Sync or Swarm: Musical Improvisation and the Complex Dynamics of Group Creativity

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Abstract. This essay draws on participant observation, ethnographic interviews, phenomenological inquiry, and recent insights from the study of swarm intelligence and complex networks to illuminate the dynamics of collective musical improvisation. Throughout, it argues for a systems understanding of creativity—a view that takes seriously the notion that group creativity is not simply reducible to individual psychological processes—and it explores interconnections between the realm of musical performance, community activities, and pedagogical practices. Lastly, it offers some reflections on the ontology of art and on the role that music plays in human cognition and evolution, concluding that improvising music together allows participants and listeners to explore complex and emergent forms of social order.

1 Introduction

The nature of creativity in the arts and sciences has been of a topic of enduring human interest. But the dominant scholarly approach to the subject, until recently, has proceeded from the assumption that creativity is primarily an individual psychological process, and that the best way to investigate it is through the thoughts, emotions, and motivations of those individuals who are already thought to be gifted or innovative. In the past several decades, however, researchers have begun to focus more attention on the historical and social factors that shape and define creativity, and on its role in everyday activities and learning situations.[1] Yet despite this shift in the field towards a systems perspective, the notion that creativity operates primarily on the level of *individuals* (albeit now situated within a rich and complex environment), or that

[1] This shift is attributed in great part to the work of Mihaly Csikszentmihalyi [1], who has argued for a systems view of creativity. The work of sociologist Howard Becker has also been influential in this regard, as well as foundational work in sociology of knowledge (Mannheim), activity theory (Vygotsky), communities of practice (Lave and Wenger), ethnomethodology (Garfinkel), and ecological psychology (Gibson).

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creativity necessarily results in a creative *product,* has proved to be remarkably resilient.

The practice of improvising music together calls into question many of these assumptions. The activity is both intrinsically collaborative and inherently ephemeral. Since roughly the middle of last century, an eclectic group of artists with diverse backgrounds in contemporary jazz and classical music–and increasingly in electronic, popular, and world music traditions as well–have pioneered an approach to improvisation that borrows freely from a panoply of musical styles and traditions and at times seems unencumbered by any overt idiomatic constraints. This musical approach, often dubbed "free improvisation," tends to devalue the two dimensions that have traditionally dominated music representation–quantized pitch and metered durations–in favor of the micro-subtleties of timbral and temporal modification and the surprising and emergent properties of collective creativity in the moment of performance.[2]

In the community of free improvisers it is not uncommon for musicians to speak of the importance of developing a "group mind" during performance. This requires, at the very least, cultivating a sense of trust or empathy among group members, and, according to some, it may also involve reaching a certain egoless state in which the actions of individuals and the group perfectly harmonize. Percussionist Adam Rudolph described his trio's approach to me this way: "We all participate in creating the musical statement of the moment. In the process of being free as a collective, you have to have selflessness to give yourself to the musical moment and not come from a place of ego."[3]

In the moment-to-moment dynamics of improvised performance it can also be difficult to separate individual contributions and intentions from those cultivated by the "group mind." Bassist Richard Davis explains: "Sometimes you might put an idea in that you think is good and nobody takes to it… And then sometimes you might put an idea in that your incentive or motivation is not to influence but it does influence."[4] Acknowledging this inherent complexity, saxophonist Evan Parker finds that:

> However much you try, in a group situation what comes out is group music and some of what comes out was not your idea, but your response to somebody else's idea… The mechanism of what is provocation and what is response–the music is based on such fast interplay, such fast reactions that it is arbitrary to say, "Did you do that because I did that? Or did I do that because you did that?" And anyway the whole thing seems to be operating at a level that involves...certainly intuition, and maybe faculties of a more paranormal nature.[5]

Research on creativity has tended to make a distinction between an ideation stage, in which the non-conscious brain produces novelty through divergent thinking, and an evaluation stage, in which the conscious mind decides which new ideas are coherent

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[2] For two useful starting points on the web, covering principally the US and European scenes respectively, see www.restructures.net and www.shef.ac.uk/misc/rec/ps/efi/. See also Bailey [2].
[3] Quoted in [7], p. 80.
[4] Quoted in [6], p. 88.
[5] Quoted in [8], p. 203.

with the creative domain. From a systems perspective, however, ideation and evaluation may occur in individuals in a complex rather than a linear fashion, and during ensemble performances they may become externalized into a group process. Keith Sawyer [3], in his recent book titled *Group Creativity*, expands Mihaly Csikszentmihalyi's [4] well-known notion of "flow"–in which the skills of an individual are perfectly matched to the challenges of a task, and during which action and awareness become phenomenologically fused–to include the process of entire groups performing at their peak.[6] Group flow, according to Sawyer, can inspire individuals to play things that they would not have been able to play alone or would not have explored without the inspiration of the group. Yet as a collective and emergent property, group flow can be extremely difficult to study empirically. Sawyer describes it as an irreducible property of performing groups that cannot be reduced to psychological studies of the mental states or the subjective experiences of the individual members of the group.

Models that focus on the creativity of individuals are not wrong, but like Newtonian science, they may be inappropriate for trying to make sense of certain types of phenomena. What we need are new models operating at a different level. In the increasingly complex and interconnected world that we inhabit it is becoming apparent that structure and organization can emerge both without lead and even without seed. What happens and how it happens depends on the nature of the network.

What implications do the study of group musical performance and the study of complex network dynamics have for musical scholarship and more broadly for our understandings of human creativity? In music, networks organize not only the social world of performance (with whom you play) but also the ideascapes of creativity (by whom you are influenced and what or how you chose to create) and the dynamics of communities (how historical, cultural, and economic factors often dictate which musicians and musical ideas gain notice and prestige). Networks make communication and community possible, but they can also concentrate power and opportunities in the hands of a few. In this essay I explore the dynamics of group musical improvisation and recent insights from the study of swarm intelligence and complex networks in order to investigate some ways in which musical studies might productively grapple with the complex of factors that establish, maintain, expand, and even destroy musical communities.

2 Insect Music

> "At one level, improvisation can be compared with the ultimate otherness of an ant colony or hive of bees. Perhaps it was no coincidence that in the wake of drummer John Stevens and the Spontaneous Music Ensemble, certain strands of English improvised music were known, half-disparagingly as insect music.
>
> David Toop [9], p. 247

[6] Sawyer draws heavily on ethnographic work by Paul Berliner [5] and Ingrid Monson [6] for his perspective on jazz and improvisation.

> Improvisation is not a revolution that pits itself against codification; it is diffuse. Like ants stripping a carcass, it works from the inside and outside of codes.
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> John Corbett [10], p. 237

> In Euro-American art-music culture this binary [between composition and improvisation] is routinely and simplistically framed as involving the "effortless spontaneity" of improvisation, versus the careful deliberation of composition–the composer as ant, the improviser as grasshopper.
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> George Lewis [11], p. 38

Scientists, artists, and laypeople alike have for centuries watched in wonder as a flock of birds spontaneously takes flight and navigates in perfect harmony, or as a hive of bees throws off a collective swarm into the air. At the dawn of the twentieth century, the Belgian poet Maurice Maeterlinck wondered, "Where is 'this spirit of the hive'…where does it reside? What is it that governs here, that issues orders, foresees the future?"[7] We now know that within the swarm a half dozen or so anonymous workers scout ahead to check for possible hive locations. When they report back to the swarm, they perform an informative dance, the intensity of which corresponds to the desirability of the site they scouted. Deputy bees follow up on the more promising reports and return to either confirm or disconfirm the desirability of the new location. Although it is rare for a single bee to visit more than one potential site, through the process of compounding emphasis, the more desirable sites end up getting the most visitors. In other words, the hive chooses: the biggest crowd eventually provokes the entire swarm to dance off to its new location.

We can sense in this and other examples of complex and decentralized decision-making certain qualities that appear to inform all life. William Morton Wheeler, the founder of the field of social insects, argued as early as 1911 that an insect colony operates as a type of *superorganism*: "Like a cell or the person, it behaves as a unitary whole, maintaining its identity in space, resisting dissolution…neither a thing nor a concept, but a continual flux or process."[8] Even the sound of the swarm can fascinate human ears. For her aptly titled "Bee Project," kotoist and multimedia artist Miya Masaoka's positioned a glass-enclosed bee hive of 3,000 bees in the center of the stage and amplified, manipulated, and blended its sounds with those from a trio of improvisers, all according to the instructions in her score. Later versions of the same work have used spatialization software to twist and tilt the sound of the hive so that listeners can be sonically located within the swarm.

As the three quotes offered at the beginning of this section illustrate, there are several ways in which we might wish to locate musical connections to the swarm. Some improvised music provokes such quick reactions from players and evokes such complicated and dense soundscapes for listeners that a literal analogy to a swarm of insects may seem rather appropriate. And the ways in which individual improvisers can be heard to be "picking at" a shared body of modern techniques and sensibilities but in resolutely individualistic ways, or to be following their own creative spark while also being sensitive to and dependent on the evolving group dynamic, may

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[7] Quoted in [12], p. 7. Maeterlink's book is available online at http://www.eldritchpress.org/mm/b.html#toc.

[8] Quoted in [12], p. 7.

bring to mind the behavior of social insects that seem to have their own agenda while also working in ways that organize the group without supervision. Finally, the notion of "insect music" has perhaps become most associated with a type of generative compositional scheme, and often with the power of computers to create complex patterns from relatively simple materials, such that questions about the ways in which creativity may be facilitated or constrained and the ways in which cultural understandings may be reflected, reshaped, or remain concealed in this type of work become particularly important.

In addition to being an extremely skilled improviser, the English drummer John Stevens will always be remembered for his instrumental role in developing the scene at The Little Theater Club in London that nurtured many in the first generation of English free improvisers. One of his early pedagogical approaches was titled *Click Piece*, and it included little more that the instruction to play the shortest sounds on your instrument.[9] In the collective setting, however, one would gradually become aware of an emergent group sound. As David Toop [9] explains, "The piece seemed to develop with a mind of its own and almost as a by-product, the basic lessons of improvisation–how to listen and how to respond–could be learned through a careful enactment of the instructions" (pp. 242-3). Steven's *Click Piece* highlights one of the central aspects of swarm dynamics; relatively simple decentralized activities can produce dramatic, self-organizing behaviors.

In the scientific community, a growing number of researchers are exploring new ways of applying swarm intelligence (or SI) to diverse situations.[10] For instance, the foraging of ants has led to improved methods for routing telecommunications traffic in a busy network. The way in which insects cluster their dead can aid in analyzing bank data. The distributed and cooperative approach used by many social insects to transport goods and to solve navigational problems has led to new insights in the fields of robotics and artificial intelligence. And the evolving division of labor in honeybees has helped to improve the organization of factory assembly line workers and equipment. As Eric Bonabeau and Guy Théraulaz [15] see it: "The potential of swarm intelligence is enormous. It offers an alternative way of designing systems that have traditionally required centralized control and extensive preprogramming" (p.79).

Beyond these business and technological applications, however, one of the main lessons of contemplating SI is that organized behaviors can develop in decentralized ways. Can exploring and thinking about SI affect the way we make and think about music? It remains difficult for many people to envision complex systems organizing without a leader since we are often predisposed to think in terms of central control and hierarchical command. The notion that music can be organized in complex ways without a composer or conductor still leaves many scratching their heads in doubt. Scientists have also been predisposed in the past to look for chains of command, instances of clear cause and effect. But the emerging field of SI demonstrates that complex behaviors and efficient solutions can be arrived at without a leader, organized without an organizer, coordinated without a coordinator.

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[9] Stevens titled the reverse strategy "Sustained Piece."

[10] Although this field is often presented as evolving in only the past few years, examples drawn from the world of social insects can be found in early cybernetics theory [13], pp. 156-7 and in dissipative structures as well [14], pp. 181-6.

The secret of the swarm lies in the intercommunication of its members. Through direct and indirect interactions among autonomous agents and between agents and their environment, swarm systems are able to self-organize in decentralized, robust, and flexible ways. Bonabeau, Théraulaz, and Marco Dorigo [16], a physicist, biologist, and engineer working together at the Santa Fe Institute, offer a list of four basic ingredients that through their interplay can manifest in swarm intelligence: 1) forms of positive feedback, 2) forms of negative feedback, 3) a degree of randomness or error, and finally 4) multiple interactions of multiple entities.

Positive feedback in SI can be usefully summarized as simple "rules of thumb" that promote the creation of structures: activities such as recruitment and reinforcement. Negative feedback counterbalances positive feedback and helps to stabilize the system: it may take the form of saturation, exhaustion, or competition. A certain degree of randomness or error is also crucial, since it enables the discovery of new solutions and produces fluctuations that can act as seeds from which new structures develop. Finally, SI generally requires a minimum density of mutually tolerant individuals, since individuals should be able to make use of the results of their own activities and the activities of others.

While something of a general and descriptive list, these ingredients do play important roles in collective improvisation. Through positive feedback musicians not only develop their own ideas from a kernel of inspiration, but they also work together to support the ideas of others and the evolving ensemble sound. They "recruit" others to support or sustain their own developments, or they may choose to "reinforce" the creative direction of others instead. Similar to the ways in which information about the best food source or the shortest path can be compounded among a swarm of bees or a colony of ants, positive feedback increases the ability of an improvising group to follow the more "promising" of many concurrent ideas being pursued by various members.

Negative feedback in improvisation helps to keep things interesting. By intentionally looking elsewhere for new ideas or new musical areas to explore, individuals can either signal transitions away from ensemble moments that have lingered too long or seem to be going nowhere (the feelings of saturation and exhaustion), or they can productively layer divergent sonic qualities and musical ideas together or provoke others to boost their own creativity (through a competitive element). Negative feedback helps to maintain a balance in the evolving improvisation so that one idea does not continue to amplify indefinitely (although a more static approach can produce interesting results as well).

Unexpected occurrences, in the form of randomness or error, often provide both source material and inspiration for individuals and groups to explore new sonic territory, musical techniques, and interactive strategies. Noticing and capitalizing on unexpected fluctuations as an improvisation unfolds can produce important structural cues, developments, and transitions, and it represents a particular joy of improvised music making in general. Without this third ingredient, groups of improvisers who work together over a longer period of time might become too familiar with one another's musical language and approach or might fall into regular strategies of support and counterbalance (and this of course does happen).

Finally, the notion that individuals and the group as a whole benefit from multiple interactions and perspectives is something of an axiom in ensemble forms of improvisation and in the community of improvisers. One of the particular challenges

of contemporary improvisation, for both players and listeners, is to remain aware of and sensitive to the many musical gestures and processes circulating between members of the group in the moment of performance and between members of the community as ideas circulate via recordings, impromptu meetings, and the overlapping personnel of various working groups.[11]

In much freer improvisation, the collective pattern of the group is more important than any of the individual actions heard in isolation. But this does not deny freedom to individual musicians. Saxophonist Evan Parker [17] highlights the ways in which freedom works within the collective unfolding of what might easily be termed swarm dynamics:

> The freedom is of course that since you and your response are part of the context for other people, and they have that function for you, it's very hard to unravel the knots of why anybody is doing what they do in a given context. I think it's pretty clear that you could sort of go with the flow, or you could go against the flow. And sometimes what the music really needs is for you to go with the flow, and sometimes what it really needs is for you to do something different. Or anybody, somebody, to do something different. So that's why people improvise, presumably, because they want the freedom to behave in accordance with their response to the situations. But since their response then becomes part of the new situation for the other players, it's very hard to say why a particular sequence of events unfolds in the way it does. But we get used to following the narrative of improvisational discourse...

Parker's notion that "the music" *needs* for things to happen, *needs* for musicians to do things, is a fairly common way in which improvisers speak about the process of performance. In his liner notes to the album *In Order to Survive*, bassist William Parker (no relation) expresses that, "Creative Music is any music that procreates itself as it is being played to ignite into a living entity that is bigger than the composer and player."[12] While these comments certainly resonate with the notion of a superorganism touched on earlier, they may also highlight an additional dimension of SI research: interactions within a swarm can be both direct and indirect. The direct interactions are the obvious ones: with ants this can involve antennation or mandibular contact, food or liquid exchange, chemical contact, etc. But indirect interactions are more subtle. In SI they are referred to by the rather cumbersome term *stigmergy* (from the Greek *stigma*: sting, and *ergon*: work). Stigmergy describes the indirect interaction between individuals when one of them modifies the environment and the other responds to the new environment rather than directly to the actions of the first individual. This helps to describe the process of "incremental construction" that many social insects use to build extremely complex structures or to arrange items in ways that might at first seem arbitrary or random. And because positive feedback can produce nonlinear effects, indirect interaction can result in dramatic bifurcations when a critical point is reached: for example, some species of termites alternate

[11] Here we might also want to envision the creative process of each individual as a type of swarm dynamic, as the processes of ideation and evaluation can work rapidly and in complex and nonlinear ways.

[12] *Black Saint* records 12015902 (1995).

between non-coordinated and coordinated building to produce neatly arranged pillars or strips of soil pellets.

But swarm intelligence has its limits and its drawbacks. Social insects can adapt to changes in their environment, but only within a certain degree of tolerance. For instance, many social insects are able to seek out and find new food sources when an existing one is exhausted, or some species are able to reallocate labor roles if the number of required workers for a specific task dwindles, all without explicit instruction. But the "army ant syndrome" offers a compelling example of the limits to this adaptability and of swarm intelligence in general. Among army ants, when a group of foragers accidentally gets separated from the main colony, the separated workers run in a densely packed "circular mill" until they all eventually die from exhaustion. Although able to function well within the group under normal circumstances, an unpredictable perturbation of a large enough degree can destroy the colony's cohesiveness and make it impossible for the group to recover.

For a musical analogy, while sensitivity to the group is an essential component of improvised performance, to blindly base one's own playing on what others do or to simply follow the group as an overriding strategy can lead to rather inflexible and ineffective results, producing a musical "circular mill." And many improvisers, if they sense that all of the participants are following each other too carefully, will "go against the grain" or "forge out on their own" into new sonic territory; in other words, they will defy the logic of the hive mind. To return briefly to our earlier example of John Stevens's *Click Piece*, although this generative approach to collective improvisation offered an effective way to make "quite ravishing" music with a large ensemble comprising players of mixed ability and experience, to more skillful and confident musicians it quickly became an unproductive limitation. Simplifying the parameters for improvisation can be useful and even necessary for making large ensembles swarm effectively, but in the more intimate setting of a small group, arguably the preferred arrangement for the majority of free improvisation enthusiasts, a less restrictive framework is usually desired.

The cohesion of small groups can also be jeopardized by imbalances that lead to polarization. Drawing on research with decision-making among corporate boards and committees, James Surowiecki [18] identifies a few qualities that appear to factor into all intimate social settings: earlier comments are more influential; higher status people talk more and more often; and status is not always derived from knowledge/experience. Since constantly making comparisons and adjustments to others can result in an unproductive "group think," it is important for individuals to champion their own ideas in small group settings. But too much vehemence in this can lead to a completely polarized setting or to an "information cascade" when others are subsumed by a singular view or opinion. In short, deference to the ideas of others is important, but so is dissent when required.

Without a doubt there are important differences in the degrees of freedom allowed in a swarm of bees and in the sonic swarm of collective improvisation. But if interesting complexities can emerge from groupings of individuals with a limited array of communication possibilities, how much more can we expect from experienced and creative artists? J. Stephen Lansing [19], an anthropologist who also serves as external faculty at the Santa Fe Institute, wonders about complex adaptive systems in general: "What if the elements are not cells or light bulbs but agents capable of reacting with new strategies or foresight to the patterns they have helped to

create?" (p. 194). Much of the current research by social scientists on complex adaptive systems is concerned with precisely this question.

The field of SI is still very much in its infancy. It is often extremely difficult for researchers to understand the inner workings of insect swarms and the variety of rules by which individuals in a swarm interact. Even in those cases when we can understand the behaviors of individuals, we may still be unable to predict or understand the dynamics of the overall system since countless other environmental factors come into play. When transposed into the realm of humans, these uncertainties only compound themselves. Discussing the business and technological applications of SI, Bonabeau and Théraulaz [15] confess that: "Although swarm-intelligence approaches have been effective at performing a number of optimization and control tasks, the systems developed have been inherently reactive and lack the necessary overview to solve problems that require in-depth reasoning techniques" (p.79). We still don't know enough about social insects, little less social humans, to be able to understand how certain group behaviors emerge and evolve.

Nevertheless, the notion that a group can have capacities and capabilities that extend beyond the scope of any of its participating members is a powerful one. In a provocative chapter titled "Hive Mind" from his book *Out of Control*, Kevin Kelly [12] points out that the hive does possess much that none of its parts possesses. Not only does swarm intelligence represent a type of distributed perception for the hive, but the hive also possesses a type of distributed memory; the average honeybee operates with a memory of six days, but the hive as a whole operates with a distributed memory of up to three months, twice as long as the lifetime of the average bee. Bonabeau et al. [16] write:

> We suggest that the social insect metaphor may go beyond superficial considerations. At a time when the world is becoming so complex that no single human being can really understand it, when information (and not the lack of it) is threatening our lives, when software systems become so intractable that they can no longer be controlled, perhaps the scientific and engineering world will be more willing to consider another way of designing "intelligent" systems where autonomy, emergence and distributed functioning replace control, prepro-gramming, and centralization (p.22).

We might also hope that the music world will continue to explore ways of organizing sonic and social experiences that do not hinge on centralized notions of control. Well aware of these concerns, trombonist/composer/scholar George Lewis [20] writes in a recent essay reflecting on improvisation and the orchestra:

> Orchestra performers operate as part of a network comprised not only of musicians, composers and conductors, but also administrators, foundations, critics and the media, historians, educational institutions, and much more. Each of the nodes within this network, not just those directly making music, would need to become "improvisation-aware," as part of a process of resocialization and economic restructuring that could help bring about the transformation of the orchestra that so many have envisioned.

3 A Web Without a Spider

If group improvisation may be heard in its best moments to demonstrate complex and emergent properties that are somehow greater than the sum of its parts, then investigating individuals and ensembles in isolation of the network of surrounding influences will not suffice. And as we move our gaze further into the social and historical realms, the notion that any one individual is controlling their own web of musical sounds and meanings becomes rather untenable. We need to reorient our analytical framework to take account of the dynamics that occur in ensembles as they perform together over days, weeks, months, and even years. And we need to acknowledge the ways in which influences in musical communities circulate through more than the sounds of performances and recordings; meaning is everywhere, not simply in the "sounds themselves." The networks involved include a host of social conventions and material artifacts that affect the ways in which music is made and heard: from the funding sources or media attention that a performer may receive to the casual conversations or critical reviews that a performance may provoke. While it may be fairly common to acknowledge the subtle influence that specific audiences and venues can have on performance, especially in relation to improvisation, the network of material, economic, technological, educational, and social factors at play, and the complex meanings that they generate through their interactions, are far more involved than that. In fascinating ways, this network-style organization both shapes and is shaped by the activity of all of its participants; everyone changes the state of everyone else. Although the spontaneous and surprising occurrences in improvised performance can attract our immediate attention, it is through the dynamic interplay of social, material, and sonic culture that we begin to sense the true lifeblood of the music.

Although networks have interested researchers for decades, until recently, each system tended to be treated in isolation, with little apparent reason or possible means to see if its organizational dynamics had anything in common with other networks. We are only now beginning to piece together some important qualities of, and approaches to, the study of complex dynamic networks on a broad scale. But Albert-László Barabási [21], one of the leading researchers in this still nascent field, optimistically predicts: "Network thinking is poised to invade all domains of human activity and most fields of human inquiry. It is more than another helpful perspective or tool. Networks are by their very nature the fabric of most complex systems, and nodes and links deeply infuse all strategies aimed at approaching our interlocked universe" (p. 222).

The notion of networks may bring to mind rather bare-boned models of how things are connected. To some extent this is true, since simplifying detail on one level of a network can highlight organizational similarities on another that would otherwise go unnoticed. Network models, however, are increasingly able to take account of some of the rich dynamics that occur when individual components are not only doing something–generating power, sending data, even making decisions–but also are affecting one another over time. Steven Shaviro [22] writes in his book *Connected, Or What it Means to Live in the Network Society*:

> As it seems to us now, a network is a self-generating, self-organizing, self-sustaining system. It works through multiple feedback loops. These loops allow the system to monitor and modulate its own performance continually and thereby maintain a state of homeostatic equilibrium. At the same time, feedback loops induce effects of interference, amplifications, and resonance. And such effects permit the system to grow, both in size and in complexity. Beyond this, a network is always nested in a hierarchy. From the inside, it seems to be entirely self-contained, but from the outside, it turns out to be part of a still larger network (p. 10).

Music, as an inherently social practice, thrives on network organization. On perhaps the most tangible level, a musician's livelihood and creative opportunities frequently depend on the breadth and depth of one's network of social and professional contacts. But network dynamics shape the sounds, practices, and communities of music in decidedly more complex and subtle ways as well. Musicians are influenced by their years of training or apprenticeship, countless hours spent listening to music both publicly and privately, and perhaps most comprehensively (yet frequently least acknowledged) by the historical and cultural conventions of a given time and locale. The topics and techniques of music education also depend on these network-style dynamics, which inform the process of choosing canons and of exploring and imparting the intricacies of musical theory and musical aesthetics. Finally the music industry's far-reaching networks of production and distribution, and increasingly its consolidated and insular organizational practices, have the power to structure, at some degree or another, the networks of inspiration and possibility for nearly everyone who is deeply committed to music.

Yet music researchers have in the past focused the lion's share of attention on the creative work of individuals, often treating their "work" as a collection of static objects (e.g., scores or recordings) to be dissected and categorized. It is not uncommon to hear graduate students in musicology programs lamenting (or coming to terms with) the fact that they must find an increasingly obscure composer or performer on whose work to focus their "comprehensive" scholarly lens. There has, of course, been a pronounced and welcome shift in the past few decades towards a "new musicology" that takes into account the historical and cultural factors that influence not only the original production of a musical "work," but also its variable reception, taking particular notice of gender and racial constructions that may affect both of these.[13] And there has been a marked increase in the number of scholars interested in expanding the scope of musical investigation into popular and non-Western topics as the fields of ethnomusicology and popular music studies have come into their own. But on the whole, music scholarship is only now beginning to focus attention on the organizational complexities of music rather than treat it as the provenance of a few gifted and prolific individuals.

The musical community has a vested interest in understanding network dynamics, although individuals may vary considerably in their specific expectations. Network thinking can shed light on the cultural power inequities that produce imbalances in social and economic interactions. It may also tell us much about the spread of ideas in musical communities and marketplaces under diverse historical and cultural

[13] For examples, see the work of Susan Mclary and Suzanne Cusick among others.

conditions. Creative musicians may hope to find in network dynamics glimpses of future directions for innovation or influence, strategies for how to avoid or disrupt network hubs and established practices in hopes of alternative community reorganization, or the means by which they might increase their own professional contacts and opportunities.

Actor-Network Theory (ANT), a sociological approach that has emerged out of science and technology studies, is geared towards embodying this very tension between the centered 'actor' on the one hand and the decentered 'network' on the other. As John Law [23], one of the field's leading researchers, remarks: "In one sense the word [actor network theory] is thus a way of performing both an elision and a difference between what Anglophones distinguish by calling 'agency' and 'structure'" (p.5).[14] In short, ANT does not accept the notion that there is a macrosocial system on the one hand, and bits and pieces of derivative microsocial detail on the other. According to Law:

> If we do this we close off most of the interesting questions about the origins of power and organization. Instead we should start with a clean slate. For instance, we might start with interaction and assume that interaction is all that there is. Then we might ask how some kinds of interactions more or less succeed in stabilising and reproducing themselves: how it is that they overcome resistance and seem to become "macrosocial"; how it is that they seem to generate the effects such as power, fame, size, scope or organisation with which we are all familiar. This, then, is the one of the core assumptions of actor-network theory: that Napoleons are no different in kind to small-time hustlers, and IBMs to whelk-stalls. And if they are larger, then we should be studying how this comes about–how, in other words, size, power or organisation are generated.[15]

As musical traditions expand in scope and popularity, better-connected "hubs" tend to emerge. In jazz, for example, the "hubs" of Louis Armstrong, Duke Ellington, Charlie Parker, Miles Davis, and John Coltrane, among others, are impossible to ignore. During their lifetimes these musicians were well respected and well connected (although not always early in their careers and not by everyone) and their influence has only grown since. With the spread of institutionalized jazz education and the increasing reliance of major labels on re-releasing canonical jazz recordings, the visibility and "connectedness" of these hubs may only continue to grow. For instance, in the last few years Columbia, Atlantic, and Verve have all drastically reduced their roster of living artists in favor of re-releasing older material. Even the Marsalises, perhaps the most visible jazz performers today, no longer have a major record deal. David Hajdu [24] perceptively writes in an *Atlantic Monthly* spread on Wynton: "Where the young lions saw role models and their critics saw idolatry, the record companies saw brand names–the ultimate prize of American marketing. For long established record companies with a vast archive of historic recordings, the economies were irresistible: it is far more profitable to wrap new covers around albums paid for generations ago than it is to find, record, and promote new artists" (p. 54).

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[14] For other important work in ANT see the publications of Geoffrey C. Bowker and Susan Leigh Star.

[15] http://www.comp.lancs.ac.uk/sociology/soc054jl.html.

For an artistic tradition to remain dynamic and healthy the network dynamics that take note of history and provide hubs for a common language and style should not become too powerful. If the disparity between the hubs and the remainder becomes too great, there may be a "tipping point" beyond which communication and innovation in a tradition can suffer dramatically.[16] In the same *Atlantic Monthly* article, Jeff Levinson, the former Columbia Jazz executive, is quoted as saying: "The Frankenstein monster has turned on its creators. In paying homage to the greats, Wynton and his peers have gotten supplanted by them in the minds of the populace. They've gotten supplanted by dead people" (p. 54).[17] The disparity of attention in music seems to be regulated through the process of interaction. This can come in the direct form of collaboration between artists, but also in the indirect form of media attention, record sales, performance opportunities, and arts funding or sponsorship.

In what is perhaps its most radical move, ANT attempts to take account of the heterogeneous networks that include not only social or human dimensions, but also the material dimensions that make human and social behaviors possible. ANT explores how these heterogeneous networks come to be patterned to generate effects like organizations, inequality, and power. Joseph Goguen explains:

> Actor-Network theory can be seen as a systematic way to bring out the infrastructure that is usually left out of the "heroic" accounts of scientific and technological achievements. Newton did not really act alone in creating the theory of gravitation: he needed observational data from the Astronomer Royal, John Flamsteed, he needed publication support from the Royal Society and its members (most especially Edmund Halley), he needed the geometry of Euclid, the astronomy of Kepler, the mathematics of Galileo, the rooms, lab, food, etc. at Trinity College, an assistant to work in the lab, the mystical idea of action at a distance, and more, much more.[18]

The goals of network theory are gradually shifting from describing the topology of systems to understanding the mechanisms that shape network evolution. Barabási [21] acknowledges that, "We must move beyond structure and topology and start focusing on the dynamics that take place along the links. Networks are only the skeleton of complexity, the highways for the various processes that make our world hum. To describe society we must dress the links of the social network with actual dynamical interactions between people" (p. 225).

As in a house of mirrors, the science of networks has seemingly led us to a place in which all of the details matter and, to some extent, none of them do. Since at least the work of Emile Durkheim we have known that large-scale social phenomenon–the predictable number of Parisians who commit suicide every year–can be independent of the particulars–which Parisians are actually led to kill themselves and why. And

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[16] For a popular science treatment of the notion of a "tipping point" see Gladwell [25].

[17] For a recent example of how powerful hubs have become in jazz, the San Francisco Jazz Spring 2005 series of concerts featured no less than seven tributes to the music of John Coltrane within a month's time, including versions of his music from the albums *A Love Supreme, Ascension, Africa Brass, Crescent,* and *Interstellar Space.* There was also a concert by the Mingus Big Band and a tribute to the music of Rashaan Roland Kirk as well.

[18] http://carbon.cudenver.edu/~mryder/itc_data/ant_dff.html.

despite the enormous complexities of the Isaac Newton example described above, scientists in the modern era glean what they need to from Newton, usually without reading his original work, and they move on to more pressing concerns.

Yet the details and vagaries of a network system do seem to matter enormously. Although network theory often focuses on large-scale behaviors, these large-scale behaviors are fundamentally provoked by the ability of one individual to influence another and the notion that people can change their strategies depending on what other people are doing. Through these dynamics alone, systems can self-organize in remarkably complex ways.

In music, the practice of free improvisation is perhaps closest to this ideal of a self-organizing system. Its bottom-up style emphasizes possibilities for adaptation and emergence; it accentuates creativity-in-time and the dynamics of internal change. The structures of improvisation can also continue to be extended in boundless ways (although the system may be circumscribed, at least in part, by the abilities, materials, and experiences of those who are participating). From one perspective, improvised music is resilient to individual "mistakes" since sounds can be re-contextualized after the fact by either the original performer or others in the group. And if one musician drops out or is unable to make a performance, the system can often continue to function without major interruption, perhaps even organizing in ways that are both novel and more complex. From another perspective, however, group improvisation may be less resilient to personality conflicts or pronounced aesthetic differences between individuals. With traditional musical practices that are organized in a predominantly hierarchical manner, personality differences can often be managed in deference to the group leader, the authority of the musical score, or the professionalism of "getting the job done." Free improvisation ensembles tend to aim for a more egalitarian organization that makes them particularly susceptible to the full spectrum of both musical and so-called "extra-musical" influences.[19]

Despite its many promising qualities, improvisation is also rarely, if ever, the "optimal" means to achieve a specific musical end (although it may in fact be both a quicker and easier route to certain types of chaotic dynamics). The internal dynamics of an improvising ensemble (particularly larger groupings of musicians) can be slow to respond to change, and are, for the most part, beyond the control of any one individual. Even when things do appear to work well, it will be impossible to analyze the system's dynamics during or after the fact with absolute precision. As with other emergent forms of order, the collective dynamics of improvisation will, by definition, always transcend the full awareness of individuals. For these and other reasons, many ensembles choose to adopt certain compositional schemes or devices in order to offer some additional degrees of control over the situation. There is no guarantee, particularly in individual performances, that divergent components will find ways to self-organize effectively.[20] In general, however, the improvising music community

[19] For a related discussion see [26].

[20] It is interesting to note that, for a music predicated on what can be a very risky endeavor–to improvise collectively in a group setting–accounts of failure can be very difficult to locate in both the academic and trade coverage of the music. Similar to mechanical systems, we may learn as much or even more by examining occasions on which improvised performance appears to falter

demonstrates the remarkable ability to absorb the new and the diverse without disruption.

Individual ensembles will often, over time, establish their own sense of identity or coherence. The boundary that develops naturally within an ensemble is not necessarily one of personal affinity or exclusion, or one of aesthetic mandate, but rather one of trust and conviviality. Like the boundary of a storm or the membrane of a human cell, this boundary is both permeable and permanent. It defines the identity of the system but also allows for the ongoing dynamics of exchange that are necessary to maintain its existence. Of course, a certain danger may lurk for both physical and musical systems if this boundary becomes either too porous or too impermeable. If too much exchange is fostered with outside forces, the identity of a system may be put in jeopardy. Likewise, if too little exchange is allowed or encouraged, a system may decline either from reduced internal dynamics, or from its inability to continue to adapt to the changing dynamics of its environment.

Network theory tells us that very different things can be connected through surprisingly short distances. Small effects can have large causes, while at other times large disturbances may be absorbed without much notice. Although the predictive power of network theory is still an open question, it may be enough that through these perspectives and approaches we can gain a better understanding of the structure of connected systems and the way that different sorts of influences propagate through them. Duncan Watts [27], another leading voice in the field, reminds us that, "Darwin's theory of natural selection, for instance, doesn't actually predict anything. Nevertheless, it gives us enormous power to make sense of the world we observe, and therefore (if we chose) to make intelligent decisions about our place in it" (p. 302).

Although only limited work has been done on large-scale music networks to date, one study that explored the relationships between jazz musicians from 1912 to 1940 found so-called "small world" properties. By using the Red Hot Jazz Archive database on the Internet, Pablo Gleiser and Leon Danon [28] found that, on average, only 2.79 steps separated early jazz musicians from one another. Their model also captured the clustering of jazz musicians by geography, with New York and Chicago as the major hubs, and by race, due to the highly segregated nature of the music industry at the time. As in most human networks, a few individuals had very high degrees of connectivity. Guitarist Eddie Lang topped their list, with connections to 415 other musicians, while artists like Jack Teagarden, Joe Venuti, and Louis Armstrong were all in the top 10 of most connected musicians. UCSD Professor Richard Belew and I are beginning a similar project to study the network dynamics of musical communities using discographic information that will take account of more contemporary artists as well.

Through the wonders of modern network technologies we can now connect to the farthest reaches of the globe in an instant. And with more than a century of recorded music available to us, we can easily engage with sounds that are similarly removed from us, both culturally and historically. But in the age of iPods and web surfing we also experience the world in increasing isolation at the same time. Yet the resoundingly social nature of music, when viewed as performance rather than product, offers the possibility for humans to synchronize their ears, brains, and bodies in ways that may be unavailable otherwise. And improvised music's particular penchant for the emergent and unexpected may even allow us to explore and expand our own homophily parameter–the sociological tendency of like to associate with like–as

familiar and less familiar sounds and people join together to find a common ground, even if only temporarily.[21]

4 Harnessing Complexity

How can these practices be nurtured, particularly within the rather serious and sedate halls of the music academy? The jazz community has traditionally stressed a type of learning that might be called in contemporary discourse embodied, situated, and distributed.[22] Not only have many performers stressed the full integration of aural, physical, and intellectual aspects of the music, but the notion that learning and development can only occur within a supportive community is seen as paramount. The Association for the Advancement of Creative Musicians (AACM) in Chicago and the Creative Music Studio (CMS) in Woodstock, NY are two of the better-known examples of this pedagogical orientation. In the standard music academy, however, the study of musical improvisation has often been shoehorned into the conventional curriculum or simply not addressed at all.

When addressed, institutionalized approaches to teaching musical improvisation have tended to stress individual facility through memorization and pre-planning, leaving little room for collective experimentation. Jonty Stockdale [29] finds that: "[I]mprovisation in jazz studies programmes is infrequently developed through a collective process, with a preference for the development of soloing facility through the absorption and imitation of pre-existing language, usage, and style. Whilst this is regarded as important for the development of a young jazz musician, matters of self-expression, individualism, and most importantly experimentation are often left to later stages, by which time exploration of free collective playing can appear unnecessary or even redundant" (p. 109).

In his account of group creativity, Keith Sawyer [3] makes an important distinction between a problem-solving and a problem-finding approach to art. Artists adopting problem-solving techniques begin with a relatively detailed plan and work to accomplish it successfully. Those employing a problem-finding approach, by contrast, search for interesting problems as the work unfolds in an improvisatory manner. Many beginning jazz improvisers are stuck in a problem-solving mode. As pianist/composer Anthony Davis expressed to me in a recent interview: "They have been taught right and wrong–these are the notes, these are the chords, these are the arpeggios that work on a given chord. This chord happens on the 5th bar [in a blues]." But through extended listening, practicing, and playing with musicians who are more experienced, Davis finds that jazz players can move from a "dependence on articulating the form" to "using the form, realizing that [the tune structure] is the beginning of something and you have to create something else… They have to do more than just keep time, they have to articulate time… They can make melodic

[21] Duncan Watts's current research shows that the most searchable networks involve individuals who are neither too one-dimensional nor too scattered. As long as people have at least two dimensions along which they are able to judge their similarity to others, then small world networks are possible–people can still find short paths to remote and unfamiliar areas.
[22] For more on this topic see chapter seven in Borgo [40].

choices that are at least as strong as the melody that was there before." Even as students become more proficient, however, Davis reminds them that, "You have to get beyond your mannerisms to really come up with a musical idea as opposed to a catalog of what you do."

Problem-finding approaches are equally important when improvising in a group, since it is often impossible to determine the meaning of an action until other performers have responded to it. The particular challenge of group improvisation, then, is that each performer may have a rather different interpretation of what is going on and where the performance might be going. In other words, intersubjectivity is intrinsic to group performances. For Sawyer [3], however, "The key question about intersubjectivity in group creativity is not how performers come to share identical representations, but rather, how a coherent interaction can proceed even when they do not" (p. 9). In part, this is possible because individuals shape a performance on both denotative and metapragmatic levels; they simultaneously enact the details of a performance and negotiate their interactions together. Even if a singular meaning to performance always remains elusive, participants can shape the ways in which their various interactions unfold.

Davis stresses that it is critical that students learn the difference between listening and following: "In order to listen, you don't necessarily follow…You try to construct something that coexists or works well with something else–not necessarily this tail-wagging-the-dog thing where you just follow someone." For Davis, "Listening is knowing what someone is doing and using it in a constructive way, as opposed to mimicry, just trying to demonstrate that you are quote-unquote listening." The very notion that everything could be heard, processed, and immediately responded to during complex moments of improvised music is, by itself, far too facile. Trombonist/composer/scholar George Lewis [11] describes a type of "multi-dominance" in improvised music–an African-American aesthetic by which individuals articulate their own perspectives yet remain aware of the group dynamic, ensuring that others are able to do so as well.

Yet exactly how group flow is cultivated in improvised performances can remain rather mysterious. Describing his general approach to me, contrabassist Bertram Turetzky remarked: "One way when I play free music, I try not to think of anything. I respond or I initiate. And whatever my intuitions tell me, I go with them… Other times in free music, I play with people perhaps I don't know. And I say, well, the last one started soft and slow and got faster and then went back… So all of a sudden I start banging things and doing all kinds of stuff… For some people, I think you have to be very rational. And you perhaps have to have an idea of where you think it could go, and be the quarterback." Turetzky acknowledged that establishing a proper group rapport can be difficult "if someone has a big ego and wants to make everything compositional." When he perceives that the group flow is in jeopardy, at times he may adopt a third strategy: "If there are three of four people, maybe I'll stop a little bit and let them see what they want to do. If there is a mess, let them sort it out. Let them start something and maybe I can support them."

Certain exercises employed by improvising actors may be useful for improvising musicians. For instance, dramatist Keith Johnstone [30] believes that, "Humans are too skilled in suppressing action. All the improvisation teacher has to do is to reverse

this skill and he creates very gifted improvisers. Bad improvisers block action, often with a high degree of skill. Good improvisers develop action" (p. 95).[23] Improvising actors are taught that, instead of denying or rejecting what has been previously introduced into the dramatic frame, they should accept the actions/words of others as dramatic "offers" and, in turn, add something to the dramatic frame, i.e., present a complimentary "offer," or "revoice" an existing "offer." The inherent challenge is to avoid circumscribing or over-directing the group flow. This does not, however, preclude the possibility of swiftly changing dramatic or musical directions, as the case may be, but care should be taken to do this in a way that keeps previous developments available for future moments of reference or expansion; a practice called "shelving" by improvising actors. Of course, evaluating exactly when "revoicing" or "shelving" the "offers" of others has been successful can be a tricky proposition. And the inherent complexity, polyphony, and polysemy of music can make this even more challenging. At heart, however, these exercises in improvised theater, and similar ones adopted by musicians, are designed to improve one's ability to listen and remember, so that the ongoing group development will be stimulated rather than curtailed.

Compositional schemes and strategies are often employed to help organize improvised music, either prior to, or in the moment of, performance. Deciding how or how much to organize performances, here again, becomes a tricky endeavor. John Zorn's *Cobra* may be the best-known "game piece" for improvising musicians. Making a distinction between his work and conventional notions of composition, Zorn remarked:

> In my case, when you talk about my work, my scores exist for improvisers. There are no sounds written out. It doesn't exist on a time line where you move from one point to the next. My pieces are written as a series of roles, structures, relationships among players, different roles that the players can take to get different events in the music to happen. And my concern as a composer is only dealing in the abstract with these roles like the roles of a sports game like football or basketball. You have the roles, then you pick the players to play the game and they do it. And the game is different according to who is playing, how well they are able to play…[24]

With their attentions already engaged in complex ways during performance, others worry that highly involved schemes for structuring improvisation can hinder rather than assist the natural development of the music. For instance, performer/scholar Tom Nunn [32] writes: "When improvisation plans are complicated–no matter how clear or well explained they might be–the attention of the improviser is constantly divided between the plan and the musical moment, having to remember, or look at a score, a graphic, or even a conductor. What often happens is that both the plan and the music suffer from this divided attention" (p. 162).

In a recent interview, contrabassist Mark Dresser discussed with me the challenges inherent in structuring pieces for improvisers: "Composition is often about control. You have to build [improvisation] in. I've built pieces that have been little prisons,

[23] For a related treatment regarding jazz improvisation, see [31].
[24] Quoted in [10], p. 233.

too. You're looking at something really specific." But he added, "It's a trip to find the balance. You try to find combinations where you have real focus and condensation, and points of real expansion. For me, it is all about being a complete musician. All of those things are interesting. At different points in the evening I try to have all of those things. Its funny, though, when you get in the composer's head it's really hard to let go of trying to control it or to create this kind of balance."

Even compositional strategies that have the sole intent of facilitating group improvisation during performance can backfire. Referring to Butch Morris's extensive system of conducted gestures designed to help organize improvised performances, Dresser commented: "I've seen the conduction thing be a disaster with people who just don't like to be controlled." Without pre-conceived strategies, however, there is an ever-present danger that improvised music will fail on its own. This danger may also increase with the size of the group. Philip Alperson [33] writes: "As the number of designing intelligences increases, the greater is the difficulty in coordinating all the parts; the twin dangers of cacophony and opacity lurk around the corner" (p. 22).

This makes those moments when group improvisation is deemed successful all the more powerful. While interviewing bassist Lisle Ellis, he confided: "A lot of improvised music I don't think is very good music. But man, when it hits, it's extraordinary! That's what I've spent my life doing–waiting for those moments when it really lines up–to find a way to have some consistency in it. Some days I think I really know how to do that and other days I think I don't have a clue." In a telling aside that highlights this balancing act of harnessing creativity, Ellis remarked, "I've got to write more stuff down. I've got to write less stuff down."

When discussing improvisation and composition, it can be particularly challenging to avoid thinking in terms of simple dichotomies while at the same time remaining leery of equally facile truisms about the music. Only with dualistic thinking, which presents two things as opposed and forces one to choose between them, are preparing for something in advance and the leap of freedom into the unforeseen viewed as antithetical or incompatible. Dresser finds that, "Within control there are lots of possibilities for freedom." And discussing his time spent as young man in classes with Muhal Richard Abrams at the AACM school, George Lewis [34] writes: "Improvisation and composition were discussed as two necessary and interacting parts of the total music-making experience, rather than essentialized as utterly different, diametrically opposed creative processes, or hierarchized with one discipline framed as being more important than the other" (p. 86). Dresser recounted a telling moment during his first tour with Anthony Braxton's quartet that resonates with this issue: "The only time that Braxton criticized the quartet, he said, 'Well, you guys are playing the music correctly, but you're just playing it correctly.' The criticism was you are being too dutiful, you're not taking a chance. That was the day that the format of the music actually changed, from being a solo-based music to an ensemble music. All of a sudden, the nature of the music became different. That moment articulated when the group came into its own."

5 Final Thoughts

Why do people tend to assume that systems are organized either by lead or by seed? In part, this is undoubtedly due to the fact that many if not most of our social institutions and artistic creations *are* organized in this way. Yet an extreme reliance on centralized organization and centralized metaphors in the past has led to a situation in which many people are unwilling or unable to imagine systems organizing in a decentralized fashion.[25] When people hear music they tend to assume a composer, a leader, or, when that music is improvised, they tend to assume that creativity emerges solely from the individual. In many cases these intuitions may be right. But one of the more encouraging aspects of much contemporary experimental music is that it is not always easy or even possible to know if a particular instance of music was or was not composed ahead of time.[26] And the generative power of computers is blurring these lines even further. Perhaps most encouraging of all, however, is the fact that creativity is increasingly being viewed as a web of network interactions operating on all scales, reflecting individual, social, cultural, and historical dimensions.

There are many compelling reasons to view artistic behavior not as some special kind of activity cut off from the rest of human behavior but rather as much an adaptation to the environment as any other human activity. Since a primary drive of human beings is to perceive the environment as comprehensible and to make successful predictions about the future, we have developed a cognitive/sensory orientation that filters out any data that is not relevant to the needs of the moment. But since such an orientation does not prepare an individual to deal with a *particular* situation but only with a *category*, or *kind*, or *class* of situations, much of the suppressed data may very well be relevant. The arts in general, and music in particular, may serve the function of breaking up entrenched orientations, weakening and frustrating our "tyrannous drive to order," so that humans are better able to deal with change, complexity, and chaos.[27]

Improvisers engage the unforeseen; they offer the experience of disorientation.[28] They look to find problems, rather than to solve them. Improvised music also reminds us that the notion of "art" is most appropriately located not in the "work" itself, but rather in the perceiver's role; a role that involves maintaining a search-behavior focused on discontinuities. Emotional affect is not intrinsic to the "work",

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[25] Decentralization may be biological coded for ants and other social insects, but it does not seem to be as natural or automatic for humans. Or it may simply be that, because we are within the system, we remain unaware of its emergent properties, just as individual bees and ants may be unaware of their group's emergent social organization (although this hypothesis is difficult if not impossible to test). For lucid writing on this subject see [35] and [36].

[26] Although this blurring may be artistically encouraging, we still need to be aware of cultural assumptions that accompany our notions of musicking. Eddie Prévost [37] recounts an AMM performance after which a woman came up to the musicians and remarked how moved she had been by the music. Once she learned that the group had been improvising rather than playing from a memorized score, she not only doubted their artistic and intellectual integrity, but she was forced to question her own powers of discrimination. "How had it been possible for her to enjoy and admire such work when its practice had been so… primitive."

[27] For some prescient writing on this subject see [38].

[28] The Latin roots of the word improvisation are *in*-not and *provisus*-foreseen.

but rather is dependent on a successful performance of the perceiver's role; emotion is the result of a discrepancy between expectation and actuality.[29] Perhaps most importantly, improvising music together allows participants and listeners to experience and explore complex, decentralized, interconnected, and emergent social dynamics.

Recent work in the cognitive neuroscience of music concerned with the role that music plays in human evolution and development supports this view rather well. Ian Cross [41], a leading researcher in this still nascent field, argues that music's nonefficaciousness–its general remove from immediate concerns for survival (from a strict biological perspective)–make it especially well suited to testing out aspects of social interaction, while its polysemy–its ability to producing multiple meanings–endows us with the multipurpose and adaptive cognitive capacities that make us human. In less technical language Cross writes: "[M]usic can be both a consequence free means of exploring social interaction and a 'play space' for rehearsing processes that may be necessary to achieve cognitive flexibility" (p. 51).[30] People cooperating in a musical activity need not find the same meaning in what they do in order for the musical event to assist them in acquiring and maintaining the skill of being a member of a culture. As Cross sees it, "The singularity of the collective musical activity is not threatened by the existence of multiple simultaneous and potentially conflicting meanings" (ibid.). Through continual engagement with art–viewed as the successful performance of the perceiver's role–we may in fact be better prepared to survive and flourish in our increasingly interconnected, and therefore interdependent, world.

It is interesting to note that two of the hottest current topics for organizational design are the sciences of complexity and jazz music. Both domains emphasize adaptation, perpetual novelty, the value of variety and experimentation, and the potential of decentralized and overlapping authority in ways that are increasingly being viewed as beneficial for economic and political discourse. Robert Axelrod and Michael Cohen [43] see in the move from the industrial revolution to the information revolution a powerful shift from emphasizing discipline in organizations to emphasizing their flexible, adaptive, and dispersed nature. And Karl Weick [44], in a special issue of the journal *Organization Science* devoted to an exploration of "the jazz metaphor," finds that the music's emphasis on pitting acquired skills and pre-composed materials against unanticipated ideas or unprogrammed opportunities, options, or hazards can offset conventional organizational tendencies towards control, formalization, and routine. In a response to the heavy reliance by journal contributors on swing and bebop as the source of their jazz metaphors, Michael Zack [45] outlined ways in which free jazz might propel discourse even further into the realm of emergent, spontaneous, and mutually constructed organizational structures.

Are there lessons from improvising music that can help us to understand, or at least to cope with, the complexity of our world? Improvising music makes us aware of the power of bottom-up design, of self-organization. It operates in a network fashion,

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[29] See Joseph Goguen's work in [39] and in the co-author chapter of [40].

[30] The notion of music as a "consequence free" activity is somewhat problematic, but it is used here in the biological sense that music, in most all cases, does not by itself do physical harm to humans. Since social interactions play an important role in our cognitive development it should also be clear that these two properties cannot be easily divorced from one another. The notion of "play" in relation to improvised music is taken up in [42].

engaging all of the participants while distributing responsibility and empowerment among them. Networks facilitate reciprocal interactions between members, fostering trust and cooperation, but they also can concentrate power in the hands of a few. Under the best of circumstances, improvising music encourages social activities that support the growth and spread of valued criteria through the network. For instance, improvisers tend to value diversity, equality, and spontaneity and often view their musical interactions as a model for appropriate social interactions. Tom Nunn [32] writes: "Free improvisers are important to the society in bringing to light some fundamental values and ideas, for example: how to get along; how to be flexible; how to be creative; how to be supportive; how to be angry; how to make do. So there is a social and political 'content' in their music that seems appropriate today, though it may not usually be overt" (p. 133).

As we continue to explore ways of improvising music, we should look for ways to assist would-be cooperators in interacting more easily and more frequently. The robustness and equity of a network system is a direct result of the range and number of interactions. We should also look to maximize participation from the fringes, rather than the core. In complex systems, a healthy fringe speeds adaptation, increases resilience, and is almost always the source of innovations. For instance, nearly every new style of American popular music has emerged from the periphery–from a localized, and often disadvantaged, community–to capture the attention of national and international audiences (at which time much of the music's original meaning may of course be sacrificed).

Fostering improvising music has the potential to overcome the inherent problems of a slow-moving traditional hierarchy, providing an effective way to handle unstructured problems, to share knowledge outside of traditional structures, and to inject local knowledge into the system. Improvising music also ensures that the cognitive models and metaphors we live by remain flexible, while it reminds us that our flexibility to learn and adapt are grounded in the bodily and the social. Without cultivating this embodied, situated, and distributed approach to music making, and without maintaining a healthy reverence for uncertainty, we can build complicated music systems, but not complex ones.

Complex systems must strike an uneasy and ever-changing balance between the exploration of new ideas or territories and the exploitation of strategies, devices, and practices that have already been integrated into the system. In other words, complex systems seek persistent disequilibrium; they avoid constancy but also restless change. Perhaps in a way similar to democracy, which along with jazz music has been a powerful symbol of liberation and resistance to oppression, improvising music teaches us to value not only cooperation, but also compromise and change. In politics, as in music, a notion of the "common good" is bound to mean different things to different individuals and groups, such that the democratic experience is one of not getting everything you want. In a similar way, the value of improvising music lies not in the outcome of a single performance, but rather it emerges over time through continued musical and social interactions. Improvising music together does not necessarily produce optimal outcomes, but the decision to improvise music together does.

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