sketching the numerous "secondary" characters—scholars and gentlemen, curmudgeons and rogues—who became involved in the struggles. Newton and Leibniz are more difficult to portray, and his Newton is not quite crusty, aggressive, and arrogant enough for me.

By relating the dispute over the calculus to the broader philosophical dispute between the Newtonians and Cartesians, Hall adds a new element for evaluating the dispute and shows how much more was at stake than priority for the invention of the calculus, as if that were not enough. In the first decade of the 18th century, the new mechanics of Newton's *Principia*, in particular the concepts of force and gravitational attraction, were nearly universally rejected on the Continent as a reactionary return to occult forces, and Leibniz was one of the most vociferous critics of Newtonian natural philosophy. Yet by mid-century Newton's mechanics and entire natural philosophy dominated European thought, so that in this aspect of the dispute the Newtonians prevailed. The Leibnizian notation and school (led by such luminaries as Jakob and Johann Bernoulli, the Marquis de L'Hospital, and Pierre Varignon) already dominated the calculus at the turn of the century and beginning of the dispute, when Newton's early mathematical work was still unpublished and largely unknown. Yet, as Hall argues, with the publication of many of his earlier mathematical treatises, Newton succeeded in his goal of establishing his priority for the discovery of the calculus, thereby diminishing Leibniz's fame, if not his stature and influence. Though we may like to consider priority disputes futile and unbecoming to science, there is, as this book shows, very much to be gained through them.

ALAN E. SHAPIRO
School of Physics and Astronomy, University of Minnesota, Minneapolis 55455

Toxicology

Quantitative Toxicology. Selected Topics. V. A. FILOV, A. A. GOLUBEV, E. I. LIUBLINA, and N. A. TOLOKONTSEV. Translated from the Russian edition (1973) by V. E. Tatarchenko. Wiley-Interscience, New York, 1980. xviii, 462 pp., illus. $32.50. Environmental Science and Technology.

This book is an attempt by a group of Leningrad toxicologists to present a systematic account of quantitative aspects of toxicology. Rather than updating the original book for the English edition, the authors prepared addenda to all the chapters except one that deals with the equilibrium distribution of nonelectrolytes between the environment and living organisms, a subject where no further developments have occurred.

Toxicity has been defined as the capability of a chemical to harm a living organism. It depends on the physical and chemical properties of the compound, on the characteristics of the organism with which the chemical interacts, and, above all, on the amount of the chemical that is absorbed by the organism, that is, on its dose. The relationship between the dose and the type and magnitude of the effects and the incidence of the effects in a population are the central concerns of toxicology. The effects also depend on the way in which the chemical is absorbed by the organism (inhalation, skin contact, ingestion, injection), how the dose is distributed in time (single dose, repeated doses, continued uptake), and on whether the magnitude of the dose is constant or variable. A deleterious effect may be caused by the parent compound or its metabolic products, which have to be identified. The transport, distribution, and elimination from the organism, both of the parent compound and of its metabolites, have to be evaluated. Effects may appear soon after exposure or may take considerable time to develop. Environmental conditions such as the presence or absence of other chemicals and the intensity of physical factors—light, temperature, humidity, radiation, and noise—may also modify the toxic action of chemicals. All these phenomena and processes have both qualitative and quantitative aspects. Statistical correlations and mathematical models may be useful tools in toxicology but are of limited value unless their biological basis is understood, at least to some extent. To express toxicological information in quantitative terms is a complex task, and the authors were wise to limit their presentation to topics with which they had personal experience. The monograph is largely based on Soviet literature and toxicological practice but includes selected references to the work done in other countries.

Of much interest is the discussion of "the relationship between the amount of poison and toxic effect" (chapter 2), for it considers threshold doses and concentrations, "toxic action zones," and maximum permissible concentrations. The view of the authors (p. 31) is that "the threshold dose depends not only on species and individual differences in sensitivity, properties of poison, and various other factors mentioned in chapter 1, but also, and perhaps first and foremost, on the method used to establish it" and that "the difficulty is compounded by the lack of agreement about what is to be considered a threshold effect." The concept of "toxic zones" has always caused misunderstanding because it has been defined in many different ways, even by Soviet toxicologists. The authors propose to define it as the slope of the dose-response line after is has been linearized. As regards methods for establishing maximum permissible concentrations, the authors think it would be desirable to make a detailed comparison of the different approaches that are currently used. It may then be possible to find principles for setting such concentrations that would be less subjective.

About a third of the book is devoted to a fairly complete and conventional treatment of the kinetics of absorption and the fate of chemicals in the organism. A new name, "toxicokinetics," is proposed. The treatment ends with an outline of an interesting but highly theoretical model for the kinetics of uptake of stable compounds.

According to some recent estimates, about 70,000 chemicals are currently used in various applications, and many of them have not yet been tested adequately, if at all. The number of chemicals is increasing rapidly; about 200 to 1000 new ones are put on the market every year. In order to reduce the cost of and time needed for toxicological assessment, an effort is being made in many countries to develop appropriate methods for screening and identifying those compounds that require long-term testing. One approach is to use rapid laboratory bioassays, such as those used in mutagenicity studies; the other is to use the relationship between chemical structure and biological activity. Soviet toxicologists have always paid considerable attention to such relationships and have developed a large number of empirical methods for calculating different toxicity indexes from physicochemical properties and even for estimating tentative maximum permissible concentrations of new chemicals. An extensive discussion of this approach is given in the last two chapters of the book. The authors recognize that the use of structure-activity relationships has had a rather limited success in predicting chemical carcinogenicity. Nevertheless, they consider it a useful tool in the selection of chemicals for laboratory testing.

Other topics discussed include quantitative evaluation of cumulative and of joint effects of chemicals.

The translation of *Quantitative Tox-*

icology will no doubt contribute to a better understanding of concepts and methods currently used in the Soviet Union for quantitative evaluation and interpretation of toxicological data.

V. B. VOUK

National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina 27709

Licensing Controversy

Seabrook and the Nuclear Regulatory Commission. The Licensing of a Nuclear Power Plant. DONALD W. STEVER, JR. University Press of New England, Hanover, N.H., 1980. xvi, 248 pp., illus. $15.

The accident at Three Mile Island intensified the debate about the safety of nuclear power in the United States. For some, Three Mile Island confirmed what they believed all along, namely that nuclear power plants can never be made completely safe. All existing plants should be shut down and new construction should be halted. For others, Three Mile Island was an isolated and preventable episode in the history of an industry that has an enviable safety record. Following minimal improvements in existing safety procedures, nuclear power should continue to help meet our energy needs. A third view, located between these two extremes but closer to the second, is that nuclear power will become a safe alternative worthy of public trust only when the governmental process by which the industry is regulated undergoes significant reform.

In a timely volume, Donald Stever gives weight to this third position by examining the controversial licensing of the Seabrook, New Hampshire, nuclear facility. From his vantage point as New Hampshire's assistant attorney general in charge of the Environmental Protection Division, Stever offers a fascinating insider's view of the six long years of licensing proceedings. He argues that it is a process with serious shortcomings, one that is likely to favor industrial interests over health and safety concerns and one that makes an accident like that at Three Mile Island a very real possibility.

Stever identifies several groups of problems that plague the Seabrook case. First, he points to the woefully inadequate preparation and examination of the application for license. Environmental impact studies were poorly conceived and inadequately executed; the assessment of risk to health and safety was based on questionable methodologies; the determination of the need for additional power was calculated on economic projections that proved wildly inaccurate; and the judgment about the financial resources of the applicant firm proved far too optimistic. The absence of reliable information makes a reasonable and prudent licensing judgment difficult at best. According to Stever, poor information results primarily from a shortage of resources—regulators don't have the time or money to conduct the necessary studies, and private interests lack the skill and incentive to gather the relevant data.

A second group of problems centers around jurisdictional divisions among the regulatory authorities involved. The divisions of authority between states and the Nuclear Regulatory Commission, between the NRC staff, its appeals board, and the Commission, and between the NRC and the Environmental Protection Agency all contribute to a complicated process that repeatedly postpones and delays decisions.

The remedies Stever offers are procedural—methods to generate more reliable information and ways to streamline the regulator's decision-making process. Both are designed to restore public trust in the regulatory machinery and head off the extralegal opposition that has plagued Seabrook. Better siting decisions are the key to an improved process. Establishment of a public planning agency would assure early public involvement in the examination of alternative sites, and adopting sites in areas removed from heavy population concentrations and fragile environmental conditions, so-called remote siting, would cushion against the uncertainties of environmental impact and risks to health and safety. Both recommendations should forge an early consensus for a chosen site.

Greater public involvement in early siting decisions would also address another weakness—the bias in favor of the applicant over those opposed to the granting of a license. Once private utilities have sunk considerable money into a chosen site or have even begun construction of the facility (a permit to begin construction can precede a license to operate) economic calculations weigh heavily in favor of the utility and, as Stever shows, are incorporated into the licensing decision. The quasipublic and monopolistic character of utility firms would appear to justify some form of public participation in decisions that affect public health and safety as well as the price and availability of power.

On the whole this is a most competent case study that uses its extensive documentation to draw well-reasoned and prudent recommendations. Yet this reader remains unconvinced that the procedural reforms suggested would do much to restore public faith in the licensing process and allay fears about the safety of nuclear power. The procedural fix is too simple. The assumptions on which it is based are questionable at best.

For any regulatory scheme to enjoy public confidence, its objectives must be broadly acceptable and clearly drawn, compatible with one another, and enforced by effective rules and procedures. The definition of public objectives is logically prior to the making of rules. Unguided by strong public consensus, rulemaking becomes a highly politicized process in which competing interests attempt to shape the rules to their benefit. Regulatory schemes in the hands of private interests seldom enjoy public confidence. Reworking the rules may alter who wins and loses but, without a clear definition of public purpose, is unlikely to generate public consensus.

Several contemporary scientific issues have recently entered the regulatory arena without sufficient attention directed to the definition of regulatory objectives, public acceptance of such objectives, and their compatibility with one another. The control of toxic substances, regulations regarding recombinant DNA technology, and the licensing of nuclear power plants are all examples of attempts to make policy in the absence of explicit and accepted objectives. While Stever is quick to condemn the process of regulatory decision-making and therefore looks for procedural remedies, it is also important to examine the substance of these issues as an explanation of regulatory deficiencies. I would argue that some scientific and technological issues are particularly difficult to regulate because acceptable objectives are impossible to define. First, experts are unable to agree about what exactly constitutes a risk to health and safety or a threat to the environment. As Stever notes, the methodological remedy promoted by advocates of risk assessment provides no panacea. Second, experts are often asked to do cost-benefit analyses, to weigh health benefits against environmental costs, safety costs against economic benefits, that presuppose an agreed-upon ranking of values in the public mind. These conditions of scientific uncertainty and disagreement over values guarantee the politicization of regulatory activity. Moreover, interest groups have been quick to recognize the power of scientific advice.