research fosters increasing inattention to the natural complexity of biological systems," he argues, and is at the root of that wider scientific inattention to the natural complexity of the total environmental system which is already leading us to trouble. Why this widespread inattention? Because, Commoner says, the integrity of science has been compromised by political pressures to narrow the gap between discovery and application and to harness science to political and social goals. These pressures have corrupted scientists, so that "the public is no longer certain that scientists—all of them—'tell the truth'. . . . The citizen has begun to doubt what he used to take for granted—that science is closely connected with truth." By claiming a special partnership in the political process, scientists have tarnished their mantles and eroded the integrity and therefore the efficacy and reliability of science.

What is the solution? There is no single, magic one, says Commoner, but one may be fashioned from a number of elements. First, the scientist should function as a teacher to inform the citizenry about the technical content of political issues. He should not, *qua* scientist, become a partisan or an accessory. Second, science must rededicate itself to its historic integrity, which lies

> . . . in the minds of scientists, and in the system of discourse which scientists have developed in order to describe what they know and to perfect their understanding of what they have learned. It is these internal factors—the methods, procedures, and processes which scientists use to discover and to discuss the properties of the natural world—which have given science its great success.

Third, science must again seek its traditional "isolation from cultural effects" in order to have the freedom to judge "in which areas the new insights of science are powerful and effective guides to action [and] in which others they are too uncertain to support a sound technology."

One may share the author's concern about the undesirable effects of modern technology and agree with his statement of the values of science without allying oneself either with his evaluation of the biological debate or with his implicit belief in the efficacy of exhortations to return to a more honest time. The current state of biology may be illustrative of his argument, but the importance given it in this book seems *sui generis*. The exhortation, moralistic at times, occupies the longest chapter of the book, which includes also an informative account of the author's own efforts at public education with the St. Louis Committee for Nuclear Information and a severe indictment of the public information policies of the Atomic Energy Commission. Beyond that, it contains little that is new and much that is familiar, including the purest intentions, a few political axes, and some dubious philosophical formulations.

Yet the problem remains. It is perhaps most fruitfully seen, I have suggested, as one of modifying old forms into newer ones more nearly adequate to the changed role that the institution of science must play in society. My hypothesis—and Commoner's evidence—is that the successes of science are forcing a change in its own ground rules in several important and related ways.

First, a science become politically important unquestionably affects the objectivity and freedom traditionally associated with the image of the scientist. Commoner is not the only one concerned about that. The efforts of most of the responsible scientists in or at the periphery of government are directed to insuring against the danger.

Second, as the technologies that science spawns begin to affect the ecological balance of the planet, there arises a need to reconsider the wisdom of the traditional belief in the "duty" of science to explore the unknown unhampered by any other considerations.

Third, the prospect that new technologies will require a combination of scientific competences to gauge their full implications may indeed call for increasing concern about the comparative rates at which the various sciences advance and may furnish additional cause for the current search for cross-disciplinary patterns of inquiry.

Finally, it may be time to look again to the metaphysical foundations of science for some of the understanding needed to resolve the difficulties that Commoner points to. It is indisputable that the spectacular advance of science for three centuries was aided by release from ancient metaphysical constraints. It is equally indisputable that science profited from remaining largely unapplied. There was little feedback about the nature of the world to interfere with the freedom and the disciplinary specialization that it thrived on. But it does not follow from this history that science can forever be free of constraints imposed by the character of the natural world that it explores. A chief philosophical implication of modern technology may be that it reveals these constraints by serving as an explicit link between knowing and the known. It is fashionable these days to contrast the mutually independent careers of science and technology in the past with the science-based technologies of the present. The implications of this change for technology and for politics have been fairly extensively explored. Its implications for science have not. Yet the fact that technology now begins to reveal more general traits of nature than have the local and unconnected reactions elicited in the laboratory may be of capital significance for the assumptions, structures, practices, and values of the scientific enterprise.

I am not sure that Commoner put all this into his book, but I do not imagine he should be displeased that this is what one reader got out of it.

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Questions and Methods in Number Theory

Sequences. Vol. 1. H. HALBERSTAM and K. F. ROTH. Oxford University Press, New York, 1966. 311 pp., illus. $10.10.

The "sequences" of the title are sequences of nonnegative integers. It should be said immediately, however, that this book is not accessible to the general reader. For although the integers are familiar to almost everyone, the material presented here is mathematically sophisticated and, in a few instances, very difficult. On the other hand, any serious student of mathematics will find a great deal to attract him, for the subject abounds with results of great elegance, power, and generality which at the same time are not overly technical.

Here are some problems of the type discussed in the book:

1) Given a sequence of nonnegative integers, can every nonnegative integer be written as a sum of two members of A? If the answer is "no," then will three suffice? And so forth. The best-known result of this kind is that every

nonnegative integer is a sum of four integral squares and that three integral squares will not suffice. If every nonnegative integer can be written as a sum of h elements from A we call A a *basis of order h*. An important problem is to determine whether a sequence is a basis, and, if so, to find its minimal order.

2) Fix $h \geqq 2$ and let $r_h(n)$ be the number of ways of writing the nonnegative integer n as a sum of h elements from A. What can we say about the values of $r_h(n)$ as a function of n? A closely related problem is the determination of the rate of growth of $r_h(0) + \ldots + r_h(N)$ as a function of N. Both of these questions are, in turn, related to those in problem 1. For to say that A is a basis of order h is to say that $r_h(n) > 0$ for all nonnegative integers n.

3) If A and B are sequences, we form the new sequence $A + B$ consisting of all distinct integers which are the sum of an element of A and an element of B. If we know something about the density of A (where "density" is a measure of the abundance of A in the sequence of all nonnegative integers) and the density of B, what can be said about the density of $A + B$? Is a sequence of large density necessarily a basis?

To a large extent the book is organized around the methods used in investigating such questions. Thus we find a chapter dealing with number theoretic methods, another with probability methods, and a third with sieve methods. The chapter on sieve methods differs from the rest of the book in that no applications of these methods are carried out in detail. However, the various applications are discussed in the chapter's excellent introduction, which also includes an interesting and highly readable historical account of the sieve technique from Eratosthenes to Atle Selberg. This account is noteworthy also for its discussion of the relationships between the various sieve methods now available.

The chapter on probability methods (whose applicability to problems of this kind was first observed and exploited by Paul Erdös) is self-contained, for it has an introduction to probability theory which suffices for the applications presented. In fact, the authors have succeeded in making each of the five chapters a self-contained unit, and there is justice in their claim "that any single chapter can conveniently be read by itself."

The authors have given us the first connected account of this important branch of the theory of numbers to appear in print and have done so in a masterly way. Not only have they performed the very difficult job of collecting results from many sources, relating them, and presenting them in a unified manner, but they have also, in some cases, corrected errors and obscurities in the original sources. There are numerous references to the literature, and for the specialist the bibliography alone will be worth the price of the book.

Halberstam and Roth have made an outstanding contribution to the mathematical literature. We are promised a second volume, but unfortunately not very soon.

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A Practical Aid

The Structure of Polymers. M. L. MILLER. Reinhold, New York, 1966. 720 pp., illus. $27.

The Structure of Polymers is directed, as a practical aid, toward industrial scientists who are not necessarily specialists in polymer chemistry but who must come to grips with one aspect or another of the relationship between molecular structure and the mechanical and chemical properties of high polymers.

Considered broadly, as it is in the present work, the subject matter pertinent to this relationship comprises a substantial part of polymer science. Miller has dealt with the problem of organization first of all by subdividing the book into chapters which are as nearly as possible independent entities, and second, by a selectivity of material of which I shall speak later. The character of his book is epitomized by two chapters, one on the stiffness of molecules as related particularly to mechanical properties and the glassy state, and another, dominated by a discussion of stereoregularity, on molecular isomerism. Also treated are molecular weight and molecular weight distribution, branching, molecular interactions, hydrodynamic volume of molecules, networks, copolymers, crystallinity, orientation, polyelectrolytes, and electrical properties.

Miller frames his discussions almost exclusively around selected experimental results. It is through his acuity in the choice of illustrative data and in their modes of presentation that the book acquires its individuality and, in my opinion, its measure of success. From his treatment of topics most familiar to me, I would judge that his survey of the literature of the last 15 years has been remarkably thorough and that he has been perceptive in its distillation.

Not everyone will agree with the author in matters of emphasis. His dismissal of the Weissenberg effect as an annoyance to operators of viscometers could mislead workers who may have to deal with extrusion of polymers. Again, older data seemingly apt for purpose of illustration may now prove to be less definitive, as in a table relating crystallite size to melting point for polyethylenes with varying degrees of branching. A plague of works of this type, the imperfect generalization, induced by a reluctance to devote space to finer distinctions, is also encountered. I find these defects to be minor.

Accessibility of information is excellent as a result of the use of about 250 carefully labeled and readily readable graphs and tables. The subject index stands up well to test and the conventional author index has been eschewed in favor of a helpful polymer index. Practical polymer scientists will find this a useful book.

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Mutagenic Chemicals

The Actions of Chemicals on Dividing Cells. BENGT A. KIHLMAN. Prentice-Hall, Englewood Cliffs, N.J., 1966. 272 pp., illus. $10.

In 1956, at the Fifth International Conference on Radiobiology, an eminent biologist, who was concerned by the public's apathy regarding the mutagenic effects of radiation, made a plea that the assembled group not publicize the potential dangers from mutagenic chemicals. The reason for this stand was the fear that if geneticists made shotgun attacks against a large number of mutagens they would weaken their warnings against the indiscriminate use of radiation, which presented a clear-cut genetic hazard. Any arguments about whether or not geneticists should heed this advice have become