'kinetic viewpoint,' although at the present time, because of the lack of comprehensive data, penetrating generalizations are likely to be elusive."

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Condensed Phases

Physical Properties of Molecular Crystals, Liquids, and Glasses. A. BONDI. Wiley, New York, 1968. xxii + 502 pp., illus. $18.50. Wiley Series on the Science and Technology of Materials.

This volume, one in a series on the science and technology of materials, is a compendium of methods for estimating thermal and mechanical properties of the several states of materials indicated by the title. The motif of the work is that of Reid and Sherwood (*Properties of Gases and Liquids*), namely the use of correlations of thermal and molecular structure properties as devices for estimating other thermal and mechanical properties. Of primary interest here are compounds of relatively high molecular weight for which correlations through critical properties are not available. The author chooses methods for each class of compounds which have some basis in physicochemical principles for that class. These are briefly discussed in most sections, and the user can look to these paragraphs for insight and, more important, for pitfalls.

The primary variables used to make the correlations are, for the most part, heats of vaporization and sublimation, which are used as a measure of interaction energy and lattice energy, and van der Waals radii, which are used to include effects due to molecular size and shape. Estimates of these parameters are in turn gleaned from dipole moments on a functional group basis and from other sources. Where important, effects of barriers for internal rotations are treated, as are effects due to hydrogen bonding in liquids. The properties discussed are: heat capacity, enthalpy, entropy, thermal expansion, bulk modulus, Young's modulus, shear modulus, thermal conductivity, "rotational" diffusion, vapor pressure, critical properties, PVT properties, and viscosity. These are discussed, where relevant, under five classes of material states: crystals, crystalline polymers, liquids, polymer melts, and glasses. In addition, changes of properties on fusion and to a lesser extent other topics are discussed. These are creep compliance, sintering, mass diffusion, and mixtures. Most of the sections are concluded with "calculating procedures," step-by-step instructions, starting from the molecular structure, for estimating the property of interest. These are the most valuable attribute of the volume.

The usefulness of this volume would have been enhanced had the author been more explicit about defining and indexing symbols; chapters 3, 7, 8, 10, and 14 lack sorely needed glossaries of symbols. There are equations containing dimensionful numerical factors in which the dimensions of other factors or terms are not explicitly stated. Phrases such as "all symbols have their usual meaning" and "appropriate" (units) will irk those who have come to material science from physics or metallurgy.

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Models for the Historian

Looking at History through Mathematics. N. RASHEVSKY. M.I.T. Press, Cambridge, Mass., 1968. xviii + 199 pp., illus. $10.

In this volume, Nicholas Rashevsky "illustrates in a number of different, sometimes almost disconnected, examples how mathematical reasoning *could in principle* be used in attempted explanations of *some* historical phenomena." Trained as a mathematical biologist, Rashevsky leans heavily on biological analogies, and to a lesser extent on physical analogies, in formulating his historical models. These models are then used to explain such historical phenomena as the displacement of "religious faith" by "rational reasoning" and the diffusion of new ideas.

If Rashevsky's major purpose is to demonstrate that it is possible to mathematize history, then his volume is about a decade too late. For a large number of investigators have been working on the application of mathematical models to history since the mid-1950's. Such research has proceeded most rapidly in economic history, where scholars could draw on the large array of mathematical and statistical models produced by economic theorists and econometricians. Today, mathematical economic history, usually called "the new economic history" or "econometric history," is no longer a novelty. It is the principal way in which economic history is taught in the graduate programs of those departments which produce most of the Ph.D.'s in the field.

The mathematization of political and social history has been proceeding more slowly. In recent years two important centers have been established to promote mathematical work in these areas. One is the Committee on Mathematical and Statistical Methods in History of the Mathematical Social Science Board (MSSB). The other is the Inter-University Consortium for Political Research (ICPR). Both groups have sponsored conferences, advanced research seminars, and training institutes on the application of mathematical methods to history. MSSB is also sponsoring a volume of papers which apply mathematical methods to a wide range of problems in American and European history. One of the ICPR projects is the development of a data bank which will enable historians to relate political to demographic, social, and economic variables. In this connection they are putting on IBM cards, by counties, data drawn from each of the U.S. decennial censuses since 1790.

Since Rashevsky's volume is too late to perform the service of turning historians to a new method, the principal issue which remains is the explanatory value of the particular models he develops. Because his aim was to illustrate the possibility of formulating mathematical models of history, rather than to provide historians with models which are empirically valid, Rashevsky frequently permits himself the luxury of making assumptions in which he has little confidence. He does not deal with the problems of procuring the data needed to test his models. Indeed, he applies himself to such titanic issues, to such vast stretches of time and space, that it is unlikely that historians will ever be able to acquire the data needed to estimate the parameters of his models. This is surely the wrong direction in which to point potential builders of historical models.

Nevertheless, historians who are interested in mathematical approaches to history, and who know calculus, may find Rashevsky's book of use. Although I doubt that his models can be made operational, they may suggest other models which can.

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