guard against excessive optimism. Measurement and accuracy by themselves do not touch even the fringe of social questions. Human relations can not be reduced to mathematical formulae or deterministic sequences. Knowledge of facts does not tell us what to do about them. The social sciences can successfully copy some of the techniques of the physical sciences, but ahead of us is the long difficult road, through trial and error, toward goals of social organization and control that lie obscured on the far horizon.

But science at least furnishes us a lead. Its methods teach patience; it stands for detachment and suspended judgment; it emphasizes the value of imagination and doubt; in a world of emotion and passion it shows us what the weighing of evidence means. That its by-products have created an unbelievably complex tangle of human ordering beyond our present means of guidance can scarcely be denied; but as a pattern of intelligence it still furnishes us the hope of deeper understanding and insight, and perhaps of some ultimate solutions.—*Dr. Raymond B. Fosdick, president of the Rockefeller Foundation, in his review for 1940.*

SCIENTIFIC BOOKS

SCIENTIFIC COMPUTATION

Punched Card Methods in Scientific Computation. By W. J. ECKERT. ix + 135 pp. Published by the Thomas J. Watson Astronomical Computing Bureau, Columbia University. 1940. $2.00.

BEFORE the beginning of the seventeenth century all scientific computations, no matter how intricate, were carried out by the slow and laborious method that the schoolboy still uses in doing his home work. The invention of logarithms by Napier in 1614 and the publication of convenient logarithmic tables by Briggs soon thereafter were the first powerful expedient to lighten the labor of computing. During the three centuries that followed mathematicians aimed to transform their formulae so that they would be adapted to logarithmic tables, and a great variety of such tables were published. At the end of the nineteenth century came the development in practical and inexpensive form of the multiplying machine, and this constitutes the second great advance. For some kinds of computing these machines offer advantages over logarithms, especially since the publication of many convenient tables of the natural (instead of logarithmic) functions. A third great advance is the invention by Hollerith of the punched card method with which the present book by Dr. Eckert deals. This was applied by Hollerith to the United States Census where it was used to great advantage in tabulating and sorting according to various arrangements millions of cards. Recently the International Business Machines Company, which has acquired the rights to the Hollerith machines, has developed among others one that is capable of doing multiplication and this has greatly widened the scope of this method and made it especially serviceable in astronomy.

The cards to be punched are very thin and measure 19 by 8 cm. They contain 80 columns of 12 spaces each, one space for each digit and two extra ones for the algebraic signs and for special purposes. As the cards are run through the machines electrical contacts are made through the punched holes and electrical impulses are brought to a switch-board which distributes them according to the nature of the problem. It is possible to add or subtract two or more quantities that have been punched on the cards, to multiply them or to dispose of them in a number of other different ways. The most recent machines are capable of performing in this way operations like the following:

$$\pm A \pm B \pm C \pm D \pm E \pm F \pm G$$
$$A \pm (B \pm C \pm D)\ E \pm (F \pm G \pm H)\ I \pm J$$

The results of these operations either appear as punches in other columns on the card or are printed on the face of the card.

Recently, Thomas J. Watson, who is president of the International Business Machines Company, has set up at Columbia University, under the direction of Dr. Eckert, an astronomical computing bureau to which has been generously contributed the free use of a complete battery of these machines. This has enabled the bureau to undertake several large pieces of work: the numerical vertification of Brown's lunar theory; the computation of standard places on Yale photographic plates, starting with the right ascensions and declinations of several hundred thousand stars; planetary perturbations, and so on. Dr. Eckert describes in detail how each of these problems was attacked, and this makes very useful reading for one who is contemplating a large piece of computation. Ordinarily it does not pay to use the punched-card method for a small or even a moderately large piece of work. Time is consumed in adapting the data to the machines, and more time is spent in adjusting the switchboards to the problem in hand. But if the problem is extensive enough the saving may be very great. Thus, for example, the cost of verifying Brown's lunar theory at the Watson Astronomical Computing Bureau was at most one tenth of that of doing it by the ordinary methods.

Dr. Eckert has done science a valuable service in

applying this method to several important problems and in describing in this book the processes used by him. This method undoubtedly has a great future, and will make possible computations that are so laborious by ordinary processes as to make them impracticable. The cost of renting the machines, which at present is the only way they are made available, is necessarily high; but with their more extended use this cost will unquestionably be reduced. In the meantime astronomers have reason to be grateful to the Thomas J. Watson Astronomical Computing Bureau for its services, which cost nothing more than the salaries of the operators on any piece of work accepted by its Board of Managers. Yale Observatory has especial reason to express such thanks, several very large projects having been made possible in this way.

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JOHN ALFRED BRASHEAR

John Alfred Brashear, Scientist and Humanitarian. By HARRIET A. GAUL and RUBY EISEMAN. viii + 220 pp. Philadelphia: University of Pennsylvania Press. 1940. $2.25.

THIS biography of a man who was born a hundred years ago and died twenty years ago, is a sympathetic portrayal of the life of a man who was not great in his scientific achievements, but who had a great influence upon others, who in their turn gave money to encourage and support scientific and educational enterprises in Pittsburgh. It is written not for the scientist but for the layman and is one in a series of lives of prominent Pennsylvanians. The life of "Uncle John" is a success story of the nineteenth century. Here a young man of humble parentage and little book learning rises from millwright to helper of the eminent Langley and to friend of the millionaires, Frick, Schwab, Phipps, Thaw and Carnegie. He is recognized in science for the "Brashear" method for silvering mirrors and for the fine optical instruments, including spectroscopes, rock-salt prisms and telescopes, made in his shop. But this book does not dwell at length on these achievements as much as on the civic responsibilities he assumed and on the influence he had over educational Pittsburgh at the turn of the century as the director of the Allegheny Observatory, as the chancellor of the Western University of Pennsylvania—now the University of Pittsburgh—as a trustee of the Carnegie Technical Schools, and finally, as the administrator of the Frick Educational Commission. The biography is simply written in a conversational style; it is at times amusing when anecdotes relating to the "Mill Lords" are told.

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SPECIAL ARTICLES

PARTIAL PROTECTION OF RATS BY RIBOFLAVIN WITH CASEIN AGAINST LIVER CANCER CAUSED BY DIMETHYLAMINOAZOBENZENE*

THE regular production of hepatic cirrhosis and cancer by the oral administration of dimethylaminoazobenzene (butter yellow) to rats has been reported by Kinosita.[1] The animals were fed 20 cc of a 3 per cent. solution of the chemical in olive oil mixed with 1,000 grams of a diet composed of unpolished rice supplemented with carrot. Subsequently, Nakahara[2] and his co-workers showed that no cirrhosis or cancer developed when this régime was supplemented with liver, and Ando[3] found that yeast had a similar effect.

Kensler, Sugiura and Rhoads[4] measured, by a modification of the method of Hodson and Norris,[5] the riboflavin levels in the livers of rats fed upon the basal diet as used by Kinosita, but without added butter yellow. The levels were found to be significantly lower than those of rats fed a stock laboratory diet. Moreover, if butter yellow was mixed with the rice, even less riboflavin was present in the livers. Most striking was the fact that the tumors which resulted from the carcinogenic régime contained only about 20 per cent. of the amount of riboflavin found in normal rat livers. If a protective supplement of yeast (Fleischmann 20–40) was administered, however, normal riboflavin levels in the livers were maintained and no cirrhosis or cancer resulted.

Further studies provide evidence that the basal diet as fed in this laboratory is inadequate in its content of riboflavin, since it supplies only about 6 micrograms of the vitamin daily. It is usually stated that about 15 micrograms daily are required to maintain rats in health. Furthermore, experiment proved that the animals fed the basal diet alone excrete in the urine very little riboflavin (2 micrograms daily per rat), less than 20 per cent. of that excreted by animals which receive the usual laboratory ration. If butter yellow is administered with the basal diet, a

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1 R. Kinosita, *Trans. Soc. Path. Jap.*, 27: 665, 1937.

2 W. Nakahara, T. Fujiwara and K. Mori, *Gann*, 33: 57, 1939.

3 T. Ando, *Gann*, 32: 252, 1938.

4 C. J. Kensler, K. Sugiura and C. P. Rhoads, SCIENCE, 91: 623, 1940.

5 A. Z. Hodson and L. C. Norris, *Jour. Biol. Chem.*, 131: 621, 1939.