Book Reviews

Sustainable Energy: Choosing Among Options, by J. W. Tester, E. M. Drake, M. W. Golay, M. J. Driscoll, and W. A. Peters. Cambridge, MA: MIT Press, 2005, 870 pp., ISBN 0262201534, $80.00/£51.95.

Energy at the Crossroads: Global Perspectives and Uncertainties, by V. Smil. Cambridge, MA: MIT Press, 2005, 443 pp., ISBN 0262693240, $18.95/£12.95 (paperback).

There is a growing need for comprehensive textbooks and reference books on energy from a global sustainability perspective. The challenge is substantial, as the subject is dauntingly broad. Two notable contributions in recent years attempt to meet it: *Sustainable Energy: Choosing Among Options* (2005) by Tester and colleagues (a group with strong links to the Massachusetts Institute of Technology), and *Energy at the Crossroads: Global Perspectives and Uncertainties* (2005) by Smil.

Sustainable Energy has the format of a textbook; most chapters include problem sets (although the use of U.S. imperial units in some cases may be confusing for an international audience). Its stated goal is to provide sufficient information for understanding energy sustainability pathways. The first three chapters include descriptions of general concepts: physical concepts, units, and thermodynamics. These are interspersed with topical discussions (on fossil reserves, e.g.). Industrial ecology and life cycle approaches are promoted as technology assessment and optimization tools. The fourth and fifth chapters focus on environmental and economic aspects, respectively. Unfortunately, the treatment of global warming seems designed to appeal to a still-skeptical U.S. audience and often comes across as timid and overcautious, possibly reflecting the time of the book's writing, whereas the economic component is treated from the narrow perspective of profitability in energy production projects. Chapters 7 to 20 describe specific technologies for energy production, storage, distribution, and consumption. In Chapters 6 and 21, the authors attempt to address energy from a systemic policy or decision-making perspective.

Sustainable Energy has very clear strong and weak points. The compelling strengths are in the technical chapters, which include detailed treatment of engineering aspects as well as discussions of economic and environmental issues. These chapters are the ones on basic physical and chemical processes and specific energy production technologies (fossil, renewable, and nuclear). The alert reader will detect a slight pronuclear bias in statements such as "If capital costs are excluded, then nuclear power is economically competitive with natural gas" (p. 706), but, overall, each chapter provides a comprehensive introduction to its subject.

The principal weakness of *Sustainable Energy* is its focus on commercial energy supply (more than half the book's content, compared to less than 10% on specific types of energy demand). The focus on the supply side leads to a scant treatment of the end uses of energy and the various efficiencies with which similar energy services can be provided (Jochem 2000). This focus on commercial energy omits the entire food production sector (still the most vital type of energy consumption) as well as traditional biomass uses. Biomass is discussed—but only in the context of the production of commercial fuels: Competition with food and fodder supplies is not mentioned. The treatment of sustainability as a theme is also lacking; the significant body of academic work examining energy and sustainability, perhaps most prominently represented by the United Nations Development Programme (UNDP) World Energy Assessment series, is neither cited nor adequately integrated. This leads to significant deficiencies and oversimplifications in the discussions of the

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links between energy access and economic and social development.

In contrast, Smil's *Energy at the Crossroads* is not designed to be either a reference or a textbook but provides some deep insights into our historical (and future) energy use. Smil is a virtuoso of energy studies; here, he brings his many experiences together to discuss the links between energy production and consumption, economy, quality of life, and environmental impacts (chapters 1 and 2). He sharply critiques past attempts at forecasting (chapter 3) but uses the lessons learned in his description of possible futures (chapter 6). Fossil and nonfossil energies are treated in terms of their trends and potential in chapters 4 and 5, respectively.

Energy at the Crossroads does not treat any particular energy production technology with the detail of *Sustainable Energy*. Its concern is with the principal technological innovations, both in extraction/production technologies and in energy consumption purposes of the past 100 years. It is highly recommended to the student or researcher who wishes to acquire a holistic understanding of energy production, consumption, past achievements, and future challenges to energy use: in short, to gain a feeling for that elusive creature, sustainable energy. If one requires more information on the state of the art of specific technologies, one can then turn to the relevant chapters of *Sustainable Energy*.

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Useless Arithmetic: Why Environmental Scientists Can't Predict the Future, by Orrin H. Pilkey and Linda Pilkey-Jarvis. New York: Columbia University Press, 2007, 248 pp., ISBN 0231132123, $29.95.

From my days as a student, I recall my thermodynamics professor coming into class one morning and announcing, "There is no set of equations that accurately describes the waves you see at the beach." Indeed, an attempt to faithfully describe even relatively simple natural systems quickly exhausts the ability of mathematical models. My professor's quote provides an apt starting point for discussing this book.

The book's title reveals its message. The authors provide multiple examples of numerical models for processes on the surface of the earth that are used extensively by the engineering community and government offices to assess the costs and benefits of public works projects and environmental management. Examples include predictions of fisheries populations, groundwater transport in mining projects, sea level rise, global climate change, beach erosion, and flood control. In case after case, the models described have come to be considered authoritative in their respective fields. At the same time, in each case their efficacy in predicting the evolution of natural systems over time consistently falls far short of their promise.

The book fundamentally calls into question what can and what cannot be modeled. Advances in nonlinear mathematics and chaos theory over the last few decades have shown that many systems by their very nature cannot be modeled to predict outcomes. Researchers have found repeatedly that we cannot ignore the effects of small perturbations on system outcomes. Though these excursions from average values frequently drive systems, the models used to describe them typically employ numerous simplifications. Often forgotten is the fact that nature is, and is not constrained by the way we model it.

Huge advances in computing power over the last half-century have created the expectation of models with the ability to describe how rapidly a fish population will decline, how groundwater will slosh around in a mine, and how warm the climate will be in 50 years. These models serve the needs of bureaucrats hungry for quantitative assessments and an engineering establishment eager to provide them. Aside from the enhanced

computational power available, the success of the engineering profession in building intricate and elaborate structures made of steel and concrete gives confidence in our predictive ability when it comes to natural systems. The implicit comparison with manmade structures ignores the fact that engineering materials have well-known properties, whereas natural structures are nearly always heterogeneous and are not designed to be impervious to their surroundings.

The authors provide the most technical detail in showing the inadequacy of widely used models in their own field of expertise, beach erosion. Models adopted 50 years ago have become canonized and are applied across a broad range of situations even though their applicability was initially limited to a small set of coastal structures. The models make numerous simplifying assumptions, such as constant average wave heights and uniform underlying geology, while ignoring the effect of factors such as wind and the interaction of waves with offshore currents. In addition, coastal systems are known to be sensitive to one-time events, such as 100-year storms, that never make it into the models but may have everything to do with scouring beach sand that costs tens of millions of dollars to replenish.

Like many geological models, beach erosion models enable prediction without the need for costly and laborious data collection. These models allow for the use of parameters to adjust the model results to a given real-world application. The apparent advantage of parameter selection is that it allows the models to generate numbers that match current reality. The use of enough independent parameters (i.e., fudge factors), however, allows any model to match any set of conditions for a given point in time.

Although quantitative models that are supposed to tell us where, when, and how much may fall short of their promise, the authors stress the utility of qualitative models. Qualitative models use scientific insight to identify relationships between physical variables in trying to predict outcomes. These models, often heuristic in nature, allow for an informed view of system evolution without claiming precise knowledge. Though they may not be the type of model one would use to build a spaceship or skyscraper, they may be the most realistic models one should use to manage a coastal area or ocean ecosystem.

Sophisticated models permeate science today. In the rarified world of high-energy physics, criticisms of string theory have emerged, claiming that as models achieve higher and higher levels of sophistication, the ability to test them using real-world experiments becomes less and less. Accomplishing self-consistency becomes an end in itself, and the scientific product may or may not be grounded in physical reality. Understanding the nature of space and time using string theory may be a far cry from determining how high the sea level will rise in a century, but the reliance on models is common to both. The physics case also provides a comparable example in which an industry has developed (i.e., the high-energy physics community) that is highly invested in the assumption that the model is valid.

How is this view of models relevant to industrial ecology? Industrial ecology is based on the proposition that quantifying environmental flows will feed models that predict environmental outcomes. Sometimes the quantification of flows itself relies on models. For example, national material flow calculations in the United States noted a sharp drop in soil erosion over the 1980s. The drop was credited to a large fall in the overall material flow for the United States in the decade owing to successes scored by the U.S. Department of Agriculture Soil Conservation Program. However, using a single factor (i.e., the soil erosion coefficient) to describe a very nonuniform process occurring over millions of acres to arrive at a precise number of tons of erosion strains credibility. Considering the different types of soils, the complicated nature of sediment deposition, and a host of local factors reveals the coefficient to be a very approximate average. More generally, industrial ecologists, by not being invested in the models developed by any one discipline, are uniquely positioned to acknowledge that greater sophistication in models does not necessarily mean greater accuracy in predicting environmental outcomes.

The book is both data rich as well as rhetorical and can be tedious in parts. The authors reiterate their message several times, often without providing addition insight. Nonetheless, they succeed in arguing that many widely used models simply cannot provide the numerical precision expected

from them. This inability to model is not the result of insufficient computing power or even insufficient scientific insight. Rather, it reflects the fact that nature, in her modesty, does not always reveal her secrets. In fact, for most real-world geological, biological, or climatological systems, her secrets may not lend themselves to precise mathematical calculation. They are what mathematicians refer to as "nonintegrable systems." Bureaucratic imperatives, such as the need for "scientific objectivity," encourage the employment of models far beyond their demonstrated ability to produce reliable predictions. The ubiquitous call for more of the same (e.g., more coefficients, more granularity, more research) may not produce a model that is more faithful to the real world.

Industrial ecologists charged with providing forecasts of environmental outcomes might try to acknowledge that the best models for systems they study may be qualitative ones that identify the salient variables and incorporate the fundamental relationships between them but also account for local factors. The attractiveness of general applicability does not obliterate the very real sensitivity to local variation. Rules of thumb and an appeal to real-world conditions strip away the arrogance of promising more precision than can be reasonably expected. Because the ambitions of industrial ecology go beyond simply modeling nature to include societal and individual behavior, the reasons for appreciating qualitative models become even greater. Although the social sciences produce ever greater amounts of quantitative analysis, industrial ecology may do best by using social science analysis to inform qualitative evaluation of systems, emphasizing experimentation and new technology to promote practical outcomes. Acknowledging our limitations in modeling, instead of seeking greater sophistication to support desirable outcomes, may be the true path to progress.

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Organizations and the Sustainability Mosaic: Crafting Long-Term Ecological and Societal Solutions, by S. Sharma, M. Starik, and B. Husted. Cheltenham, UK: Edward Elgar Publishing, Ltd., 2007, 303 pp. ISBN 9781845426422, £79.95.

The word *mosaic* is used in the title of this book in a rather unusual context combined with sustainability. I set out to see how it was used throughout the text as a thread to tie the work together, as suggested by its place in the title, but I noticed that the word did not appear in the index. The editors use the word to refer to the "complex interactions among social, environmental, and developmental impacts of organizations at the community, regional, national, and global levels." (5). Having acknowledged that sustainability is somehow a property of a complex, highly interrelated system, the editors slip back into a more conventional academic stance, arguing that, for analytic purposes, the focus is to be on a subset of that system.

Although they may be excused on practical grounds for this reductionist framework, the idea of a mosaic gets more or less lost as a consequence. This is too bad—because truly systems-based texts are rare and critical. The editors make no attempt to bring together the various pieces other than the conventional descriptions of the individual contributions in the opening chapter. The upshot is that they offer a set of isolated, separate case studies and theory papers without fitting them into the promised mosaic. This is a problem of the book as a whole but not of the parts. Readers interested in specific sustainability topics can find valuable information here.

The first contributed chapter, by Rands, Ribbens, Casagrande, and McIlvaine-Newsad, sets forth an ideal vision for sustainability and for the institutional behavior necessary to bring it about. In two extensive tables, entries identify the essential systemic characteristics of sustainability at five levels: ecological, individual, organizational, political-economic, and socio-cultural. In a semantic style somewhat like the way the systems principles of the Natural Step are parsed, the authors itemize the actions that various players at each level will (must) take in the ideal sustainable world they describe—for example, "Socio-economic values that facilitate ecologically sustainable activities will be widely held, including

respect for the earth, simplicity, interdependence with nature, appreciation for beauty and for nature, and so on"(35). An example of their system in use, based on life in the Republic of the Marshall Islands, replaces the generic entries by specific examples. The authors recognize limitations to the approach. They note the difficulty of converting the ideal behavior—that is, what people must do—to actual behavior—what they actually will do. And the Marshallese example is mostly hypothetical, not based on experience on the ground.

Crista Walck examines a case of land use in the American Southwest from an ecological perspective. Limiting the definition of sustainable development to the "design of human systems to ensure that the use of natural resources does not diminish quality of life or adversely impact the environment," (60) she finds that the history of land use in this region has shown that the short-term strategies of various users over historical time has led to the failure of these institutions because the resource became so deteriorated that they could not continue. One of her not-surprising conclusions is that the commons need to be (publicly) managed. I was surprised, however, to find neither Garrett Hardin (1968) nor Elinor Ostrom (1990) cited, given that they recognized this problem some time ago. Long-term sustainable solutions for resource use require involving all the users (others would say *stakeholders*) involved in decision making combined with inputs from the best available science.

The key role of stakeholders in sustainable resource use is also the central theme of David Saiia's chapter. The novelty of this work is the development of a mapping process arraying stakeholder salience (importance) versus network connectedness. The technique allows players and analysts to follow temporal shifts in the position of each stakeholder group during whatever political decision-making or management process is occurring. The method is used to analyze an extended process of negotiation in Ecuador, especially the role of the Fundacion Maquipucuna, a nonprofit organization focused on conservation and sustainable development, concerning use of land for coffee raising. The chapter by Andrade also looks at the political–institutional dimension of development in South America, specifically on the game played by Aracruz Celulose and indigenous native tribes. The method used in the analysis focuses on strategic behavior by the several groups involved. A key finding from this case study is that "company versus stakeholder games are rarely resolved, but [rather are] managed"(230).

The remaining six chapters have a strong orientation on business practices related to sustainability. Hoffman and Bazerman take on a critical issue for sustainability: the failure of firms to "practice what they preach." Acknowledging that part of the appearance of implementation failures may be due to the contentious and ambiguous nature of the concept of sustainability, the authors single out many other, more organizationally rooted barriers to action. Among those identified is the well-established notion that sustainability is a win–lose situation—that is, any effort toward environmental protection or social responsibility would have negative impacts on the companies' financial performance. Another barrier is the compliance attitude that regulatory regimes promote to the detriment of more proactive strategies. More focus on understanding these kinds of barriers can lead to more effective sustainability policies and plans.

Frank Wijen looks at the obverse of barriers: the establishment of a new institutionalized structure as a prerequisite for sustainable corporate behavior. Building on a case study of a large multinational food company, he found that the combination of high embeddedness of environmental practices and high ambition (values) supported the routinization of sustainability practices. The confluence of both of these qualities is argued as the critical factor, as opposed to other theories suggesting isolated factors, such as string leadership. Perrini and Tencati look at stakeholder management from the corporate perspective and describe a new evaluation and reporting system. To successfully manage stakeholder relationships—important to building and maintaining stockholder value—firms must utilize tools that go beyond those in use today—for example, the Global Reporting Initiative.

Drawing on institutional theory and the notion of fields of actors, Howard-Grenville, Hoffman, and Bhattacharya examine the reasons

why some firms are better able to implement sustainable practices in a sea of conflicting interests than others are. They point to four distinct conditions under which firms can successfully change established positions and behavioral patterns: capturing an issue within a mature field, bridging between fields, creating a new field, and defending a mature field in crisis. Beyond contributions to theory, the chapter underscores "the importance of managing a company's external relations for taking action towards sustainability" (209).

Peter Utting shifts the focus from internal processes to look at the role of regulation, explicitly related to corporate social responsibility (CSR). Building on an excellent history of this concept, he analyzes four different contexts in which CSR regulations can be articulated: NGO-driven systems, confrontation/collaboration exchanges, voluntary and legalistic processes, and frameworks for producing policy coherence. Overriding the political ramifications of these frameworks, he argues that the major barrier to the adoption of CSR practices is the continuing neoliberal trend toward deregulation and flexibilization in global markets and polities. The last chapter in the volume examines the evolving professionalization of sustainability within firms. Gallagher's working definition of professionalization is "a process of learning and adopting the behavioral standards and normative values of a given occupation" (273). Pointing out the importance of creating such standards and norms for sustainability where few have been historically embedded in firms, she offers a hopeful prediction that such behavior-driving factors can arise through the creation of a new class of sustainability professionals who add this quality to their already established roles.

The book would make a positive addition for academic researchers whose work is primarily based on sociological processes: institutionalization, social networks, interest group dynamics (stakeholder theory), and the like. There is little breakthrough content that adds to the literature showing up in the usual academic journals, but the cases that accompany many of the chapters are useful in elucidating these various theoretical areas in practice. The editing is excellent, and the chapters are uniformly clear and readable. But, as I began, it would have been much more fulfilling to see the mosaic metaphor evolve more rigorously and powerfully.

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The Earthscan Reader on Sustainable Consumption, edited by Tim Jackson. London: Earthscan James and James, 2006, 398 pp., ISBN 9781844071647, £22.95 (paperback).

The Earthscan Reader on Sustainable Consumption as a work of scholarship reflects the political, social, and intellectual controversial nature inherent to this topic. Each country is challenged to better understand consumer behavior and respond to the environmental impact of affluence. Yet it is indeed consumption that drives the economy. A more complete understanding of how to realize sustainable consumption patterns while building a healthy economy is critical to our future. Tim Jackson has made a necessary step in that direction with this contribution to the literature.

The reader is organized into four parts, each representing a specific theme. The first part of the book is dedicated to framing the field of sustainable consumption. This section briefly reviews the history of consumption; reflects religious sacred text interpretations on teachings of consumption (United Nations Development Programme); and presents a global economic perspective informed by Agenda 21, which is the main policy agenda that arose from the Rio Earth Summit in 1992. Following a brief chapter by Nick Robins and Sarah Roberts beginning with a rationale for putting consumption on the agenda ("Making Sense

of Consumption"), next in this section Thomas Princen discusses consumption and its externalities—where economy meets ecology—which leads into "how the consumption angle raises questions outside the production angle" (51). Questions regarding long-term sustainable resource use and effects along the value chain are posed, with the policy maker and consumer in mind. This is followed by an analysis of European household metabolism (Henri C. Moll, Klaasjan Noorman, Rixt Kok, Rebecka Engstrom, Harold Throne-Holst, and Charlotte Clark), an accounting of sustainable consumption via a review of studies of the environmental impacts of households (Edgar G. Hertwich), and, finally, a chapter on the challenges for sustainable consumption policy by Tim Jackson. In this chapter, Jackson reminds us that

> changing the culture of consumption is difficult. The evidence is unequivocal in that respect. Overcoming problems of consumer lock-in, unfreezing old habits and forming new ones, understanding the complexity of the social logic in which individual behaviors are embedded: all of these are prerequisites for successful initiatives designed to deliver pro-environmental and pro-social behavioral change. (123)

The title of part 2 is Resisting Consumerism. In this section, we learn more about the relationships among socioeconomic status, happiness, and consumption (Alan Durning, "The Dubious Rewards of Consumption"). Durning provides evidence for the stark reality behind why enough is never enough. The theme is reinforced by the subsequent chapter from Fred Hirsch, which, in part, states that

> major changes in social patterns or social norms can take place without being willed by any individual and without being consistent with any summation of individual wishes. A "tip-over" of activities from social to market provision is a neglected example of the social irrationality that can result from rational individual economic behavior. (141)

Briefly, then, Alex Kotlowitz takes us for a trip down Chicago's Madison Avenue exploring "false connections" of the consumer society. A chapter titled "Living More Simply," by Duane Elgin (author of the book *Voluntary Simplicity*), asks us to examine our lives and, in part, look for specific ways we can promote "activity, self-reliance, and involvement" (153) through better understanding our consumption practices. Elgin suggests we examine our interpersonal communication styles to become more direct, clear, and honest, moving in a direction of integrity and authenticity toward developing greater trust. He honors the idea of silence in our communications toward greater authenticity, discusses simplicity related to work life, and ends with an integrated path to living simply. Amitai Etzioni reinforces Elgin with "Voluntary Simplicity: Characterization, Select Psychological Implications and Social Consequences." The section ends with ten tangible principles (Juliet Schor) for the consumer to adopt in "stopping the upward creep of desire" (178).

The third part of the book, titled Resisting Simplicity, begins with an article discussing the politics of sustainable consumption in the Netherlands (Susan Martens and Gert Spaargaren). The reader learns about the beginnings of the first comprehensive consumption policy as part of the Netherlands Environmental Policy Plan of 1989. Questions posed here address how everyday practices of consumers influence the political decision making and how that is tied to consumption routines and levels of personal comfort. Public discussion involving consumption has risen over the past several decades, and sustainable consumption is finding itself imbedded in "different initiatives involving individuals, social groups, and industries" (201). A variety of principles involving policy making related to sustainable consumption have been around since the 1970s. Such work includes the characterization of citizen-consumers; the degree of citizen-consumer differentiation; procedures to promote greening; the relationship between citizen-consumer and life-world; the perceived potential for improving the environmental performance of everyday consumer practices; and, finally, the potential to achieve comparable or even greater comfort, convenience, and safety through practicing sustainable consumption.

The section continues with "The Poverty of Morality" by Daniel Miller, which involves, in part, how consumption is materialistic and capitalistic. This leads to several propositions in

a following article, "Relative Poverty—Relative Communication" (Mary Douglas), describing the ritualistic and social objectives inherent to consumption. The final chapters of part 3 concern themselves with looking at why enough will never be enough (Kjell Arne Brekke and Richard B. Howarth) and the evocative power of things (consumer goods and the preservation of hopes and ideals; Grant McCracken), ending with a philosophical analysis of modern consumption, "Consuming Goods and the Good of Consuming" (Colin Campbell).

The fourth and final section of the book, Reframing Sustainable Consumption, begins with a chapter by Elizabeth Shove titled "Efficiency and Consumption: Technology and Practice." This is followed by a chapter by Kersty Hobson on the rationalization of lifestyles that highlights a need for forging a sustainable consumption agenda. The chapter ends with the idea of reshaping policy perspectives and enabling spaces of hope. Next comes a chapter by Laurie Michaelis discussing the ethics of consumption. It looks at the consumer society, forces for the growth of consumption, the cultural roots of mass consumerism, and our relationship with nature and ends with reflection on what, indeed, living the good life involves. The next chapter, "Making Ends Meet—in the Household and on the Planet" (Karl Dake and Michael Thompson), relates culture theory to consumption styles. This is followed by a look at the costs and benefits of consuming (Mihaly Csikszentmihalyi) and, finally, an inspiring chapter by Jackson about moving toward a social and cultural psychology of sustainable consumption.

I highly recommend this book to students, professors, policy makers, and anyone working toward gaining a coherent appreciation of a number of key contributions to the field while being inspired to also contribute. This reader presents a thoughtful selection of the best literature available in the field and is organized as a practical and essential framework for better understanding a very central topic at the core of many environmental issues.

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Reference

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Industrial Ecology: Mit Ökologie zukunftsorientiert wirtschaften [Industrial ecology: Dealing with ecology in a forward-looking manner], by Ralf Isenmann and Michael von Hauff. Munich, Germany: Elsevier, 2007, 330 pp., ISBN 9783827418067, € 49.50.

This is a book full of surprises. The first one was that it is not, as I thought, the first book ever in German on industrial ecology. There was one edited as early as 1977 by the East Germans Riedel and Donner on how to use and reduce *Abprodukte*—a book on what we would now call waste minimization, recycling, or zero emissions. Material accounting was a major method in the former communist countries. This leads to an interesting related question: Has there ever been a serious study on whether socialist concepts of material accounting come closer to industrial ecology than the capitalist concepts of monetary national accounts (the GNP)? I do not know the answer; maybe the reader knows.

Another surprise to me was that in a historical review of industrial ecology by Suren Erkman (chapter 2), the article by Frosch and Gallapoulos (1989) in the *Scientific American* is declared as the major breakthrough to industrial ecology as a science. I reread that article and, indeed, found some "holy" sentences: "The traditional model of industrial activity . . . should be transformed into a more integrated model: an industrial ecosystem"(99). Or "Today's industrial operations do not form an ideal industrial system"(99). And "Creating a sustainable industrial ecosystem is highly desirable from an environmental perspective"(99). I felt much sympathy with these words. Still, I reconfirmed my own belief that if there ever was an article—and not a book—that was a catalyst to industrial ecology, it was the one by Ayres and Kneese (1969) in the *American Economic Review*.

More issues like this make the book challenging reading. Particularly, how should we define industrial ecology? Should we (cf. chapters 4 and 5 by Michael von Hauff and Ralf Isenmann) follow and stay with Lifset and Graedel (2002)?

> Industrial ecology is *industrial* in that it focuses on product design and manufacturing processes. . . . Industrial ecology is *ecological* in at least two senses: It looks to . . . natural ecosystems as models for industrial activity; and it places human technological activity—industry in the widest sense—in the context of the larger ecosystems that support it, examining the sources of resources used in society and the sinks that may act to absorb or detoxify wastes. (Lifset and Graedel 2002, 3–4).

Or is the definition by Marina Fischer-Kowalski (chapter 7) more suitable? She focuses on the metabolism of systems and pleads for a social perspective as a necessary element of industrial ecology.

> Industrial metabolism . . . is the metabolism of industry, of industrial production and its preceding and following processes. It can, however, also be understood as the metabolism of industrial societies—in contrast to other societal formations. (89)

No definite answer seems possible, as I found at least another dozen definitions in this book—according to the motto "everyone to his taste." So we better leave that to the benevolent reader and return to the intentions of the editors.

They want the book to contribute to the future orientation of industrial ecology (part I) and the description of actual topics (part II), to the methods and instruments of industrial ecology (part III) and to a comprehensive understanding of keywords and interrelations (part IV). Accordingly, they organize these four parts with, all in all, 21 individual chapters, comprising such diverse fields as sustainable water management (chapter 8), supply chain management (chapter 11), environmentally friendly public procurement (chapter 14), and sustainable information society (chapter 15).

The overarching goal of the editors is to fully establish industrial ecology as a science in the German-speaking countries. Of course, it is too early to judge whether such a demanding goal was or can really be achieved. Seen dialectically, it might have been wise to start with a rather broad approach to all these issues, following the traditional wisdom that "science is what scientists do." But, necessarily, this leads to the exposure of various contradictions among the contributions to this volume. Also, some authors just produce no effect. An example is the chapter on the issue of "circular economy" (chapter 6). From classical to neoclassical economics, the concept of circular economy has been understood as circulation between production and consumption only. In this way, the entirety of industrial metabolism has been conceptually hidden, with all the negative practical consequences of exhausting scarce resources and damaging and polluting the environment. In this chapter, the chance to clear up this conceptual issue once and forever is totally missed.

All in all, there are quite a few valuable contributions to this book. Among them is an empirical investigation by Walter Leal on higher education (chapter 21), which reveals that in the German-speaking countries industrial ecology as a fully established academic unit or faculty is still in its infancy—a situation that probably reflects the current status of the discipline of industrial ecology in general. At the same time, it is clear that the research groups around German, Austrian, and Swiss pioneers such as Baccini, Brunner, Fischer-Kowalski, Haberl, and others play and played a key role in developing the discipline at global level. Establishing and communicating industrial ecology as an important lever toward sustainable development—this, then, is the major question of the book, and its major message.

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