, who Bordo does not address at all. Still, this is a fine piece of work especially for its superb analysis of “patterns” in the “chaos” of contemporary “free” expression.

⁶ The problematics of analogy formation and the construction of correspondences is central to my theoretical concerns, first articulated skeptically in my article on tropes of the subject in Freud and Deleuze and Guattari (1993); and more fully realized enthusiastically in my development of a model of emergent (and transgressive) trans-disciplinary inquiry. See “*Chess RHIZOME* and Phase Space: Mapping Metaphor Theory Onto Hypertext Theory” (1999; translated into Portuguese, 2002). I argue that the concept of metaphor (and meaning tropes and analogies generally) can be recuperated from a Deleuzian perspective, by recasting the function of tropes generally as “tools” with “agency” capable of performing work (much in the way Bruno Latour and Peter Galison discuss the exchange of tools in science generally, and computer hardware and software specifically). In this way, the question of “identity” becomes discarded, and the issue of the “event” of emergent juxtaposition of allied conceptual questions in distinct disciplines, becomes foregrounded. I believe this to be the underpinning to Deleuze’s exhortation to “forge alliances” despite his critique of metaphor and analogy as forms of transcendental identity. The process of forging alliances exemplifies the condition of emergence, as the hybrid disciplines of complexity studies, cognitive science and nanotechnology demonstrate. The theoretical problems underpinning this particular issue of the cultural work of metaphor with respect to the relationship between jazz and emergence, formed the basis of my presentation on “Jazz as a Viral Metaphor” at the NSF Seminar in Honor of Peter Galison’s notion of the “Trading Zone,” ASU, 2006—a talk available in quick-time video online at: www.inflections.org. See also my forthcoming essay: “Reconciling Deleuze’s Rejection of Metaphor with His Plea to Forge Disciplinary Alliances: Tropology as an Emergent Property in *Difference and Repetition*,” first presented at a panel I created for the Modern Language Association entitled “Between Semiotics and Geometry: Metaphor, Science and the Trans-Disciplinary ‘Trading Zone,’” with guest speakers Peter Galison, Brian Rotman, Ken Knoespel, James Bono, James Paxson and Arielle Saiber, Dec. 28, 2004.

⁷ I address this topic as a trained jazz musician as well as a student of the epistemological processes by which emergent, “forged alliances” that enable hybrid investigations of topics that traverse science, philosophy and the arts may occur. I have been profoundly altered by the direct intuition concerning the unfolding of time while performing as a jazz improviser, and as a composer who often uses improvisational materials in my compositions. That intuition might be called an embodied yet distributed cognition that emerges spontaneously during the performance of jazz. At that performative moment, one senses that musical duration is not determined like notes scripted on the page of a lead sheet, arrangement or full-fledged composition, but becomes a contingent, virtual field resonant with infinite possibilities, which seems to capture what the Bergsonian tradition, as well as the now fifty year-old work in the physics of self-organization associated with the work of Ilya Prigogine and Henri Atlan (to which Deleuze in particular owes much), calls “becoming.”

⁸ I am especially indebted to the following studies: Berliner, Paul F., *Thinking in Jazz: The Infinite Art of Improvisation*; DeVeaux, Scott. *The Birth of BeBop: A Social and Musical History*; Litweiler, John. *Ornette Coleman: A Harmelodic Life*; Owens, Thomas. *BeBop: The Music and Its Players*; Peretti, Burton W. *The Creation of Jazz: Music, Race, and Culture in Urban America*.

⁹ Conversations with Dr. Nelson Harrison, Pittsburgh, PA, June and July, 2009. Dr. Harrison, whose Ph.D. is in clinical psychology, is an alumni of the Count Basie Orchestra and many other ensembles over the years, and a nationally recognized jazz educator in Pittsburgh, recently interviewed for the 2009 PBS documentary *From Harlem to Montmartre*. This is a complaint voiced by many well-known jazz musicians over the years. I repeat their arguments here, despite having been a 1970’s product of precisely that form of education.

¹⁰ I would like to acknowledge my good friend Mark Lawrence McPhail’s work on complicity. We’ve had many long conversations on this topic, because of the fruitful ways that our interests have impinged on each other. While his work focuses on how black intellectuals become complicitous with dominant intellectual culture through embracing the essentialist discourse of the academy, my work focuses on the relationship between aesthetic transgression and complicity in the avant-garde through its embrace of the processes and institutions for the dissemination of the art work, and an implied dependency on the consumers of that work. See *The Rhetoric of Race Relations*, and *Zen In the Art of Rhetoric: An Essay On Coherence*.

¹¹ One historically significant example of a successful analogy can be located by comparing the work of 19th Century physicist Ludwig Boltzmann and pioneering information theorist Claude Shannon. The mathematical equation at the core of Ludwig Boltzmann's Order Principle ($S = -\sum p_i \log_2 p_i$; or more simply $S = k \log p$, with k containing an equation called Boltzmann's Constant), describes the behavior of a complex system (Given a complex closed system, the history of that system will tend inevitably to the state of greatest probability). Boltzmann's Order Principle provides a profound mathematical analogy upon which Claude Shannon constructs his mathematical formula ($H = -\sum p \log_2 p_i$), which distinguishes noise from information in a communications channel (In a closed communications channel or system, information can lose, but not gain, specificity). To confirm his commitment to the mathematical analogy, Shannon coins his discovery "The Entropy of Information"). While I discuss this in my 1989 dissertation "From Being to Becoming: Physics, Hegemony, Art and the Nomad in Ezra Pound, Marcel Duchamp, John Cage and Thomas Pynchon," as well as in my Fables manuscript and several articles (1992; 1993), see essays by N. Katherine Hayles (1991); David Porush (1992); and books by Hayles (1990), William R. Paulson (1988); Michel Serres (1990); and of course, Ilya Prigogine (1980); Ilya Prigogine and Deleuze student Isabelle Stengers (1984). I was lucky enough to have met Prigogine in a conference in 1979, and to interview him twice for my research in 1994.

¹² Here we should remember the work of Brian Rotman, who in three books from the Writing Science Series of Stanford University Press (1987; 1993; 2002), has confronted, with a thorough knowledge of mathematics and contemporary philosophy and literary theory, the semiotic, and yes, rhetorical nature of mathematical discourse. Metaphor and mathematical symbol are not as distinct as they seem.

¹³ I would like to express my debt to William R. Paulson, my "de facto" dissertation director at the University of Michigan, for showing the relevance of the work of Michel Serres to understanding 2nd and 3rd order cybernetics. This proved a valuable context for understanding the work of Jacques Attali. It did not take long to discover the contribution of Henri Bergson and Ilya Prigogine to Serres' project.

¹⁴ A read of Jacques Attali's political economic analysis of noise and aesthetics in the context of the music industry should be complemented with the brilliant study by Aden Evans, entitled *Sound Ideas: Music, Machines and Experience*; as well as one by Mark Katz, *Capturing Sound: How Technology Has Changed Music*. In particular, Evans' insight into the physics of meter as well as pitch pertains

here, since it offers a material grounding for an understanding of polyrhythmic textures, built in layers of proportion in a way similar to the proportions capable of generating the overtone series with respect to absolute pitch. But, as this paper argues, the time-space geometry of meter and pitch, as understood by Western classical musicians and their auditors simply cannot capture the embodied and embedded rhythms and “blues” notes of jazz. These distinctions that I’m making between meter and pulse, and between chord-scale relationships as represented in Slonimsky as opposed to the system devised by jazz theorist George Russell, speak to the embodied cognitive life of improvisation.

¹⁵ This argument pursues such a synthesis by foregrounding Deleuze’s debt to the intuitions of Henri Bergson in his masterworks *Matter and Memory* and *Creative Evolution*, in a way that also underscores a material rather than a metaphysical context for Bergson’s work, and which confronts many objections to what some critics have derided as Deleuze’s “vitalist” bias. I refer here not only to the works of Jean Baudrillard, Francois Lyotard, but to that of Zizek as well.

¹⁶ Here I am using the terms epistemology and ideology in a guarded way, because many believe that Deleuze himself would take exception to its use in this context. I am merely emphasizing the interdependence of positions and assumptions in the commitment to action, whether aesthetic or political.

¹⁷ Bergson’s answer to the rigidity of western cognition and the conceptual systems that this rigidity produces, is to postulate “an original *impetus* of life”. This impetus, “sustained right along the lines of evolution among which it gets divided, is the fundamental cause of variations, at least of those that are regularly passed on, that accumulate and create new species” (1911: 87). The memory, or instinctual habit of the system, when engaged with the contingent flow of time through the impetus of its vital force, proceeds to differentiate, and then to stabilize that difference, through preserving the memory of difference against contingency. In some way then, matter is instinct and memory, energy is creativity and intuition. Crucial for Bergson is the correspondence of this evolutionary process, which he calls “the continuity of life” (1911: 27) governing physical systems with the growth of human thought and social formations towards greater complexity and diversity. How we interpret this continuity rises the same problems as those posed by the overreliance on calculus in physics, and on mechanistic and finalistic models in biological evolution: “In vain, therefore, does life evolve before our eyes as a continuous creation of unforeseeable form: the idea always persists in that form, unforeseeability and continuity are mere appearance—the outward reflection of our ignorance. What is presented to the

sense as a continuous history would break up, we are told, into a series of successive states" (1911: 30). What Bergson would hope for is a form of science capable of observing that "continuity of life" without freezing time, which would parallel the role of intuition in cognizing the present moment as a field of infinite emergent potentiality. In a famous passage, he writes: "We believe that if biology could ever get as close to its object as mathematics does to its own, it would become, to the physics and chemistry of organized bodies, what the mathematics of the moderns has proved to be in relation to ancient geometry" (1911: 37-8). We recognize now, of course, that what Bergson was prophesizing, in effect was the eventual deployment of N-Dimensional geometry, and in particular, the work of Riemann, Poincaré (that he describes in "On Mathematical Discovery") and eventually Gibbs, in the formation of phase space as a way to visualize emergent processes in physics, chemistry, biology and cognitive science. See also my discussion of the epistemological and ideological implications of top-down and bottom-up cognitive processes with respect to the cultural work of the avant-garde, in "Portals in Duchamp and Pynchon" (1994).

¹⁸ See David James Stump's 1988 dissertation "Conventionalism and Truth: Poincaré's Mediation Between Relativism and Absolutism in Science," Northwestern University, 1988, UMI Order Number 8811513. See especially the chapter "The Development of Non-Euclidean Geometries and the Fall of the A Priori." I got a chance to meet and talk with Professor Stump when I was invited to give a talk at the Duchamp/Poincaré conference hosted by Stephen Jay Gould and Rhonda Roland Shearer at Harvard in 1999, and very much appreciate our discussions on conventionalism, as well as his bibliographical help. In my book project *Fables of Emergence*, I go into much greater detail on the complex, mutually influential relationship between Poincaré and Bergson, and their influence on the work of Marcel Duchamp.

¹⁹ While I cover this territory (with less detail) in my essay theorizing about my attempts to model through hypermedia the relationship between metaphors and epistemology in the pursuit of transdisciplinary inquiry, "*Chess RHIZOME and Phase Space: Mapping Metaphor Theory Onto Hypertext Theory*" (Rosenberg 1999; 2002), the focus on that essay concerned the visualization of the contingencies of navigation and the spontaneous aggregation of thought structures across disciplines in N-dimensions (what are now familiarly referred to as "data clouds"). Poincaré's work on creativity is especially apt for my discussion of contingent performances in real time with respect to phase space, since not only do his swirling atoms suggest data clouds, but he is talking about the central insight enabling the emergence of phase space as a geometry of

complex systems.

²⁰ Here I point to my past work on phase space as an ontological model in Deleuze (1990; 1992; 1999); and my debt to Manuel Delanda's superb discussion of Deleuze, *Intensive Science/Virtual Philosophy*.

²¹ When I interviewed Ilya Prigogine in May, 1994, he specifically cited both Bergson and Poincaré as major inspirations for his research on the physics of self-organization, and acknowledged his affinity for the philosophical work of Gilles Deleuze, particularly his masterwork *Difference and Repetition*. Incidentally, we have, in Poincaré's model of creativity with reference to the hooking and unhooking of thought atoms, as well as to the reconfiguration of the walls themselves after these thought-atoms are put into motion, a precise illustration of what Deleuze and Guattari call processes of "de-territorialization" and "re-territorialization."

²² To anticipate my argument, Deleuze and Guattari's distinction between the bottom-up contingencies of smooth space (phase space) and the top down geometrical constraints of striated space (calculus) becomes most useful in pursuing the analysis of a dialectic between improvisation and music notation in the composing practices of Charlie Parker and his cohorts. What makes this distinction useful is the way that it can perform two functions: Initially, it helps us to connect Be-Bop composing practices to the dialectic of *durée*, *memoire* and *élan vital* described by Bergson in *Creative Evolution*. Henri Bergson describes creative evolution as an engagement of the smooth space of contingent duration, with the striated space of memory, propelled by the vital impetus or *élan vital* lying within each individual (*qua* contributing improviser). Second, it gives us a way to deploy by analogy the rules and models of complex systems such as the role of phase space diagrams in the visualization of self-organizing processes in physics (Part One) and cognitive science (Part Two), so to see how this dialectic of the smooth space of collective improvisation, preserved by the memory of the tape recorder and transcribed into the striated space of standard musical notation, makes possible the analysis of the deformations and discontinuities of harmony, melody and rhythm enabled by the contingent moment of improvisation, and accelerates the evolution of jazz musical forms to bewildering levels of complexity in fifteen years, a very short period of time from a historian's perspective on music. It is important to recognize that this evolution encompasses melody, harmony and rhythm--not only the ways in which the melodic solos of Charlie Parker and his followers surpass in complexity and sophistication the work of earlier performers identified with "Swing" music, the saxophone of Lester Young and trumpet of Louis Armstrong, but also includes

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the introduction of poly-tonal clusters by Thelonious Monk, the juxtaposed (and competing) primary (polytonal) triads of Bill Evans, as well as ambiguous chordal voices in 4ths (rather than 3rds) of McCoy Tyner—to name three influential pianists, and, the pioneering poly-rhythmic textures of drummers Kenneth Clarke and Max Roach—culminating in the achievements of Elvin Jones. This breakdown of the logic of standard melodic, harmonic and rhythmic resolution leads eventually to new chord-scale relationships, harmonic progressions both complex and tonally ambiguous, and new forms of collective improvisation as exemplified by the work of Charles Mingus, Miles Davis, John Coltrane, Eric Dolphy, Ornette Coleman, and eventually, the Art Ensemble of Chicago, Dave Holland, Albert Ayers, Sam Rivers and many others. Poly-tonality, poly-rhythms, and contingent, spontaneously performed contrapuntal textures all become possible because of the “creative evolution” of the musical lines of flight of Be-Bop performers and composers.

²³ To which Gregory Seigworth hints when he performs a schizo-analysis of Freud’s life and death drives and Deleuze’s de- and re-territorializations in “Fashioning a Stave, or, Singing Life” (2006).

²⁴ Some may object to my comparing Dave Holland with Ornette Coleman and the Art Ensemble of Chicago, but aside from his significant musical contributions as a bassist and composer (see my discussion below of his composition “Conference of the Birds”), let me also point out that he helped found the famous Creative Music Studio in Woodstock N.Y., where the serious study of World Music, with its resources drawn from all over the post-colonial world emerging from European domination, first began in earnest. I was lucky to spend time there in 1976, and I performed “Conference of the Birds” throughout the 1970’s with my own ensembles.

²⁵ Here I would like to express appreciation for my studies in counterpoint under Swiss musicologist Etienne Darbalay, Marlboro College, 1972-3, famous for his groundbreaking work as founder, editor and performer of a number of lost manuscripts of C.P.E. Bach; as well as a number of composition teachers (including Stu Balcomb, one the editors of the original *Real Book*) at Boston’s now famous Berklee College of Music, as a classical composition major, with minors in jazz arranging and performance 1974-6. Very recently, Ronald Bogue has written a marvelous study of Renaissance counterpoint with respect to the Baroque and Leibniz’s notion of “monads”. I learned much from this essay, and while not directly relevant to my analysis of the emergence of calculus and reversible time, and its connection to the birth of time signatures, even temperament and key signatures, it certainly enriches the connection to

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Deleuze's analysis of this key epoch.

²⁶ The following scales can be heard, as performed on guitar by me, on the on-line version of this paper. Find the sound files at <http://www.inflexions.org>.

²⁷ I was fortunate to audit informally George Russell's jazz theory course at New England Conservatory while attending the Berklee College of Music.

²⁸ These scales can be heard, as performed on guitar by me, on the on-line version of this paper. Find the audio files at <http://www.inflexions.org>.

²⁹ The following scales can be heard, as performed on guitar by me, on the on-line version of this paper. Find the audio files at <http://www.inflexions.org>.

³⁰ The following four examples can be heard, as performed on guitar by me, on the on-line version of this paper. Find the audio files at <http://www.inflexions.org>.

³¹ I have written elsewhere of the role of chess in the production of Duchamp's posthumous masterpiece *Étant Donées* (Rosenberg: 1992; 1994; 1999). The invisible floor of the assemblage constitutes of intersecting planes of chess boards, as if in N-Dimensions. Let me mention also the fact that Duchamp taught Cage how to play chess, and played with Samuel Beckett on and off for 9 years when they both were living in Paris.

³² You can hear an audio file of John Cage's "Music For Marcel Duchamp" (1947) attached to the on-line version of this paper at <http://www.inflexions.org>.

³³ My thanks to Erin Manning for pointing out the ample evidence for the consequences of this phenomena of avant-garde posturing with respect to John Cage and Merce Cunningham. This observation should complicate Eugene Holland's excellent point concerning the genealogy of "habit" and the refrain in music, and its relationship to Deleuze's notion of repetition (Holland, 2008).

³⁴ See my articles on Thomas Pynchon (1992;1994) and the article on my hypermedia project *Chess RHIZOME* (1999; 2002), for more sustained discussion of chess, science, avant-garde art and epistemology. See also David Shenk's recent book on the history of chess with a sustained discussion of my work, which can also be found on several international chess theory databases.

³⁵ *The Bride Stripped Bare By Her Bachelors, Even*, ed. Marcel Duchamp and Richard Hamilton, especially pages 1-2. Notice that this passage, though written before World War I (1913), anticipates the form and substance of Duchamp's *Given: 1. Waterfall* 2. *The Illuminating Gas* (posthumously, 1968). As I (1992; 1993; 1994) and others like Linda Henderson have demonstrated (1998), Duchamp read both Poincaré and Bergson carefully, and fully recognized the implications of an scientific revolution involving irreversible time and emergence, as his journals and his posthumous work reveal. I have argued (Rosenberg: 1994) in fact that *Étant Donnés* can be "read" as an allegorical tableau making visible the major characteristics of emergent systems: the irreversible flow of the fountain; the complex systems implied by the glow of the gas lamp; the portal to the reclining woman's womb as the site for morphogenesis; and self-reflexivity as exemplified by the ocular subject position of the observer as voyeur.

³⁶ See the fine work by both Ronald Bogue and Eugene Holland on territoriality and birdsongs in Deleuze and Guattari.

³⁷ You can hear an audio files of these works attached to the on-line version of this paper at <http://www.inflexions.org>.

³⁸ My thanks to Gene Holland, who forced me to clarify this point!

³⁹ According to Thomas Owens, Benny Harris deserves joint authorship of "Ornithology" (19-20).

⁴⁰ We could easily apply, as I have done in research on avant-garde architects Arakawa and Madeline Gins, the language of phase space and of emergent, bifurcating systems, in a discussion of bodies moving through architectural spaces (Rosenberg: 2002; 2009-forthcoming). More significant work on embodiment and emergence can be found in Erin Manning's work on dance with respect to "becoming" and "incipient action." See her just published *Relationescapes: Movement, Art, Philosophy*, especially 13-28. See as well Manning's discussion of Arakawa and Gins in the last chapter of this volume.

⁴¹ You can hear an audio file of John Coltrane's "Giant Steps" attached to the on-line version of this paper at <http://www.inflexions.org>.

⁴² You can hear an audio file of Herbie Hancock's "Tell Me a Bedtime Story" attached to the on-line version of this paper at <http://www.inflexions.org>.

⁴³ You can hear an audio file of Ornette Coleman's "Broadway Blues" attached to the on-line version of this paper at <http://www.inflexions.org>.

⁴⁴ You can hear two audio files of Miles Davis's "It's About That Time" attached to the on-line version of this paper at <http://www.inflexions.org>.

⁴⁵ You can hear an audio file of Dave Holland's "Conference of the Birds" attached to the on-line version of this paper at <http://www.inflexions.org>.

⁴⁶ With regard to the history of American Roots Music, I am indebted to my old childhood neighbor and personal hero Peter Guralnick, whose series of books constitute a most impressive history of the blues tradition from the delta, through Chicago, Memphis, Detroit and Muscle Shoals, and his latest study, Sam Cooke and his desire to both perform and produce (and thus own the means of his own production) the music of his tradition. His brother Tom Guralnick is the famed founder of a jazz performance space in Albuquerque, NM, widely praised, called The Outpost, and an avant-garde saxophonist and composer in his own right.

⁴⁷ See the movie *'Round Midnight*, which includes in the lead role Dexter Gordon as the fictional stand in for the doomed piano player Bud Powell, but who in his real life puts the lie to the self-destructive personae of those ex-patriot jazz musicians. This film boasts a cast of superb jazz artists such as Herbie Hancock, Ron Carter, John McLaughlin, Bobby Hutcherson, Billy Higgins, Wayne Shorter, Tony Williams, Freddie Hubbard, Cedar Walton and many top French jazz artists. It offers the best version of the top players from the 1960's and 1970's, paying homage to the earlier generation, such as captured by Art Kane in the famous photograph of gathered luminaries in Harlem, 1958. The movie romanticizes (reifies) and in fact allegorizes the role of Europeans, especially French audiophiles, in keeping "jazz alive" during those years of exile.

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