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Symbolic Language of Science.

WE have received from Prof. McAdie, of Blue Hill Observatory, an off-print of a note on the subject of uniformity in aerographic notation, which occupies nine pages (169-177) of the Blue Hill Meteorological Observations, forming vol. lxxxiii., part 4, of the Annals of the Harvard Observatory. It invites agreement with regard to the symbolic representation of the quantities and operations required for the discussion of problems in the dynamics and physics of the atmosphere in pursuance of a suggestion of Dr. Otto Klotz in *Science*, vol. xlv., p. 360, 1917.

There can scarcely be any difference of opinion as to the desirability of arriving at an agreed practice in the use of symbols by different workers in the same subject. So far as the atmosphere is concerned, Prof. Bigelow held a very comprehensive review of the rank and file of the analysis of atmospheric operations in his discussion of cloud observations which forms the second volume of the Report of the Chief of the Weather Bureau for 1898-99; the first volume of the work on "Dynamic Meteorology and Hydro-

graphy," by V. Bjerknes and others (Carnegie Institution of Washington, 1910), sets out the representation of the physical quantities to be employed in a systematic manner, and a book by Mr. L. F. Richardson, now in the printer's hands, ranges over the same field. Ideas of uniformity are naturally developed to some extent in the various parts of the Computer's Handbook of the Meteorological Office, which endeavours to provide the worker in atmospheric dynamics and physics with the necessary material and forms for numerical computation arranged upon a systematic basis, and aspires to attach to each quantity its appropriate symbol.

But the subject bristles with difficulties of many kinds. We have available in practice, let us say, five alphabets ("lower case" roman and italic, "upper case" roman and italic, "lower case" Greek), a few letters taken from other alphabets, and a few additional symbols for units or operations. With these we have to represent the items of a considerable number of quite separate categories; for example, we want to represent: (1) defined quantities for specific units, as *m* for metre, *g* for gram; (2) quantities undefined as to unit, as ϕ for latitude and λ for longitude, which may be in radians or degrees, and *u*, *v*, *w* for velocity irrespective of unit; and (3) symbols of operation, as of multiplication, division, summation, and differentiation of various kinds.

In the absence of a sufficiency of letters or alphabets, we are accustomed to make out with suffixes and indices, but here we are liable to get into vexatious difficulties with the printer, and more particularly with the typist, who must be reckoned with in these days, and is apt to display a misguided ingenuity in substituting for a carefully selected symbol the nearest thing to it that can be got out of the keys; and, in any case, if the symbolism could be so arranged as to allow the print to "run on," it would be useful for both reader and publisher.

No adequate account can be given of the details of Prof. McAdie's scheme without reproducing it *in extenso*. With three alphabets and some suffixes and indices (apparently without making any use of the discrimination between roman and italic type), he represents ninety-four quantities, including such modern conceptions as electron, Planck's element of action, Taylor's eddy conductivity and viscosity, and Richardson's turbulivity. He uses them in five pages of fundamental relations. But the allocation is not altogether suc-

cessful; the letters are all gone, and some very ordinary quantities, such as area and vapour-pressure, have no symbol. N means Avogadro's constant, S entropy, E energy, and W external work; but somehow or other, definition or no definition, N—S and W—E are written down as representing wind components. If it be agreed that kb means kilobar and s means space, there is a certain depravity in using kbs, as Prof. McAdie does, to mean simply a plural of kb.

Furthermore, it is not really possible with our limited number of letters to allocate so many of them for purely arithmetical purposes. Very many of them are wanted for algebra; in fact, many more than are actually available before any allocation takes place. Prof. McAdie allows only x , y , z , and t for co-ordinates, but we must be permitted to change our co-ordinates. In the past, polar co-ordinates, co-ordinates referred to moving axes, and direction cosines have claimed letters which Prof. McAdie proposes to hand over for fixation.

The fact is that the allocation of a letter in common use to one specific and conventional meaning is a very awkward policy. It is not unfair to argue that if we want a symbol to be allocated definitely to a new quantity, and taboo for everything else, we ought to invent a new figure and get it canonised by a sufficient authority to induce printers to stock it. It sounds impracticable, but is at least worth consideration, for meteorologists have already done it in the case of symbols for atmospheric phenomena. Otherwise workers in sciences which are adjacent and not altogether independent are likely to select the same letters for different quantities, and there must be confusion. Perhaps the language of science ought to expand its notation as ordinary language has done by proceeding from single letters to syllables, and that would certainly be an easy and effective way of dealing with the question if we could do away with the convention that multiplication needs no symbol of operation, and require that every operation should be represented by a suitable sign.

Indeed, all ideas of allocating symbols for special quantities lead up to the suggestion that the study of the effectiveness of the language of science ought no longer to be left to the casual play of forces of individual workers. An Academy of Science might with advantage have a literary side, and there might even be lectures on the art of expression, symbolically or otherwise, of scien-

tific truths, with examples, some good and some bad, taken from scientific literature. Scientific institutions tend to separate themselves from the study of the classical languages and become independent centres of learning, and as they do so they ought to make adequate provision for the study of the history and literature of science in order to make sure that the literary form of the results which the institutions will present to the world will not be entirely neglected, as apparently it is now in some contributions to science. Scientific achievement is not really complete when only the author is satisfied with the results. It might be useful to make out how much scientific literature is neglected because its form is crabbed, repulsive, or even unintelligible.

These are quite natural expansions of the idea of economising the effort of the writer and reader by an agreement as to the use of symbols. That is an obvious and essential step, but we ought first to come to an agreement upon some general principles whether, to begin with, there is, or shall be, any difference in meaning between a symbol in roman and the same letter in italic. The Computer's Handbook draws a distinction. It reserves roman for units or symbols of operation. It uses italic to indicate varying quantities, and sometimes capitals for defined quantities. Thus g is gram, but g is gravitational acceleration; θ is temperature, but T is temperature on the absolute scale. Another general question is whether operations should be consistently indicated by letters or by signs, or either mode of indication be allowed as the writer finds convenient.

The difficulty in the way of getting agreement on these questions is not so much unwillingness on the part of workers as lack of authoritative reference to recognised classics. After carrying on an elaborate series of computations with the improvised symbolism that suggests itself as one goes along, it is too laborious to go over it again to bring it into agreement with someone else's notions; and as one is naturally led on gradually in the course of a research to take in more quantities, one can scarcely begin it by selecting a system of notation. It grows of itself as the work progresses. But if the Royal Society were to alternate the list of publications as an advertisement in the lining of its Transactions with a list of recognised symbols, or if in some other way some convention were made quite easy of reference, we should have little difficulty in adhering to it.

NAPIER SHAW.