and development by private firms, and, in some sense, the social value of more technological progress in the industry must be high. Finally, they propose that federal purchasing power be used in civilian markets to speed innovation in products which the government buys extensively. An experimental procurement service would promote the purchase of new products, their performance would be monitored and recorded, and the results would be made public.

To those who have followed recent developments in this area, the relationship between these proposals and the ill-fated Civilian Industrial Technology Program will be apparent. In 1963, the Department of Commerce proposed the Civilian Industrial Technology Program to encourage and support additional research and development in industries that it regarded as lagging. The proposal met with little success on Capitol Hill. Industrial groups opposed the bill because they feared that government-sponsored research could upset existing competitive relationships. The program also included an industrial extension service, which was later established by the State Technical Services Act in 1965. Nelson, Peck, and Kalachek criticize the latter legislation for failing to stress sufficiently the use of the new extension service as an experiment to determine the benefits and costs of aiding firms that are technical laggards.

This book represents the thinking of some of the best and most influential workers in this field, men who have had an opportunity to participate at times in policy-making as well as to conduct relevant research. To a considerable extent, the limitations of the book reflect the important limitations of the basic fund of knowledge in this area. As the authors admit, there is little evidence to support some of their judgments and policy proposals. For example, what solid evidence supports their belief that undue emphasis on short-reach applied R&D "represents a far more serious distortion than concentration in large firms and in a few industries and product fields"? Fully aware of the difficulties in constructing an explicit model to provide estimates of social rates of return from research of various kinds, the authors make a determined effort to reach policy conclusions without such estimates. Their conclusions are very interesting and their discussion is worthwhile, but, as they recognize, the results are limited significantly by the weakness of the relevant base of fundamental knowledge.

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Concepts and Concept Learners

Experiments in Induction. EARL B. HUNT, JANET MARIN, and PHILIP J. STONE. Academic Press, New York, 1966. 261 pp., illus. $9.50.

The activity of "concept learning" may be defined as follows: "Given a set of objects which are to be partitioned into two disjoint sets, to find a description which is valid for all objects in one set and is not valid for any object in the other set." When one attempts to form a precise mathematical model for such an activity, however, one finds this definition woefully inadequate. The word *object* and the word *description* themselves need definition. In the consensus of workers active in modeling concept-learning activities, the following definition seems to be acceptable:

The act of concept learning is meaningful only when it is carried out in a specified environment. An environment is specified by setting down a set of properties (often called "dimensions") by which objects can be distinguished. Each dimension has a set of values. No object can have more than one value in the same dimension. An object in the environment is completely specified by specifying its value in each of the dimensions.

A description is a statement made in a language designed to reflect the structure of the specified environment. The language has a set of unary predicates as its building blocks—predicates which stand for sentences like "This object has value A of dimension B." The language also has auxiliary logical symbols by which predicates can be combined to yield compound sentences. Since each individual object satisfies the conjunction of a unique set of predicates, any concept can be described as a rather large sentence in what the logician calls a "normal form." (We shall not consider here the cases when the set of dimensions and values is not finite, although we thus exclude some important classes of concepts.) However, the idea of expressing a concept in normal form is impractical in any device of realistic size (including any physically realizable neural mechanism of the human brain). A concept learner has to come out not with just a description of a set of objects but with a "simple" description.

One often makes a second, more exacting demand of a concept learner. It is expected that a correct description be obtained by the learner with the knowledge of only a few objects from the set to be described and only a few from its complement. This is clearly an impossible task unless the class of sets to be described is somehow restricted and this restriction is reflected in the structure of the concept learner.

When the logical connectives in the language specifying the environment are restricted to "and," "or," and (under duress) "not," one can design a concept learner which yields simple descriptions of some sets of objects and more complicated descriptions of other sets of objects. A number of concept learners of this nature have been designed and investigated by the authors of *Experiments in Induction.* The descriptions the authors have used are expressed in "tree" form so that conjunctions are the simplest and hence the most easily generalizable of the connectives. A number of specific methods (not necessarily logically complete or efficient) have been suggested and tried for cases where the concept is not expressible as a conjunction. The performance of these learners has been studied statistically by varying the order in which the objects are presented to them and has been compared with that of humans. It would be very interesting to make a logical study of the learners to find out why concepts are learned more efficiently for some sequences of presentation than for others, especially in view of the authors' tentative conclusion that the use of specially selected methods for presenting evidence does not improve the learners' performance.

At this early stage of experimentation it is obviously unfair to expect that the concept learners designed so far will be of practical utility except in very special cases. As the authors have pointed out, the problem of developing proper dimensions (a new set of concepts) for the purpose of simplifying the most frequently occurring sets is an important problem meriting further attention. (This problem is called "feature extraction" in a related field.)

Many tricks used by humans, involving the processing of names of dimensions and values and yielding what Bruner, Goodnow, and Austin call "relational concepts," will need more sophisticated modes of description. It can be expected that the present book will arouse interest and direct activity in these directions. This will be greatly facilitated by the fact that in an appendix the authors present exact descriptions of their algorithms in a precise but simple computer-independent language (the "Iverson language"). The authors are to be commended for their appreciation of the problem of communication between programmers and for coming out with an acceptable solution, building, in the process, one bridge over the gap between psychologists and computer scientists.

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Uncharted Territory

Vegetation Mapping. A. W. KUCHLER. Ronald, New York, 1967. 478 pp., illus. $15.

The high-quality vegetation maps available in France, Austria, Germany, and Russia are both useful and impressive. Such detail, so important for much biological-planning work, is rarely at hand in this country. It is gratifying, therefore, to see a new American book devoted to the subject which not only details the ecological basis, technical aspects, and various methods of vegetation mapping, but also emphasizes the need for it and explains its possible applications. The same author gave us a most welcome small-scale vegetation map of the U.S. in 1964, with an equally valuable explanation. One hopes that these sparks will impel us to begin to match the vegetation mapping now under way in much of Europe.

Longer than Ellenberg's excellent *Aufgaben und Methoden der Vegetationskunde* (1956), the book goes a great deal further (and in English) in discussing the importance of ecology to mapping, the importance of thinking through in advance the technical problems of mapping, and the various (climatic, physiognomic, floristic, and "comprehensive") approaches. The book contains practical ideas: on maintaining uniformity in procedure yet finding original solutions for the problems peculiar to a particular area; on choosing the proper scale; on using color to maximize ecological-climatic land-use information; and on the merits and weaknesses of systems now in use. It offers an explanation of the superb Gaussen system and a fine discussion on the values of such maps to land managers and planners.

The book is hardly flawless: it is wordy and repetitious and written in parts as though for a high school audience; it is overly preoccupied with climate and with European ecology; and it does not clearly explain "potential natural vegetation." More serious, it says nothing about vegetation maps prepared from the General Land Office Survey notes of the first surveyors; many such maps (for example those by Vestal, Kenoyer, Potzger) portray in considerable detail presettlement and hence "original" vegetation distribution. But the flaws, though not unimportant, pale before the potential usefulness of the book. The analysis of maps and techniques from all over the world (of the 552 bibliographic references, 332 are in foreign languages) is a significant contribution in itself. With this book to provide methodological order, it is possible that the affluent society will produce vegetation maps as good as its road, topographic, soil, and geologic ones and that the eco-bio-geo-cenologist-planner need not always peer hopelessly at the grey stippling of his aerial photographs, wishing he could see beneath.

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Chemistry of Earth Metals

Peroxides, Superoxides, and Ozonides of Alkali and Alkaline Earth Metals. IL'YA IVANOVICH VOL'NOV. Translated from the Russian edition (Moscow, 1964) by J. Woroncow. A. W. Petrocelli, Translation Ed. Plenum Press, New York, 1966. 160 pp., illus. $9.

For a comment on the contents of this work, it would be difficult to improve on two paragraphs taken from Petrocelli's preface to the translated edition:

> Professor Vol'nov is eminently qualified to write this monograph since for many years he has been a leading investigator and prolific writer in the field of peroxide, superoxide, and ozonide chemistry. He has succeeded in presenting a lucid and detailed discussion of past work, the present state, and the future potential of this area of unfamiliar oxidation state chemistry.
>
> Of particular interest is Professor Vol'nov's extensive compilation of available thermodynamic, kinetic, and structural data for the alkali and alkaline earth peroxides, superoxides, and ozonides. In addition, he has reviewed the known methods of synthesis, as well as the practical applications for which these compounds are suited.

The volume is an organized publication of the articles by Vol'nov and coworkers, with logical additions of the work of others in appropriate areas. The chemistry of the compounds is well done and well referenced. The references given are a valuable part of the work, and while Vol'nov's preface indicates they will be limited to those from 1950–1962, many older references are included. On the other hand, a milestone in superoxide development, the work of C. A. Kraus and students in this country, is not referenced.

Chemists interested in the mechanism of oxidation and oxidation states of the alkali and alkaline earth metals cannot afford to overlook this work. The picture the author paints of development chemistry, costs of products, and applications is not, however, as complete as he is capable of producing. The research and development chemistry is shown to be heavily Russian, while the costs of products and applications are given for countries other than Russia. The commercial uses of oxycompounds in Russia cannot be so generally known as to be uninteresting to Russian readers, and an account of them certainly would have been a welcome addition to the translated work. If applications for superoxides do not exist in Russia, then nearly a million pounds of KO_2 powder forwarded under lend-lease (1942–45) from this country could have created a stowage problem.

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High-Pressure Phenomena

Advances in High Pressure Research. Vol. 1. R. S. BRADLEY, Ed. Academic Press, New York, 1966. 406 pp., illus. $16.

This series of which R. S. Bradley is editor should serve as a supplement to his recent work *High Pressure Physics and Chemistry*. It is planned that volumes in the series will appear at intervals of a few years and will deal