

Industrial Ecology Redivivus

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An obvious part of the attraction of the term “industrial ecology” is the suggestion that industrial systems can fruitfully be analogized to natural ecosystems. Virtually all of the foundational industrial ecology writings, from the original 1989 *Scientific American* article by Frosch and Gallopoulos to the first industrial ecology textbook by Graedel and Allenby in 1995 to more specialized articles such as many published in this journal, draw on the analogy. More broadly, the idea that “natural” systems should form the foundation of a redesign of industrial products and institutions, and capitalism itself, is suggested by a host of books such as *Ecological Design* (Van der Ryn and Cowan 1996) and, more recently, *Natural Capitalism* (Hawken et al. 2000).

The fascination of the superficially oxymoronic analogy between industrial systems and natural systems seems sure to continue, especially as it appears to offer the potential for continuing insights as well as a potent image for pedagogical purposes. The usefulness of the analogy is thus apparent, although its limitations are profound and perhaps not fully appreciated by some. For example, pivotal terms such as “nature” are assumed by many to be objectively clear and fixed in meaning, when in actuality they are contingent cultural constructs, changing over time. As Merchant (1995, 153) noted, “Nature, wilderness and civilization are socially constructed concepts that change over time and serve as stage settings in the progressive narrative.” Thus, what the analogy essentially

suggests is a substitution of one contingent, culturally constructed, mental model of industrial activity by another, not a progressive movement toward a somehow more valid design end point. Our culture is simply absorbing the shift of the underlying scientific metaphor of the world from physics in the twentieth century to biology in the twenty-first.

More fundamentally, human systems are of a higher order of complexity than biological systems (such as a salt marsh or forest community). Human systems and human history are characterized by contingency and the interplay of complex systems dynamics with intentionality. Moreover, human systems exhibit powerful reflexivity: A salt marsh is unchanged by what a scientist may learn about it, but her knowledge feeds directly into the human systems surrounding the salt marsh and changes

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their future paths in unpredictable ways (e.g., passage of legislation protecting the salt marsh). In addition, of course, cultural, technological, and social processes are uniquely human projects, with their own evolutionary time frames that have no parallels in traditional natural systems. It thus becomes a major category mistake to confuse productive analogy with implicit mapping, for the regimes of the human and the natural are not comparable in the latter sense.

But there is perhaps a far more fundamental observation about this analogy. The industrial ecology literature, reflecting no doubt the ideologies and biases of those in the field, is almost entirely devoted to reinterpretation of our cultural construct of “industrial” to be more “ecological.” But it is more valid, and far more challenging, to understand that the term “industrial

ecology” calls us to reinterpret our naïve concepts of “ecological”—the “natural”—in human and industrial terms. Put bluntly, hiding under the relatively comfortable idea of believing that industrial systems should be more ecological in their functioning—more networks of materials, rather than linear use and disposal of materials, for example—is the uncomfortable reality of a human earth on which ecology is in fact the industrial. In such a world, it is not just that biological networks are a useful way to think about industrial networks. Rather, it is also the case that industrial systems are a better and increasingly more necessary element of our understanding of natural systems.¹

Consider, for example, the Everglades in the United States, a natural wetlands extending the width and half the length of the state of Florida. There, decades of population growth, agricultural expansion, and economic development have resulted in significant changes in the biological structure of the Everglades, particularly in the avian communities. By some estimates, the nesting success of birds has declined by 95% since the mid-1930s (Kloor 2000). In fact, studying the biological structure of the Everglades using traditional ecological tools, such as predator/prey analysis, would be misleading at this point, for arguably the greatest single factor in structuring the biology of that system is trade law and subsidies regarding sugar and the flows of political power and money that lie behind it. In other words, the biology of the Everglades is an industrial artifact. Broadening the point somewhat, it is apparent that the biota on most islands is a result of human demographic dynamics—the Polynesian and European waves of migration, for example. Eco-tourism and commodity markets for pulp, paper, aquaculture products, and the like increasingly define ecosystems around the world. Indeed, we would not need to be talking about global climate change if it were not for the apparent fact that the dynamics of climate itself are increasingly determined by human economic and social patterns, by advanced capitalist markets, technologies, and cultures.

More subtly, natural systems that were previously relatively unaffected by human influences

are increasingly integrating into human systems, so that the reflexivity and contingency of the latter come to also characterize the former. Fluctuating demand for pulp and paper, commodity products on world markets, directly and immediately impacts land use and preservation of biodiversity in logging and forestry operations. Genetic engineering over time changes the very concept of species, from something that is found by observation of the “external world” to something that is created in the human infosphere, as a result of contingency, intentionality, and economics. The climate change negotiating process itself is in part a process by which previously non-human components of the carbon cycle are given an economic value and thereby integrated into market structures, with all their human characteristics. And if this appears new, it is only because the scale of the industrialization of nature is increasing rapidly, making it ever harder to ignore—because, after all, Karl Marx perceived the process of turning human and natural values into commodities a hundred years ago in the *Communist Manifesto* and other writings.

Thus, it is arguable that the industrial ecology community—indeed, the broader environmentalist discourse of which industrial ecology appears to be a part—has, for a number of reasons, failed to appreciate the most important connotation of its rich and evocative title. Structuring more efficient material networks is useful and interesting, for sure. But far more profound is the need to perceive, and understand, the implications of living in a world characterized by industrial ecologies at all scales. This task is certainly made more difficult by the fact that most industrial ecologists would rather that the world were otherwise. But wishing will not make it so, and the erstwhile metaphor that designates our field does us a favor if it drags us from such a comfortable illusion.

Note

1. Note that this dichotomy between the two analogies is mirrored in the conflict in the deeper green community between those that would redefine society as a subset of “natural” systems,

such as members of Earth First!, and the Marxist-inclined social ecologists, such as Murray Bookchin, who see “ecology,” and the world itself, primarily as a human construct (Bookchin and Foreman 1991).

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