Book Reviews

Energy Use and Building Design

Architecture and Energy. RICHARD G. STEIN. Anchor/Doubleday, Garden City, N.Y., 1977. xii, 322 pp., illus. $12.95.

To the current energy debate Richard Stein's *Architecture and Energy* offers this proposal: cut the energy waste in the heating, cooling, and lighting of buildings. Because efficiency losses of up to 50 percent are inherent in energy production processes, a Btu saved is worth two Btu's produced. As the American Institute of Architects reported in earlier publications to which Stein contributed, by 1990 the energy that could be saved by energy-conserving building design would be approximately equal to the energy that could be produced by any one of the domestic sources projected to be available then. Energy conservation in building thus deserves at least as much emphasis as the development of new energy sources.

This view is now being taken up in many quarters, as witness Amory Lovins's advocacy of "soft technology" and the more timid proposals in the Carter energy plan. Stein brings together in one readable volume the substance of the case for energy conservation through building design and a discussion of how energy-efficient buildings might look and how they might be built and operated to save energy. In separate chapters that can be read as independent essays, Stein shows that the use of techniques of energy conservation now available offers the most benign and conservative energy alternative we have and is much less demanding of limited capital and environmental resources than any energy development option.

Why then is there not a national effort aimed at making buildings energy-efficient? Part of the reason, Stein's examples help explain, is that it is difficult to overcome conventional ways of financing, planning, and constructing buildings, that in effect our buildings are an intrinsic part of the industrialization of the United States that was set in motion a century ago.

Take as a most obvious example the design of a conventional office building, glass on all sides irrespective of orientation, a beacon of illumination as part of the cityscape at night. Such buildings are given design awards each year, they elicit pride as symbols of corporate presence or downtown renewal, and they represent in a metaphorical sense the heart of urban civilization.

It is what is not seen that is disturbing: the glass facade exposed to the sun may require air conditioning at the same time its opposite side calls for heat. To maintain glare-free and even lighting across an office floor that has a full window wall on one side, the number of lighting fixtures has to be increased in order to fight the natural daylight by brute force; the excess heat of the additional lights in turn increases the air-conditioning load. In some of the worst offenders that Stein describes, such as the World Trade Center, the office manager who wants to work at his or her desk at night has to turn on a quarter acre of lighting—an obviously bad design in terms of energy efficiency, but one sustained by established professional design and construction practices.

Stein describes how the standards for lighting levels in buildings were established and in some instances more than doubled or trebled for schools and offices between the 1950's and 1970, as if we had suddenly gone nearsighted as a result of some national disease. The increase may reflect a desire to sell more lighting fixtures rather than a concern for human comfort, as Stein points out in a chapter that raises serious questions about industry involvement in the promulgation of building standards.

To further make his point, Stein analyzes an advertisement by a lighting fixture manufacturer that pictures a supposedly energy-conserving installation in a modern office floor, with lighting fixtures shown in use by the square yard irrespective of the use designated for the area below, be it for desks, lounge, circulation, or storage. Taking his analytic scalpel to the facts as reported in the advertisement, Stein shows that a reduction in energy use nine times that shown could have been effected without affecting human comfort.

Stein devotes other chapters to a number of issues that are fundamental to understanding the complex relation between building design and energy consumption. Because of differences in the efficiency of energy production at the power plant source and of energy transmission from plant to building, end-use energy consumption—that charged to the building owner—does not accurately reflect the actual energy use that results from the selection of a particular fuel or heating and cooling system. The analysis of building energy consumption in terms of source energy costs, Stein argues, gives a more accurate picture of how energy efficiency can be affected by the size and capacity of the power plant. Decentralized, smaller-scale plants are often more efficient in source energy use in the first place and promise the further benefits of reduced transmission losses and heat recovery or "co-generation" options (whereby waste heat from power production can serve nearby buildings).

In addition to the energy consumed in operating a building, energy is consumed in the production of building materials, in building construction, and in demolition of a building structure at the end of its useful life. Looked at from this perspective, the analysis of alternative building materials in terms of their net energy costs is becoming increasingly important, and it can be argued that buildings should be built to last as long as possible rather than for the limited lifespan that first-cost economics often justifies. Stein notes that some buildings in European cities are still in use after 400 years. Similarly, in particular instances it might be shown that the renovation of existing building structures requires far less net energy expenditure than does the typical bulldozer approach to urban redevelopment.

New concepts of energy accounting, in terms of source energy use and net energy use, will have to be brought into building design decisions, and these costs will have to be reflected in the market price of energy and products. Even this change would only indirectly meet the real issue, the improvement of environmental quality by reducing or eliminating pollution and related health and safety risks and by reclaiming land for open space, food production, air and water purification, and recreation—no mean task in light of Stein's observation that one-third of the area between Boston and Washington is either built or paved.

The first steps toward such goals are immediately available, though, as is shown by Stein's analysis of existing buildings operated by the State of New York, in which energy consumption could be reduced by one-half with a capi-

tal expenditure that would be repaid in fuel cost savings in two years. Much of the reduction would be achieved through the now familiar steps of winterization—improved insulation, temperature setbacks related to use, reduced and often improved lighting. It is less expensive to improve the energy efficiency of the existing buildings than to build a power plant of equivalent capacity.

These issues will increasingly be brought into the economic and political realm. We are able to see to the end of our existing fossil-fuel base, so the heating and cooling plant of an existing building fueled by gas or oil will probably have to be replaced, with the attendant conversion costs, well within the useful life of the building. Beyond this, energy use is an ethical and social issue: "Buildings designed to overuse energy penalize everyone who needs energy for survival," Stein writes in showing the connection between energy use in the United States—35 percent of all energy use globally—and subsistence living conditions in much of the developing world.

The basis for optimism that Stein offers is rooted in his conviction that design is the act of intelligence applied to the allocation of existing resources and that there is an esthetic based on the "virtue of necessity," a phrase from the painter Paul Klee. "We could well expect a marked improvement in the quality of the built environment in the United States if there were a drastic reduction of energy use per square foot and a more intelligent use of the energy that remained," Stein writes. Whether one is already converted to this point of view or has yet to be convinced, the reader will find that in Stein's book the argument for it is carefully researched and modestly proposed.

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Pollution Processes

Marine Pollutant Transfer. H. L. WINDOM and R. A DUCE. Lexington (Heath), Lexington, Mass., 1976. viii, 392 pp., illus. $21.95.

Reiterating the truism that the oceans constitute the final repository for increasing levels of anthropogenic wastes, the editors of this book note the need for a comprehensive understanding of the transfer of pollutants such as heavy metals, petroleum, and chlorinated hydrocarbons in the marine environment. The book, an extension of a workshop sponsored by the National Science Foundation's Office for the International Decade of Ocean Exploration, presents the findings of the NSF/IDOE Pollutant Transfer Program in an admittedly incomplete attempt to summarize present knowledge concerning the movement of certain pollutants across major interfaces (air-sea, river-sea, biosphere-sea, particle-sea, sediment-sea).

The opening chapter, which summarizes the workshop, contains generally thoughtful interpretations of various research alternatives by the panel chairmen. The generalizations about global mechanisms prove to have certain weaknesses when applied in specific studies. This is almost unavoidable given the complexity of the subject and the piecemeal way in which data have been collected. The remaining 14 chapters are filled with useful information, some old and some new, concerning the movement of heavy metals, petroleum compounds, organochlorines (DDT, PCB's), and certain less well known organic contaminants (phthalic acid esters, halocarbons) across various interfaces. Heavy metal bioaccumulation and transfer are described by C. Patterson *et al.* and R. A. Duce *et al.*, and H. L. Windom and his associates, in a summary of their studies concerning cadmium and mercury transfer in southeastern Atlantic coastal areas, lucidly describe some attempts to construct simple models of metal movement through specific marine systems. Some attention is paid by other authors to the fate and distribution of pelagic tars. R. W. Risebrough *et al.* give a thorough though somewhat overlong account of DDT and PCB movement through marine food webs, with an emphasis on the higher trophic levels (birds and mammals). In short, the book is a combination of literature reviews and accounts of individual research efforts that conforms fairly well to its stated goals.

The scope of the subject and the paucity of information about it have led to some omissions and overgeneralizations. For instance, there is little discussion of marine microbial activity even though consideration of such activity, together with trophodynamic response, is basic to any understanding of pollutant transformation and movement. Other factors, such as widespread physical alteration (due to channelization, dredging, damming, diking, and the like) in coastal drainages, are likewise ignored even though there is increasing evidence that they can be important to the movement of pollutants through various aquatic systems. The literature reviews and much of the original research described in the volume are sound. The book is most noteworthy, however, for the attempt it makes to bring some organization to what has been a relatively chaotic branch of marine research. For this reason it should prove useful to specialists in marine research and pollution ecology.

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Structural Carbohydrate

Chitin. RICCARDO A. A. MUZZARELLI. Pergamon, New York, 1977. xvi, 310 pp., illus. $38.50.

In spite of its bulk in the world's biomass and its importance as the main component of the integument of arthropods, the most abundant living organisms, chitin has received relatively little attention from researchers. Chitin is important in biology as the most widely used structural carbohydrate in the animal kingdom, being absent only in vertebrates and echinoderms. It is useful in analytical chemistry for ion exchange, chelation, and affinity chromatography and in an assortment of medical applications, but more important is its increasing use in industry for metal chelation, membranes, and photographic processes.

Muzzarelli's book shows the importance of chitin, and it is the first book to set forth the chitin chemistry needed in industrial and academic research. The first four chapters deal with the chemistry and properties of chitin, the last three with its uses and applications.

Muzzarelli begins with an outline of chitin occurrence and synthesis. It seems most likely that the chitin fibers, in fungi at least, are spun from chitin synthetase granules or chitosomes in much the same way cellulose fibers arise in other plants. It will be interesting to see if similar chitosomes are responsible for the chitin of animal cuticles and what role they may play in fiber orientation. Chitin associations with carotenoids, glucans, and proteins are dealt with sketchily because of the inadequacy of our knowledge of the chemical linkages concerned. Inhibitors of chitin synthetase, such as polyoxin in fungi and benzoyl phenylureas in insects, promise to be useful for experimental studies as well as to have practical application as fungicides and insecticides.