Another serious omission is in the historical context. McMahon tells the story of the electrical engineers without reference to the professionalization of other branches of engineering. Yet what was happening elsewhere definitely affected his leading characters as they established institutions, values, and educational curricula. Third, McMahon says little about the role of the IEEE and its predecessors as arbiters of accepted knowledge in the profession. Yet fostering knowledge was their principal purpose. Surely understanding how they accomplished it is crucial to understanding the character of electrical engineering. Finally, I may be old-fashioned, but I still expect a few standard collections of information in a book like this: a short chronology, a chart of membership growth, publication statistics, a list of key officers, selected organizational diagrams, and the like. McMahon gives us only narrative.

Criticisms of what is missing are always weaker than criticisms of what is included. What is there is generally good. McMahon's book, which has no predecessor in this field, is a major contribution to the history of technology and will become a standard reference. And, together with *Engineers and Electrons*, it has its own place in the history of the IEEE. By commissioning these two excellent books, continuing sponsorship of the Center for the History of Electrical Engineering in New York, and fellowships for historical research, the IEEE has passed another significant milestone in its maturity as a professional society: taking responsibility not only for the future of electrical engineering but also for its past.

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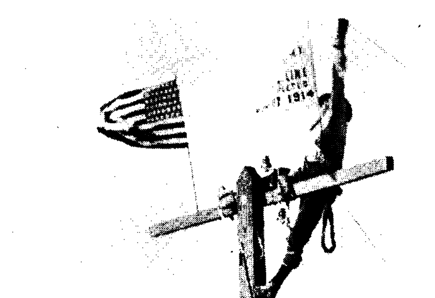

"The completion of the transcontinental telephone line in 1914." [From *Electrons and Engineers*; AT&T]

Science Surveyed

Science and Scientific Researchers in Modern Society. JOHN P. DICKINSON. Unesco, Paris, 1984. 254 pp. Paper, 90 F.

An Introduction to Science Studies. The Philosophical and Social Aspects of Science and Technology. JOHN ZIMAN. Cambridge University Press, New York, 1985. xii, 203 pp., illus. $22.95.

The British expression "science studies" has not become popular in the United States to characterize academic programs or a field of study. Here, we cover much the same ground that phrase encompasses in programs devoted to "science, technology, and society" or in programs and conferences that look broadly at the history, philosophy, and sociology of science and technology. In addition to such academic enterprises, it is possible for an individual—often a scientist—to approach the subject through a reflective personal survey.

Dickinson's *Science and Scientific Researchers in Modern Society*, commissioned by Unesco, takes that approach. The book makes modest claims for itself. "For a writer to set out to cover, on his own and in a single volume, the whole range of facts and misconceptions, adventures and difficulties to be encountered in the world of scientific research, as well as its network of relations with other intellectual and political activities in modern society, would be foolhardy and presumptuous indeed," Dickinson writes in his foreword. What Dickinson says he is going to do instead is "to offer to the general reader, and more particularly to the young person who may be on the brink of a career in scientific research, a picture of the wider aims of that research, of the scientific researcher's life, and of his interaction with society." Dickinson presents his account under six headings, beginning with "Scientific research in contemporary perspective." The other areas dealt with are distinguishing features of scientific research, scientific careers, professionalism, the scientist as citizen, and the future. The author discusses such issues as repeatability and generalization, quantification and standardization, continuity and anti-authoritarianism, norms and responsibilities, and academic freedom. The chapter on careers is somewhat pessimistic. There is an interesting discussion of codes of ethics, and two appendixes include examples of such codes and lists of organizations and conferences concerned with responsibilities of the scientific profession. An annotated bibliographical index and a fairly extensive list of suggested readings round out this useful but restrained volume.

In *Introduction to Science Studies* Ziman undertakes the task eschewed by Dickinson. His success in carrying out the endeavor is at least in part attributable to the fact that he really does not attempt it alone; his is a masterly summary of the whole range of the science studies literature, from philosophy of science to sociology of science to science and technology policy studies. At the same time, it is a personal summary, depending explicitly on Ziman's earlier formulations, especially in *Public Knowledge* (1967) and *Reliable Knowledge* (1979). Ziman is also strongly influenced by Jerome Ravetz's *Scientific Knowledge and Its Social Problems* (1971).

Ziman makes a deliberate choice, at the outset, to begin his survey with the more traditional views of philosophers and internalist historians and sociologists of science concerning issues of epistemology, communication, recognition, and the like. That is, he defers his discussion of the technopolitical dimension of "collectivized science." Nevertheless, he does organize his summaries of other people's views around his own collective-science–oriented model of "public knowledge." In making this choice, he admits that it might be more realistic to work from the outside in, so to speak. However, he recognizes that many scientists and engineers still cling to the old model of "reliable knowledge" as the ideal of "academic science."

Ziman warms to his task about two-thirds of the way through the volume, in a chapter headed "Collectivized science." There he has this to say: "The conventional description of the scientific community as a republic or oligarchy of autonomous scientists, exchanging communications for personal recognition, is not yet out of date, but it must be radically modified to take full account of the structures that have grown up to coordinate and *manage* scientific work." The modifications, he says, affect not only the internal but also the external sociology of science. "Science," he writes, "has . . . moved from the periphery of society towards the centres of power, and is apparently becoming an organ of the state apparatus, the ruling class, the military-industrial complex, or whatever it is that governs our lives in an advanced industrial country." The balance of the volume is Ziman's attempt to justify this thesis.

Ziman's book is a *tour de force*. He makes reference to a very high percentage of the major works cited in the two standard surveys of science studies: *Science, Technology and Society* (1977), edited by Ina Spiegel-Rösing and Derek de Solla Price, and *A Guide to the Culture of Science, Technology, and Medicine* (1980 and 1984), edited by the present reviewer. When the editors and authors of the latter volume began their project, they lamented the fact that the perspective of a spokesperson for science would not fit into the scheme of the volume. Now there is such a voice. Ziman's introduction to science studies, to what one author has called the "metascientific" disciplines, is an excellent companion to the compendia mentioned. It would also make a fine textbook for an introductory course in a science, technology, and society program.

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Mathematical Chemistry

Perspectives in Theoretical Stereochemistry. I. UGI, J. DUGUNDJI, R. KOPP, and D. MARQUARDING. Springer-Verlag, New York, 1984. xviii, 247 pp., illus. Paper, $19.30. Lecture Notes in Chemistry, vol. 36.

The past several decades have seen spectacular development in the interaction between mathematics and stereochemistry. Enumeration problems in static and dynamic stereochemistry have been linked to permutation groups and their partition into cosets and double cosets, and experimental observations, such as observations of coalescence patterns in dynamic nuclear magnetic resonance, have been interpreted in terms of these abstract mathematical objects.

This book is written by authors who participated in this evolution of mathematical chemistry, coining the term "permutational isomerism," for instance. The book is divided into three parts. The first part discusses the main classical concepts and presents the notions of permutational isomerism and chemical identity group. The second part discusses the mathematical concepts needed for further applications of the chemical identity group. The applications are discussed in the third part, in which a chemical nomenclature and documentation system based on permutational isomerism are proposed.

According to the authors, "There is definitely a need for new types of ideas, concepts, theories and techniques that are usable beyond the scope of customary methodology. This is why the present text was written" (p. vi). The most adequate way to analyze the book is to discuss some of these unconventional ideas and to compare them with previous work.

The chemical identity group is defined in the book as a group of permutations preserving the chemical identity of a compound in which all the ligands are chemically distinguishable. According to the authors, it does not express geometric symmetries. However, it plays the role played by the idealized rotational subgroup of rigid molecules in more conventional approaches. For instance, for an AsF_5 molecule, if the distinction between axial and equatorial sites remains possible with five different ligands, one can speak of an idealized D_3 rotational subgroup, instead of the actual C_1 subgroup. The authors write that, "since there is no such thing as an approximate symmetry," the use of the idealized rotational subgroup is a "logical inconsistency" (p. 46). But when the chemical identity group of the above pentacoordinate As compound is obtained by the authors, it turns out to be isomorphic to D_3. This can only be justified if one assumes at least implicitly that two of the five ligands are axial and three equatorial and that axial-equatorial exchange does not preserve chemical identity. Another assumption (one axial, four basal, for instance) should lead to another chemical identity group. Thus the authors do not in fact avoid consideration of idealized (approximate) geometric symmetries.

Nonrigid molecules are usually described by the point group or rotational subgroup of a configuration corresponding to a minimum of the potential hypersurface and by the Longuet-Higgins group, which includes permutations (and permutation-inversions) depicting feasible operations. The chemical identity group a priori includes dynamical information (such as inversion operations for nonrigid ternary amines), and from this point of view it is similar to the Longuet-Higgins group. Hence the chemical identity group ignores the symmetry properties of the polytopes situated in potential wells. This seems to be adequate only when the depth of the wells is vanishingly small.

The discussion of the so-called Dieter group is another unconventional aspect of the book. The authors define this group as the chemical identity group of an arbitrary system Q of permutational isomers. The physical meaning of such a group when Q is actually arbitrary is not obvious. However, when the system Q contains exactly all the isomers that can be reached from a given one by arbitrary sequences of a fixed mode of rearrangement, then it is easy to realize that the Dieter group reduces to the Longuet-Higgins group (disregarding the effect of inversion about the center of mass). The Dieter group of a system Q of interconverting permutational isomers is also defined as the chemical identity group of the common intermediate X or ensemble of intermediates X of these interconversions, although it is not demonstrated explicitly that these two concepts coincide.

When the system Q consists of only two permutational isomers connected by a given isomerization, then it may be verified that the Dieter group is the Pechukas group expressing conservation of nuclear symmetry along a path of steepest descent.

Hence the definition of the Dieter group includes two important groups related to molecular symmetry, the Longuet-Higgins and the Pechukas groups. It is unfortunate that these properties of the Dieter group are not fully discussed in the book.

The Dieter group is intended by the authors to be predictive; they write that if it "is trivial, then no non-trivial mechanism is possible" (p. 38). This proposition seems questionable because it excludes any non–self-inverse mechanism having a connectivity of 1. Indeed, for a pair of isomers connected by such a mechanism the Dieter group reduces to the identity operation.

The Dieter group has been worked out explicitly in the book for Berry rotation and Turnstile rotation mechanisms. In one case the set Q has been chosen to consist of two isomers connected by a Berry rotation mechanism; in the other case it consists of the six isomers on a cycle of six consecutive Turnstile rotation steps. This choice is justified by the authors on the basis of the periodicity of the permutations (two for the Berry rotation, six for the Turnstile rotation). This looks completely arbitrary since both rotations can be described by any permutation of the coset associated to the isomer obtained in one step of both