

**CONVERGENCE: THE EMERGENT IMPROVISATION FILM
BY ELLIOT CAPLAN AND SUSAN SGORBATI**

Attachment A: Guiding Questions

Must a living agent, in order to participate in a self-organizing ensemble, be embodied? (Embodied, in this context, implies a tactile, kinesthetic sense of touch and boundary in time and space.)

In order for agents to structure themselves into groups where there is no outside instruction, must movement be central to forming?

Is connection, bonding or coherence among agents that create ensemble structures always connected to pleasure (which might include food, absence of pain, aesthetic beauty, building shelter)? Therefore, are ordering principles necessarily pleasurable?

In order for emergent structures to appear, must all topological levels be acting at once? Topological levels in this case are both local interactions, small group ensemble interactions, and global interactions as well as developmental principles, spatio-temporal principles, and constraints.

Does selection over time refine a structure as well as create new adaptable ones?

Is there a connection between adaptive functionality of a system and aesthetic beauty?

What does the relationship between Edelman's ideas of integration and differentiation and Kauffman's NK models tell us about structuring principles?

How do we measure in a dynamic system the exact point of criticality where the pattern emerges that describes the particular integration structure with the number and movement of the differentiated agents? Can we predict when those patterns will occur for any particular system?

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Attachment B: The Science

While exploring concepts that underlie emergent phenomena with many distinguished scientists including Gerald Edelman, Stuart Kauffman, and Bruce Weber, Susan Sgorbati has developed artistic experiential experiments that aim to amplify and extend our understanding of these issues by way of behavioral and artistic, as well as scientific and mathematical modes of discovery and expression.

Terence Deacon captures the essence of the wonder of emergent structures and behaviors when he says: "Complex dynamical ensembles can spontaneously assume ordered patterns of behavior that are not prefigured in the properties of their component elements or in their interaction patterns" (Deacon 2003,274).

In physical, chemical, and biological systems, self-organizing structures can emerge spontaneously when a given system is held far from equilibrium by flows of energy gradients and when that system has mechanisms for tapping such gradients (Peacocke 1983; Wicken 1987; Casti 1994; Schneider and Sagan 2005). These processes involve an interplay of selective and self-organizing principles from which higher-order structures can emerge by constraining activities at lower levels of organization. (Kauffman 1993, 1995, 2000; Depew and Weber 1995; Weber and Depew 1996; Weber and Deacon 2000; Deacon 2003; Clayton 2004).

Such emergent systems can, under special dynamic circumstances, select activities and/or behaviors that enable them to capture and exploit energy gradients. (Kauffman 2000). In this way, self-organization emerges naturally; indeed, Kauffman believes, this "order for free" is embedded in all evolved organisms. (Kauffman, 1995,71) Crucially, Edelman's fundamental theory, Neuronal Group Selection, accounts for the self organizing characteristics of the human brain by invoking a similar interplay of selective and self-organizational principles that give rise to complex animal behaviors, including consciousness (Edelman 1987; Edelman and Tononi 2000; Weber 2003). In Edelman's model of the emergence of consciousness there is a central role for both complexity and an interactive process he calls reentry that in humans and other animals with complex brains results in coherent neuronal activity in a "dynamic core" (Tononi and Edelman 1998). Consciousness, according to Edelman, is all of a piece, what he calls "the remembered present," that is a continuous, unrelenting reconstruction of the past integrated into the present moment (Edelman, 2004,8)

Bibliography of Sources

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Attachment C: Key Concepts

1) **Agency:** Individual dancers and musicians exhibit agency, or in this context the choice to move or to create sound. An essential aspect of this agency is the sensation of being “embodied.” This feeling/cognitive state is based on a solo practice that incorporates a knowledge of a personal mind/body connection (a kinesthetic awareness) and an attention to time, space, and boundary issues. Dancers and musicians who acquire advanced skills that include a diverse repertoire of gesture and sound practice ensemble awareness that develops the ability to simultaneously focus on the particular, the local interactions, and the global patterns around them.

2) **Movement:** In this context, movement is the energy force driving the self-organizing system, creating the individual actions, the local interactions, and the global ensemble patterns. Movement is key as the system would be static without it. The impulse to move, to touch, to form connections as well as to move away from boundaries are essential actions by the performers. All living things inherently express their vitality in movement. Movement is an essential component in any kind of structuring process.

3) **Embeddedness:** The elements of this particular system contain constraints and boundaries in a particular environment. The structuring patterns cannot be deconstructed from their environment. The global behavior is integral to the environment and will alter with any changes in the constraints. Time and space are essential components and will dictate the nature of structuring. For example, the relationship of movement, time and space within particular constraints will either create a coherent dynamic structure, a chaotic structure, or a rigid one that will halt the composition.

4) **Memory:** Structuring is an act of learning by the elements that are building the shape and patterns. Learning involves memory, reconstructing past experience into present thinking and action. This learning is essentially selectional, choosing certain patterns over others. Edelman speaks of “degeneracy” or many different ways, not necessarily structurally identical, by which a particular output occurs (Edelman and Tononi 2000, 86). The ability to recreate patterns to refine structuring processes increasingly depends on degenerate pathways to find more adaptable solutions to build onto forms. The dancers and musicians exhibit this complex system of memory in their building of compositional structures.

5) **Topology:** In this way of structuring, a 'metatopology' occurs where the system has the ability to operate on all levels at once (Sgorbati 2006, 209). Scale and amplification are important. According to Terence Deacon, a topology is "a constitutive fact about the spatial-temporal relationships among component elements and interactions with intrinsic causal consequences" (Deacon 2003, 282). Three levels of interaction exist at once: the local neighbor interaction, the small group ensemble locally, and the global collective behavior. The composing dancers and musicians need to be aware of all levels at once, signaling cues for moving the structure towards critical points of transition resulting in coherent forms.

6) **Complexity:** Dynamic compositional structures among dancers and musicians arise when simple rules are followed through improvisation based on certain constraints in the environment. This leads us to speculate that there are three interactive levels of analysis to these complex structures: systems approach (evolutionary biology), developmental approach (morphology), and psychological approach (meaning) as a way of observing structuring principles (Susan Borden personal communication with Sgorbati, 2006).

Sheets-Johnstone, M. (1999), *The Primacy of Movement*, Amsterdam: Benjamin.

Taylor, M.C. (2001), *The Moment of Complexity: Emerging Network Culture*, Chicago: University of Chicago Press.

Tononi, G. and G.M. Edelman (1998), Consciousness and complexity, *Science* 282:1846-1851.

Weber, B.H. (1998), Emergence of life and biological selection from the perspective of complex systems dynamics, in *Evolutionary Systems*, G. van de Vijver, S. Salthe, and M. Delpo (eds), Dordrecht: Kluwer.

Weber, B.H. (2000), Closure in the emergence of life, in *Closure: Emergent Organizations and Their Dynamics* J.L.R. Chandler and G. van de Vijver (eds), *Annals of the New York Academy of Sciences*, 501:132-138.

Weber, B.H. (2003), Emergence of mind and the Baldwin effect, in *Evolution and Learning: The Baldwin Effect Reconsidered*, Cambridge MA: MIT Press, pp. 309-326.

Weber, B.H. and T.W. Deacon (2000), Thermodynamic cycles, developmental systems, and emergence, *Cybernetics and Human Knowing* 7:21-43.

Weber, B.H. and D.J. Depew (1996), Natural selection and self-organization: Dynamical models as clues to a new evolutionary synthesis, *Biology and Philosophy* 11:33-65.

Wicken, J.S. (1987), *Evolution, Information and Thermodynamics: Extending the Darwinian Program*, New York: Oxford University Press

Bar-Yam, Y. (1997), *Dynamics of Complex Systems*, Reading MA: Addison-Wesley.

Casti, J.L. (1994), *Complexification: Explaining a Paradoxical World Through the Science of Surprise*, New York: HarperCollins.

Clayton, P. (2004), *Mind & Emergence: From Quantum to Consciousness*, Oxford: Oxford University Press.

Deacon, T.W. (2003), The Hierarchic logic of emergence: Untangling the interdependence of evolution and self-organization, in *Evolution and Learning: The Baldwin Effect Reconsidered*, Cambridge MA: MIT Press, pp 273-308.

Depew, D.J. and B.H. Weber (1995), *Darwinism Evolving: Systems Dynamics and the Genealogy of Natural Selection*, Cambridge, MA: MIT Press.

Edelman, G.M. (1987), *Neural Darwinism: The Theory of Neuronal Group Selection*, New York: Basic Books.

Edelman, G.M., and G. Tononi (2000), *A Universe of Consciousness: How Matter Becomes Imagination*, New York: Basic Books.

Edelman, G.M. (2004), *wider than the sky: the phenomenal gift of consciousness*, New Haven: Yale University Press.

Kauffman, S.A. (1993), *The Origins of Order: Self-Organization and Selection in Evolution*, New York: Oxford University Press.

Kauffman, S.A. (1995), *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*, New York: Oxford University Press.

Kauffman, S.A. (2000), *Investigations*, New York: Oxford University Press.

Laughlin, R.B. (2005), *A Different Universe: Reinventing Physics from the Bottom Down*, New York: Basic Books.

Peacocke, A.R. (1983), *An Introduction to the Physical Chemistry of Biological Organization*, Oxford: Oxford University Press.

Schneider, E.D. and D. Sagan (2005), *Into the Cool: Energy Flow Thermodynamics and Life*, Chicago: University of Chicago Press.

Sgorbati, S. (2006), *Scientifiquement Danse: Quand La Danse Puisse aux Sciences et Reciproquement*, Bruxelles: Contredanse.