tage of any part of their environment they can: a plant will happily feed a butterfly for carrying pollen even if its caterpillar is a most voracious pest. Odum speaks of herbivores' rewarding the plants they eat by fertilizing them; maybe selection favors animals with the most usable manure. Others (*1*) have spoken of protozoans, who must multiply quickly before their unavoidable replacement, as benefiting from the metabolites of other protozoans: apparently these interactions have evolved into a symbiotic pattern where the occupant of each niche secretes a metabolite essential to the others. The pattern spreads because invaders succeed which can take advantage of the symbiosis in such communities. I was a little more surprised when Odum spoke of herbivores' concentrating food in packages convenient for other animals to eat; what about elephants, which are specially selected to avoid predation? Odum would no doubt reply that even mammoths and whales found a predator to whom they were quite convenient; unused energy always does.

What have ecological communities to tell us of morality and religion? A Taoist (*2*) wrote:

> If you indeed want the men of the world not to lose the qualities that are natural to them, you had best study how it is that Heaven and Earth maintain their eternal course, . . . the birds and beasts their flocks, the trees and shrubs their station. Thus you too shall learn to guide your steps by Inward Power, to follow the course the Way of Nature sets.

Nature is full of lessons on the benefits of avoiding unneeded disequilibrium. Microorganisms (*3*) possess forms of drops and splashes, not because surface tension formed them, but because such equilibrium forms avoid unnecessary stress. Likewise, overreliance on poisoning competitors rather than outcompeting them is a shortsighted strategy, a "crime that does not pay." I am not sure, though, that ecology gets us far beyond the "silver rule": do not unto others as you would not have them do unto you. Real cooperation between species seems too opportunistic, and poisons too frequent, to say more.

In population genetics, one encounters "selfish genes" (*4*) which spread by biasing the meiosis of heterozygotes in their favor (meiotic drive or segregation distortion). Most such genes are harmful to the population: on chromosomes other than the distorter's, selection favors modifiers suppressing the distortion. The transmission rules of genetics are thus *selected* as "rules of fair play." At loci close to the distorter, however, selection may favor "riding the distorter's coattails": organisms with too few chromosomes, like parliaments with too few members, may be easy to subvert. Only with sufficiently loose linkage or numerous chromosomes or both is there a reasonable chance that selection will favor the good of the species.

Likewise, decent rules of conduct, which Odum would prefer to see grounded in religion, are necessary to society's survival. Odum uses his understanding of communities to explicitly construct a morality and religion. To quote his summary of the subject:

> The key program of a surviving pattern of nature and man is a subsystem of religious teaching which follows the laws of the energy ethic. . . . We can teach the energy truths through general science in the schools and teach the love of system and its requirements of us in the changing churches. System survival makes right and the energy commandments guide the system to survival.

I find the construction of a God for reasons of state singularly unpleasant: a belief in a God we ourselves made, as opposed to the One who made us, seems to me to lack point, and this particular Antichrist seems to me a superb vehicle for a rather nasty tyranny. Odum's morality, on the other hand, is well worthy of study. I don't doubt that ecology groups will be publicizing some of his "commandments."

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Pollution Economics

Environmental Side Effects of Rising Industrial Output. ALFRED J. VAN TASSEL, Ed. Heath Lexington, Lexington, Mass., 1970. xxiv, 550 pp., illus. $19.50.

This is a collection of essays appraising pollution problems in the United States as of 30 years hence from an economic point of view. Each essay was written by a graduate student in a research seminar in the School of Business at Hofstra University, under the direction of A. J. Van Tassel. Each addresses a different problem—industrial water, population growth, electric power, pesticides, and so on. The authors undertake the large and difficult task of estimating current pollution coefficients —ratios of pollution to economic output—in various sectors and technologies and of forecasting how these might change. These coefficients are then multiplied by the economic activity levels that Resources for the Future has projected for the year 2000 (H. H. Landsberg, L. L. Fischman, and J. L. Fisher, *Resources in America's Future*, 1963). In this way estimates of pollution flows for that year are generated.

Van Tassel in the concluding essay judges that there is likely to be an increase in pollution, which may be held within tolerable limits by technological changes and legislative restrictions. However, "if the projected quadrupling of gross national product between 1960 and 2000 has validity, the battle promises to be a hard one" (p. 431), and he opts (p. 450) for a reduced rate of economic growth.

The flow model implicit in the book is approximately as follows: The economy in its several sectors in year t utilizes its capital stock, labor force, technology, institutions, and environmental resources in production activities as in the chart on the next page. The writers see the volume of bads as primarily dependent upon three variables: volume of annual production, technology, and institutions. The model is a sensible analytical statement at a gross level, and the authors correctly imply that feedbacks from the obnoxious bads cause technology and institutions to change. They give little attention, however, to the political and economic processes by which this occurs; and without such analysis how can they judge whether or not the response to the pollution feedback—the dotted lines in the chart—will overcome the tendency for the annual rate of pollution to increase? Is it purely chance whether new legislation occurs in $t + 1$? How much will it depend upon odors, or Ralph Nader, or economic and health damage, or crusades by scientists? As the annual pollution feedback tends to become larger each year, year after year, does society become acclimated and less sensitive, or does it become militant? What roles

might be played by market processes and government dictation in improving pollution conditions?

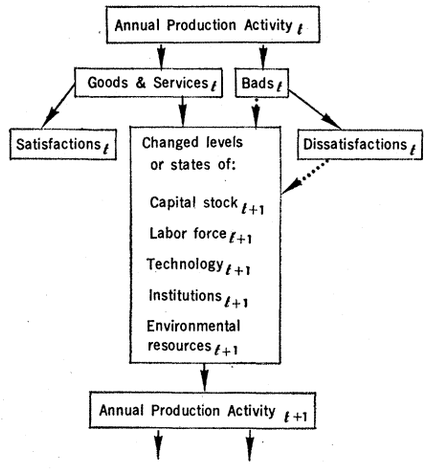
In particular, pollution fees, noted briefly in the book, would be a major change in economic institutions. Such fees would alter relative prices and hence the projections. An emissions tax on gasoline would be likely to reduce the estimate of a fourfold increase in gasoline consumption between 1960 and 2000 (p. 245) and might possibly increase demand for mass transit systems. Fees on wastes might stimulate the kinds of recycling that the authors only hope for (p. 334) or simply assume will happen (p. 340). What is desirable might become commercially feasible if appropriate taxes on social bads existed. For example, the shipment of mineral slags (p. 310) to markets or the use of algae as fertilizer (p. 449) could be thereby stimulated.

There is yet another troublesome oversight: pollution feedback on the stock of environmental resources is largely neglected. Cumulative pollution may cause this stock to deteriorate. The nation's capacity to produce goods in $t + 1$ may then be reduced because of decline in the quality or quantity of environmental resources. This would tend to counter improved technology and investment. Business, consumer, and government perceptions of this effect could stimulate technological and institutional changes to reduce pollution. Chapters 6, 10, and 11 do consider the cumulative effects of "bads" and calculate the projected buildups (atomic waste, gutted land) in the year 2000, but elsewhere they are overlooked. For example:

1) What would be the significance of the quantity of nitrogen and phosphorus nutrients entering the water systems in the year 2000 via chemical fertilizer and feedlot runoffs and sewage wastes (pp. 418–22) if the lakes and rivers were no longer capable of supporting life or waste-degrading bacteria?

2) The sale of pesticides is projected (p. 395) but not the estimated buildup in parts per million in lower and higher forms of life. This buildup may already be dangerous, as is acknowledged on pages 379 and 447.

3) The use of chemical fertilizer in the year 2000 is projected (p. 403) but no measure of the depleted capacity of soil to fix nitrogen. The fertilizer need per acre to achieve a fixed yield is probably rising. Because of irrigation, there has been a degradation of agricultural land from increasing salt content in the San Jacinto Valley of California.



4) Other conditions of environmental quality in the year 2000 that are not measured are the concentration of carbon dioxide in the air; the level of background radiation; the acid content of surface waters from accumulation of sulfur dioxide washout; contamination of underground water from deep wells used for waste disposal (on page 65 such wells are regarded as a solution rather than a problem).

But overall, we find much to applaud in this book. One merit is Hofstra University's successful endeavor to have students do serious work on this important public issue; the level of student accomplishment is quite high. Another is Van Tassel's sensible economic model and his use of the RFF projections to provide a common framework for the students' independent efforts. Further, the book takes the welcome view that pollution is a problem for rational analysis and discussion rather than mysticism, propaganda, or political manipulation. On the other hand, some of Van Tassel's major conclusions—for example, his preference for slower growth in national output—cannot be drawn directly from the component studies. It can be argued logically that if high standards of environmental quality are to be attained the resources are more likely to come from an expanding than from a stable or slow-growth economy.

The virtues of the book outweigh the defects. It is easy to criticize such a study for omissions, much harder to remedy them in this new interdisciplinary field. We recommend the book as a serious effort and a substantial accomplishment.

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Perspective on Japan

Japan's Managerial System. Tradition and Innovation. M. Y. YOSHINO. M.I.T. Press, Cambridge, Mass., 1968. xvi, 292 pp. $12.50.

Social Change and the Individual. Japan Before and After Defeat in World War II. KAZUKO TSURUMI. Princeton University Press, Princeton, N.J., 1970. xiv, 442 pp. $15.

Japanese Society. CHIE NAKANE. University of California Press, Berkeley, 1970. xii, 158 pp. $5.

Japan's economic miracle will undoubtedly stir America sometime in the 1970's as Russia's success in launching Sputnik did in 1957. Unlike the awakening to Sputnik, the awakening to Japan's economic achievement will result not from a single event but from the gradual awareness, first among business and government leaders and then among the general public, of the scope of Japan's progress. This response may lead to a self-regenerative movement in the United States, to xenophobia, or to both, and the impact may well be more profound than that of Sputnik.

Already Japan has surpassed America in producing cameras, tape recorders, ships, and even pianos. Japan has the world's fastest trains and the world's largest steel company. With a population less than half that of the United States, the Japanese are now constructing more private dwellings than we are. A year ago, when computer science was offered on Japanese educational television over a million copies of the course textbook were sold. We can expect spectacular Japanese improve-