proper course of internalization is the effluent charge.

Edel bypasses most of these ecological refinements, sketching briefly, and graphically, the different options available for paying externality costs. This is straightforward economic analysis, and it does not treat in much detail the considerable problems of measuring—in monetary terms—the marginal benefits derived from environmental protection.

Freeman *et al.* give the most careful account, using as an ecological backdrop the materials balance model devised by Robert Ayres and Kneese several years ago. The materials balance model is adapted from the input-output matrix of economics, and it is biologically a good deal more naive than the ecosystemics Garvey employs. But given the paucity of environmental data, the accuracy of any operational Ayres-Kneese model could hardly be disputed. More important, the materials balance approach permits an articulation of the emphasis laid upon general economic equilibrium by Freeman *et al.* That is, piecemeal policies which regulate only one form of pollution are eschewed, on the grounds that they may well create perverse situations. Thus, water pollution might be made much worse by a program concerned solely with air pollution control. Commoner's dictum that "everything is connected to everything else" is here given economic form. Within this wider framework, Freeman *et al.* can also show that effluent charges are the most promising solution.

In short, these analyses of environmental policy discover two classes of option: the radical restructuring of the social order suggested, as Edel points out, both in the name of an environmental "crisis" and in the name of social justice; or else effluent charges. Cursory inspection of American society reveals little major restructuring. And only one or two states have effluent charge schemes in operation; even these are rather timid by the standards of comprehensiveness put forth by Freeman *et al.* Has theory fallen short of reality?

The answer is both yes and no. As Freeman *et al.* note wryly, "the reason [effluent] charges have not been effectively tried in this country is that they would work" (p. 170). What the economic analysis omits, in other words, is politics. There are sizable political barriers to instituting the incremental changes which would improve the environment—and perhaps stave off a revolution. As Freeman *et al.* suggest, effluent charges would likely be charged most heavily against influential industrial polluters. The legislators who had voted to put them in would thus be at a disadvantage when it came time for campaign contributions.

Thus, while effluent-charge schemes, and similar methods for fine-tuning the marketplace, may work quite well to diminish pollution by individuals who are both self-interested and relatively powerless, these methods will not work in the Galbraithian industrial state. So it is that environmental lawyers litigate, and lawmakers cling, albeit desperately, to regulatory schemes that are politically viable though only randomly effective against polluters.

Is massive social restructuring, then, the only way? Perhaps not. For what is absent in the analyses presented in these books is a sense of how organizational design can be matched up to the technology of pollution control, on one side, and political resources, on the other. The President's proposal to reorganize the Atomic Energy Commission into separate research and regulatory bodies demonstrates that renovation of bureaucracies is not always contingent on violent overthrow. From the viewpoint of organizational sociology, one might say that the "vertical integration" which had linked the promotion and regulation of nuclear power proved to be politically untenable. Of course, there is no guarantee that the new dispensation will satisfy demands either for electricity or of environmentalists. But what has been brought tantalizingly into view is the possibility of political—that is, one might hope, legitimate—power for the redesign of institutions.

That power will, in the best of circumstances, be wielded hastily, if not illegitimately. More significantly, there are still few usable guides to the relationships connecting institutional design and institutional effectiveness. The argument that effluent charges are easier to administer than direct regulation of effluents seems correct. But it does not tell us how to rig even a sensible (let alone optimal) combination of economic and regulatory strategies when effluent charges are politically unobtainable.

These are matters for research, not teaching. They suggest that these three books, while meeting the needs and tastes of a variety of environmental studies classes, also need to be supplemented by institutional analyses, which remain scarce. In the meantime, any of them will serve as a cogent summary of the economic approach. Freeman *et al.* have the most thorough coverage, but the systematic survey of energy conversion and transport offered by Garvey and the radical perspective of Edel provide useful background.

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Sociophysiology

Illness, Immunity, and Social Interaction. The Dynamics of Biosocial Resonation. GORDON ERVIN MOSS. Wiley-Interscience, New York, 1973. xvi, 282 pp. $14.95.

One of the more persistent frustrations experienced by the student of health and disease stems from the nagging awareness that a vast array of forces affect bodily function and that he can study the influence of only a few of them at a time. In part, this limited approach is necessitated by the sheer complexity of the phenomenon under study; in part it is attributable to the diversity of disciplines involved in the subject and to the difficulty researchers from different disciplines often have in transcending methodological and conceptual barriers.

Nowhere is this difficulty more vividly illustrated than in the work of those attempting to study the influence of the social and psychological environment on human health. Sociologists have usually focused on the influence of the social situation, social psychologists on variations in perceptions of such situations, and physiologists on bodily reactions to these perceptions and the biologic consequences of such reactions. Rarely has an effort been made to study all these dimensions simultaneously in an integrated way. The purpose of Moss's book is to develop a theoretical model linking social participation, physiological processes, and susceptibility to disease into a unified framework.

A key concept in the development of this framework is "biosocial resonation," which is defined as "the continuing reciprocal influences of physiological processes and social behavior in social interaction." The term "biosocial" is intended to emphasize the interrelationship of biological and social pro-

cesses; the term "resonation" is intended to suggest a model of "continuous variation, reaction and response with no discernible beginning or end." Concepts of "cause" and "effect" are considered inappropriate in the model, emphasis being given instead to finding patterned relations and configurations of clustering variables in particular kinds of situations. Similarly, such "intervening" variables as emotion, stress, and motivation are regarded as not useful because they distract from consideration of the "dynamic wholeness of physiological and social activities."

Man is viewed as a biosocial being living in a social milieu of "resonating communication networks." These are composed of people transmitting and modifying a particular configuration of information consisting of language, values, and preferred patterns of interaction. Communication networks may be well defined or informal and may vary in size from a clique or a family to a whole society. Individuals participate sequentially and simultaneously in many different networks, whence they may experience conflicting, inaccurate, or incongruous information. Moss's interest is in the effects such experiences may have on the central nervous system, on the autonomic-neuroendocrine system, and on susceptibility to disease. He emphasizes that this process may produce a generalized susceptibility to a wide variety of diseases; he rejects a "one stress–one disease" model. Communication networks can also protect participants by preventing exposures to information incongruities in the first place, by assisting in resolving encountered incongruities, or by providing relief from symptoms of incongruities.

In developing this thesis, Moss covers a remarkably broad range of topics encompassing the role of the central nervous system in perception, stress research, autonomic and neuroendocrine responses to perceived incongruities, typologies of social participation, and theories of equilibrium, homeostasis, and social change.

This is not an easy book to read. The style is occasionally lucid and lively but more often is cumbersome and obscure, in part because of an overreliance on jargon. The presentation is essentially humorless and is virtually devoid of illustration to ease the heavy going. The argument is richly documented, with 427 references in 250 pages of text, but all the citations have been chosen to support the thesis offered; no antithetical citations are presented. Nevertheless, if the reader persists, he is assured of several worthwhile conceptual formulations and occasionally a brilliant and innovative insight.

This book addresses a significant and timely issue in an ambitious and imaginative manner. Unfortunately, the goal Moss seeks is not entirely achieved. In the end, the model he develops appears to consist of causes (perceived information incongruity), effects (increased susceptibility to disease), and mediating variables (social immunity, social cure, and social therapy). While one can aspire toward a model of dynamic wholeness with no discernible beginning or end, it may be inevitable that in any particular analysis one must still begin somewhere and end somewhere. Nevertheless, in looking for causes and effects, it is surely useful to maintain a broader appreciation of the context within which the analysis takes place. Moss has therefore made a fundamental contribution in providing a series of sensitizing concepts that alert us to the complexity of the relationships involved in the study of social behavior and disease. In doing so, he has also provided a thoughtful and provocative approach to the problem that will surely stimulate lively discussion, debate, and more vigorous research effort.

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Invertebrate Neurobiology

Information Processing in the Visual Systems of Arthropods. Proceedings of a symposium, Zurich, Switzerland, March 1972. RÜDIGER WEHNER, Ed. Springer-Verlag, New York, 1972. xii, 334 pp., illus. Paper, $11.50.

The visual system of arthropods has attracted a great deal of attention recently, and the reasons are not hard to find. The behavioral capacities of arthropods are rich and varied, including both relatively simple and stereotyped motor acts and learning and memory. A principal motivation for this interest in arthropods has been the hope, indeed the expectation, that their nervous systems, with several orders of magnitude fewer neurons than those of mammals, and their eyes and optic ganglia, with their exquisite organization of many repeating subunits, would, in the words of the editor of this volume, "provide a suitable model for the study of information processing in neuronal networks." Most of the experimenters who have risen to this challenge have quickly concluded, however, that an approach through systems analysis is largely unsatisfactory. Too much remains uncertain. As a consequence, recent efforts have also been directed at a more sophisticated understanding of the physiological optics of compound eyes, a detailed knowledge of the patterns of synaptic connectivity of the receptors and visual interneurons, investigation of the photochemistry of arthropod visual pigments, and studies at the single-unit level of both receptors and cells in the optic lobe.

This volume contains 45 papers presented at a symposium of European workers. Almost without exception the participants represented either Swiss or German institutions, so the prospective reader may well ask whether the book provides more than a limited sample of work now in progress in this field. The restriction is not serious. Several of the most active laboratories were represented, and the proceedings reflect a generous cross section of work in progress.

The book is organized into nine sections. The first three (containing 14 papers) deal with fundamental phenomena such as the paths of light in the eye, the visual pigments, and the neural wiring of the receptors and optic lobes. Particularly noteworthy for the reader new to these preparations is the chapter by Kirschfeld describing an integrated view of physiological optics, neurohistology, and optomotor behavior of flies.

The next two sections (11 papers) treat intensity- and wavelength-dependent functions. The pair of contributions by Kaiser and by Liske on the spectral sensitivity of the optomotor system of the bee and on the spectral sensitivity of directionally sensitive units in the optic lobes, although labeled preliminary, suggest an interesting story in the making. Although color vision is presumed to be present in many arthropods, heretofore only the honeybee has been subjected to quantitative behavioral analysis. Toggweiler's work on ants, which exploits the capacity of Hymenoptera to learn visual discriminations, is a welcome extension of this powerful technique.

Most of the final 20 chapters describe a variety of behavioral experiments on pattern recognition, orientation to visual cues, and learning. The longest and perhaps most lucid contri-