



Book Review

Sync: The Emerging Science of Spontaneous Order by Steven Strogatz, NY: Hyperion, 10 chapters, 338 pp

Reviewed by James Brody

The courtship of physics and biology gives us stories that encompass quarks to politics and I spend hours looking through them for very broad functional relationships, insights both for my private practice in psychology and for my views of evolution. I like big pictures, done with big brushes, especially if the picture required calluses and blood on somebody's fingertips. I also like gossip. *Sync* meets all of my appetites in much the same way that *Linked* (Barabasi, 2002) did. Strogatz, however, gives a richer set of models and gossip than Barabasi. And Strogatz, like Barabasi and Feynman, relies on drawings and metaphor to make his point rather than sets of nonlinear mathematical formulae, usually decorations for their authors and beyond human solution.

Coupled Oscillators

"Synchrony" applies to the behavior of two objects that act at the same time and Strogatz discusses a different aspect in each chapter. His survey includes sleep, brain waves, synchronization in the orbits of planets and asteroids, aspects of quantum mechanics, and emergent, networked, swarms whether of fireflies, crickets, chemical arrangements in cells, or generators for electricity. He gives a fine explanation of coupled oscillators...things that alternate between "on" and "off"...such as pendulums, cricket chirps, and the glow from fireflies...and

the means by which they often move into synchrony. Of course, my scattered mind immediately leaped to the partnerships between environments and organisms that Lewontin (2000) and Kauffman (2000) discuss. Organisms and settings tuning each other into finer and finer amounts closeness of fit and ever smaller evolutionary steps (Kauffman, 2000). Large evolutionary steps may often be less adaptive not because of strains within the organism but between the organism and a relatively stable environment that it already occupies. *Coupled oscillators provide a handy model for such exchanges.*

It's Not What You Know But...

Strogatz followed up on Mark Granovetter's 1978 report that small, tight clusters of people gain immediate access to very large audiences through a system of sparse interconnections that cross long distances. A socialite in Manhattan who makes a friend in Tokyo gains faster access to other people who also live in Tokyo. Scientific collaborators work in tight clusters when they do research and publish but nearly every cluster has a member with immediate ties to a famous, remote individual such as Paul Erdos. Erdos, in turn, connects to many clusters. Thus, you can live in a small world but the number of steps between you and not only Erdos but also any other mathematician increases

only as the log of the total number of participants.

Heisenberg's Uncertainty Principle

We cannot know both velocity and position for an atomic particle. Old stuff but packed with a surprise! As we slow velocity by cooling, the particle's locus expands until it overlaps those of every other particle. Many particles then act as one, forming a Bose-Einstein condensate.

My imagination roams again: jump some levels and apply the same relationship. Industrialized human groups make assembly lines, large corporations, and Internet companies. (Barabasi, 2002, refers to the Microsoft operating system as a "black hole.") In lagging economies we also form large organizations: extremist political coalitions. (See Ertel, 1981, for changes in German politics prior to and during WW2, also described in Eibl-Eibesfeldt, 1989.) Organizations become larger while their individual components, like the particles in a chilled Bose gas, lose both identity and access to resources. Workers start to act *en masse* and so do customers. It becomes plausible that in gases and in societies, *resource restrictions on individuals favor organized monopoly and tyranny*. As Howard Bloom might say, "Holey Moley!" Diverse clusters, on the other hand, respond to local conditions and to their occupants and appear to be a more fulfilling, if more expensive, condition for my selfish genes and probably for yours.

Along these lines, imagine that networks can function as living organizations that replicate themselves, perform cycles of work, and search for sources of energy to sustain them (Kauffman, 2000). It is a small step to apply these possibilities not only to traffic flow as Strogatz does but also to political movements and personal ideas that become obsessions of love or hate, pursuit or escape. The emergent organization not only competes for resources but also sacrifices the interests of its components and consumes their larger environment. Yes, your beliefs can organize, then confine or destroy

you, perhaps for the same thermodynamic reasons that *Microsoft* or *Verizon* can.

A Caution

An abundance of word-processors spawns an abundance of "new sciences" every year just as the creation of publishing houses in Victorian society gave an immense political advantage to Darwin in comparison with earlier naturalists (Browne, 2002). Thus, it's wise to be cautious about network models. Strogatz, for example, protests that "the rules governing human interactions...were unknown and possibly unknowable" (p. 261). A few pages later, he comments: "It's precisely because the models are so dumbed down that their fidelity can be so unnerving" (p. 273). He ends his thoughts with speculations that we may be far more robotic than we commonly believe. He is not alone. Pinker (2002) reaches a similar conclusion when he describes our verbal apparatus as a "spin doctor." Rowe (1994, p. 91) comments: "...the conceptual distance between the human expression of individual differences and the extended phenotype of a species may not be so great." I agree with them, we are neither so fancy nor so talented as we dream and humanity exists because we are not only emergent, we are also channeled. On the one hand, synchrony could be one more brief candle for restless moths who stay up late and listen to Art Bell. On the other, we might find wisdom and gold in *Sync* despite its lack of dust and wrinkles.

Gossip

Strogatz shows us the greatness in those whom he introduces, some of whom were students when first noticed. Ailing Christiaan Huygens started the sync industry in 1665 when he noticed that the two pendulum clocks in his bedroom ticked and tocked at the same instant. In the 1890s power grids developed when engineers learned that properly-connected generators synchronize themselves. In 1924 Satyendranath Bose contacted Einstein about revisions to Planck's law of radiation and their collaboration led to predicting some very peculiar behavior in very cold gases, Brian Josephson pre-

dicted superconduction in "Josephson junctions" in the 60s, and in the 1980s Art Winfree found that coupled oscillators synchronize even without a master baton waver.

Winfree, who died in November, 2002, was a pivotal character in Strogatz's career, helping with *Sync* even when conscious only a few hours each day. Strogatz dedicated *Sync* to him. Strogatz's senior thesis title: "An Essay in Geometric Biology." Winfree anticipated Strogatz by a decade or more. (Winfree's *The Geometry of Biological Time* now sells new for \$89, \$103-\$160 used!) Cameos of Norbert Weiner, Ed Lorenz, Brian Josephson, Duncan Watts, and Yoshiki Kuramoto appear with explanations of brain synchronization, chaos (yes, chaos can synchronize!), superconductivity, lasers, Josephson junctions, sleep cycles, small world social networks, and power laws. There is even a genteel summary of phase transitions and why they matter.

The personal vignettes live. For example, Strogatz (p. 206) describes Cambridge in 1981: "The English girls never got my jokes, the Brussels sprouts were gray, the drizzle was relentless, and the toilet paper was waxy." (Small wonder that Hamilton went to Africa and sorted termites by sex!) Norbert Weiner gets accolades for his imagination, a small exposé about publishing a graph on the basis of data that he hoped to acquire later, and some teasing: The Weiner's moved. Mrs. Weiner gave him a note with directions to their new home. He used it for calculations, threw it out, and returned to his old home, baffled about where next to go. He asked a small girl if she knew where the Weiner's lived. She responded: "Yes, Daddy, come with me." I don't believe this one and neither does Strogatz but I would love to be famous enough to spark this kind of tale!

Bottom line: buy *Sync*! Strogatz and similar theorists will eventually inform and then reform our explanations of human evolution in a way that enriches our stories from Gould and Hamilton and replaces those told to us by Bowlby. *It*

is probable that natural selection for genes was originally guided by the extraordinary power of network rules, themselves a vital, little appreciated part of our original environment of evolutionary adaptation, one more subtle, pervasive and persuasive than mother's milk or a predator's teeth. To the extent that network phenomena and genetic preferences are persuasive weavers in our phylogeny and ontogeny, we can expect many fewer instances of mismatch between what we still are and what our culture has become.

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This review was prepared in a Barnes and Noble cafe in Devon, PA. Hire a human, buy your books in a store!

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