

Book Review

A review of *Out of Control: The New Biology of Machines, Social Systems, and the Economic World*, by Kevin Kelly, 1994. Cambridge, MA: Perseus Books, 521pp. ISBN 0201577933. \$22.95 USD.

Reviewed by:

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In *Out of Control: The New Biology of Machines, Social Systems, and the Economic World*, Kevin Kelly presents an elaborate exploration of “the breaking science of adaptive, distributed systems and the emergent phenomenon they engender” (p. 451). Throughout this text, Kelly embraces complexity science as an effective tool for describing the complex systems that are emerging in society. Kelly posits that these complex systems are contributing to the development of a new “neo-biological age” whereby artificial systems may re-emerge as independent living systems (p. 3).

Kelly attempts to build his arguments by taking the reader through a series of topics that are structured as responses to questions that he encountered as he explored adaptive and distributed systems. Structured in this manner, his text could have easily become riddled by chapters that were irrelevant and difficult for the reader to piece together. However, Kelly does a superb job of tying the chapters together and leaving the reader with a strong sense of direction. Kelly also avoids difficult jargon (for the most part) and enables the reader to understand the complex systems that he describes through accessible and even humorous examples. These include a range of discussions from computer viruses to a “laugh-out-loud” chapter on the biosphere.

Kelly begins his exploration of adaptive and distributed systems by exploring how the organic world is slowly being combined with the physical

and how this “bionic convergence” (p. 3) is leading to (1) humans making things more lifelike, and (2) life becoming more engineered. Kelly refers to these new complex systems as “vivisystems” (p. 3). He argues that in these emergent vivisystems the power of the collective cannot be inferred from a single element (p. 20). Kelly moves beyond simply describing these systems and their benefits by identifying the need for a societal shift away from the commonly used “atom” metaphor to a more interconnected a “net” metaphor (p. 27).

Kelly’s text begins to unfold and elaborate on these vivisystems by exploring how “complexity must be grown from simple systems that already work” (p. 46) and how this growth must take place “incrementally and often indirectly” (p. 68). Kelly importantly notes that vivisystems, which are inherently unstable, rely on semiotic relationships for their evolution to occur. In these systems there is “autonomous control” (p. 111), as organisms become their own cause and effect. These systems “co-evolve towards a shared destiny” (p. 128) through turbulent ecological relationships (p. 153).

Kelly describes the ecology of machines by illustrating how they naturally form biological webs (p. 182; similar to economic networks, p. 187). For Kelly, this trend in machine ecology is the merging of “the born with the made” in a neo-biological world (p. 183). Kelly suggests that this transition is exacerbated by an individual’s constant attempt to create a simulacrum of him or herself.

The result of this evolution is more flexible responses and durable systems that do not adhere to “any methodical or correct ways of doing things” (p. 311). He also suggests that we are naturally cultivating a synthetic world that can be autonomous and self-replicating while at the same time becoming increasingly unresponsive to external control. These emergent systems will be able to “self-tune” themselves to “higher and higher levels of complexity ... while staying balanced on its edge” (p. 403).

Kelly highlights how he believes that emergent complex systems are linked to culture and are dependant on non-linear conceptions of evolution. He argues that culture acts to accelerate biological change or adaptation and in return we have the greater capacity to produce culture (pp. 360–361). Kelly notes that since there is no “end product” when referring to vivisystems there is a need to redefine evolution as a process of restructuring where “with every remaking evolution becomes a process more able to alter itself. It is thus source and function at once” (p. 419). From these understandings, Kelly argues, “vivisystems are naturally unpredictable” (p. 442). However, Kelly also notes that because we participate in these same systems we also have the ability to learn “to anticipate what is immediately ahead” (p. 449).

In his conclusion, Kelly offers five trends, which he suggests are driving modern society towards an increasingly biological structure. Kelly proposes that these trends are based on the beliefs that

- Despite the increasing technization of our world, organic life—both wild and domesticated—will continue to be the prime infrastructure of human experience on the global scale.
- Machines will become more biological in character.
- Technology networks will make human culture even more ecological and evolutionary.
- Engineered biology and biotechnology will eclipse the importance of mechanical technology.
- Biological ways will be revered as ideal ways. (p. 471)

Kelly suggests that these key factors will ultimately contribute to the rise of complex artificial systems that can best be described as born rather than made and a culture that is increasingly biological in nature. Coupled with these trends, Kelly also outlines nine organizing principles, which he defines as essential for any complex system. The nine organizing principles include “distribute being, control from the bottom up, cultivate increasing returns, grow by chunking, maximize the fringes, honor your errors, pursue no optima, have multiple goals, seek persistent equilibrium, and change changes itself” (p. 468). Kelly notes that in all complex systems (from computer chips to human conception) these organizing principles form the foundation and will, in the future, lead to a neo-biological reality.

Much of Kelly’s work seems as though it should be the preamble to *The Matrix* movie trilogy as he flirts with aspects of science fiction throughout his text. His attempt to rationalize and predict the transition into a neo-biological society requires the reader to make a substantial leap of faith regarding the ability of machines to become self-aware. Kelly also makes grand assumptions about the interrelatedness of our social structures often implying that systems such as governance are part of a grand complex system while failing to explicitly explore that connection.

It is Kelly’s endeavor to use complexity science to describe democracies and economics that unravel many of his main arguments. For example, Kelly utilizes the broad application of the “net” metaphor as a way to place all systems within a larger single complex system. This approach fails to take into account the rational and intentional actions of the state and the rift that is often present between the state and its citizens as a result of its democratic structure. Kelly, by attempting to create a universal application or “overarching theory” (p. 284), attempts to take the useful tool that is complexity science and transform it into a meta-theory that suggests the ability

to describe all systems. This results in what I perceive to be the greatest weakness of Kelly's text.

For educators, Kelly's work is beneficial as it enables them to see the structures of the classroom and their individual practices through a new lens. Kelly provides an overview of trends that are becoming increasingly apparent in our world today. What Kelly identifies, as new transitions towards more biological structures exist at all levels of society and are apparent in our everyday social interactions. These interactions commonly occur in the classroom setting, and, at times unknown to teachers, can contribute to the development of meaningful teaching experiences for both students and educators.

Kelly's identification of how technological networks are becoming increasingly biological in nature enables educators to begin to understand the classroom as an evolving system in which students can take a more active role in constructing the environment and their learning. By conceptualizing the classroom as a biological and emergent complex system, teachers and students can become co-participants in its structure and evolution. In this approach, the classroom becomes an organic entity where control emerges from the bottom up and the system (classroom) begins to self-organize so that it can meet the needs of those who are a part of it while it continues to grow. From this perspective, Kelly enables educators to see how the classroom can be understood as a complex, biological, and emergent system.

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