

To Catalyze Effective Sustainability Solutions, Science Must Study and Transform Itself

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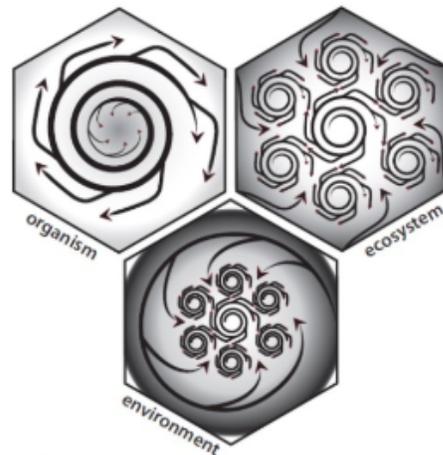
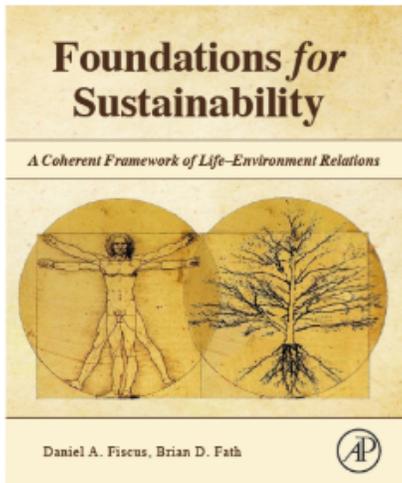


Image on the left courtesy of Steve Fiscus and the authors. Image on the right by Sarah McManus, “Hexaflexagon Design for Representing the Hyperset Formalism of Life”. This art work and more are published on [Sarah’s website](#)

Science is an important tool to help develop solutions as we address the global ecological crisis. Science has helped understand causes and develop solutions to many subsets of our systemic crisis, including climate disruption; species extinctions; pollution; energy challenges; food, water, and soil challenges; ocean acidification; nitrogen cycle disruption, and more. However, scientists can yield potentially greater leverage for lasting solutions if we embark on a self-reflection to study science itself. The goal is to foster a paradigm shift toward great leaps ahead for solving the systemic global ecological crisis. We published a book, ***Foundations for Sustainability: A Coherent Framework of Life-Environment Relations***, in November 2018 that presents this case in detail.

Three ideas provide context for science reform toward paradigm shift. First, we identify industrial culture as the source of the causes of our systemic global ecological crisis. Next, we see industrial culture as driven by science. Finally, we see a two-way interface by which science not only learns about the world and increases knowledge, but also transforms the world. We cite and employ the “modeling relation” of Robert Rosen to explain how and why the two-way

bridge between science and the world necessarily leads science to alter the world. For examples, note that to build a microscope, or to compare two fertilizer application rates on experimental farm plots, scientists must alter the real-world systems they seek to understand. This alteration occurs directly (on the farm plots) and in the larger surrounding environment (in manufacture of a microscope using energy, materials, human labor, etc.). We suggest this world-altering characteristic applies to all of science.

Our proposal to turn science inward to study and transform itself emerged from studies of ecosystems, ecological networks, and related systems sciences. Applying a systems thinking focus on function and purpose to biology, ecology and life sciences, we see the need to revise fundamental understanding of life, humans, culture, and environment.

We propose that the function of life systems is not only to survive and reproduce, as often considered for organism and individual life forms. Nor is the function primarily to evolve, as often considered for species and population life forms. We also see an integral function of life systems is to improve the quality and capacity of the environment to support life. This self-referential goal is inherently beneficial – the better the environmental quality for life support, the better the odds of life survival and evolution. As we document in our book, solid evidence demonstrates that life systems considered holistically – integrating organism, ecosystem, and biosphere forms – do in fact improve their environment as they operate. Archetypal observations that prove this claim are Earth’s oxygen atmosphere and terrestrial soils.

Once we consider that life as a unified whole improves its environment, we then become aware that industrial culture is aberrant. Failing to achieve the fundamental life system function of environmental improvement is an indicator of something deeply dysfunctional in industrial culture, and by extension, in the essence of science. The profound impact increases: industrial culture, informed and driven by science, not only fails to improve the environment – industrial culture degrades and seriously damages the capacity of the planetary environment to support life.

This narrative, a system of ideas, brings to light a new area for examination in work to solve the global ecological crisis. Using the systems approach, and comparing system function with respect to environment, we can ask a dual set of questions:

- *What kind of system improves itself and its environment, survives, evolves, heals and repairs itself and its environment, gains energy, and increases in complexity over time?*
- *What kind of system damages and degrades its environment, breaks down, wears out, and runs out of energy over time?*

The answer to the first question is “Life”, the life-environment system as a unified whole, which achieves those unique outcomes that are positive for both the Life system and its environmental context.

Answers to the second question could be “a machine” or “industrial culture”. Machines have a negative impact on their environment in accord with the 2nd Law of Thermodynamics. And machines suffer entropic degradation due to friction, rust, and other effects which machines themselves are unable to heal or self-repair.

Our hypothesis to explain these observations focuses on over-reliance of the mainstream scientific paradigm on a root metaphor (fundamental conceptual model) of the mechanism going back to Descartes and Newton. During the practice and enterprise of science, via the closely linked enterprise of technology, and extending to all of industrial culture, science has projected the idea of the mechanism onto the world. We have not merely imagined the world as made of mechanisms; we have actively transformed the world into, and it now embodies and realizes, our scientific paradigm’s central image.

If we adopt a holistic mental model in science – our collective intelligence – then we have potential to see new explanations and the capacity for culture to achieve the essential Life functions of self-improvement and environmental improvement.

The alternative paradigm we propose is for “*science in service to Life*” where Life is defined as “Life–environment as a unified whole”. *Foundations for Sustainability* presents *six founding principles* of holistic Life science and describes in–depth and with quantitative examples *seven Life lessons* gleaned from ecological network analysis and systems ecology. Instead of a root metaphor of “mechanism”, our book explains why study systems of the world are better treated as webs or networks. We suggest six other Life-oriented root metaphors as well. We credit, cite and employ the work of many network and systems ecologists, and other thought leaders, who have contributed the ideas and methods that make this paradigm possible.

The strategic approach to work on the science paradigm, and to promote a holistic science of the unified Life–environment system, is complementary to existing analytical, reductionist, and mechanistic science. We can continue to use analytical science, develop and test hypotheses, and advance knowledge in increments focused on specialized topics. And, we can use holistic science to develop and test new paradigms and *advance knowledge in large leaps of synthesis*. In both cases, the science involved is rigorous, quantitative, evidence–based, peer–reviewed, and amenable to replication of experiments.

We humans can move toward sustainable relationship with the environment – if we challenge strongly held ideas in mechanistic science, synthesize the wealth of evidence and holistic

science now available, and make a creative leap to a new paradigm and cultural system of ideas. Such a transformation can help address the systemic symptoms that permeate our entire culture, that were caused by, and are perpetuated by, everything we believe, think, and do. Paradigm, then, is strategically the best place to work on systemic solutions.

We offer this blog article, and our book, in efforts to start discussions with anyone seeking innovative ideas and methods in ecology, environmental science, sustainability, or systemic cultural change. We welcome and appreciate any correspondence, feedback or collaboration on this project.

Fiscus, D.A. and B.D. Fath. 2018. Foundations for Sustainability: A Coherent Framework of Life-Environment Relations. 292 pp. Academic Press, Elsevier. Cambridge, MA. USA. Book website is [here](#).

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