Letters

Culturology

It may be of interest to readers of *Science* to learn that *Webster's New International Dictionary of the English Language* has included, in the addenda to the second edition (1954), the new name of a moderately old science—namely, *culturology*.

The science of culture (dealing with customs, institutions, beliefs, languages, arts, tools, and so on—in short, those characteristics which distinguish the human species from all others) was first defined, and its scope was first outlined, by the eminent English anthropologist Edward Burnett Tylor (1832–1917), in "The science of culture," the first chapter of his great work, *Primitive Culture* (1871). The scientific study of customs, beliefs, languages, and artifacts, both modern and prehistoric, has, of course, been the chief occupation of many cultural anthropologists—ethnologists and archeologists—since Tylor's day, and even long before.

But much of the work of anthropologists is not concerned with culture at all, but with the fossil remains, bones, muscles, genes, physiological processes, and so on, of men and other primates. And many "cultural" anthropologists have occupied themselves with nonculturological, psychological, psychoanalytic, and sociological (focusing upon social interaction among human beings) problems. The need arose, therefore, for a term that would distinguish the science of culture from other kinds of studies carried on by anthropologists. *Culturology* suggested itself in the tradition of scientific nomenclature that has produced *mammalogy, parasitology, mineralogy,* and so on.

Culturology was introduced into anthropological literature in 1939 in an article of mine, "A problem in kinship terminology" [*Am. Anthropologist* **41**, 571 (1939)]. It was given greater currency in 1949 in my book *The Science of Culture*. The first person to use this term, however, as far as is known, was a distinguished German chemist, philosopher, and Nobel prize winner, Wilhelm Ostwald (1853–1932), in *Energetische Grundlagen der Kulturwissenschaft* [(Leipzig, 1909), p. 112]. Later, in "The system of the sciences" [*Rice Inst. Pam.* **2**, No. 3 (1915)], he defined this concept more fully [see L. A. White, *The Science of Culture* (1949), pp. 113–117; 409–415]. I did not discover Ostwald, however, until 1949, some 15 years after I had begun to use *culturology* in my lectures.

The term *culturology* has encountered adverse criticism and opposition. Among other things, it has been called "a barbarism," an epithet applied in years gone by to *sociology* by some of Herbert Spencer's friends in an attempt to dissuade him from using this word (see H. Spencer, *Principles of Sociology,* vol. 1, preface). By "barbarism" they were alluding to the fact that *sociology* is derived from both Greek and Latin sources—as is *culturology*—and this, according to the late V. Gordon Childe, is something that one reared on *litterae humaniores* finds objectionable. But, over the years, *sociology* won acceptance and has now become commonplace. Also, the English language itself has been quite hospitable to hybrids of Greek and Latin derivation, such as *penology, dictaphone, television, jurist, socialist, deist, scientist, petroleum,* and *cablegram.*

Because *culturology* is so apt, specific, and precise; because it is homologous with other names of sciences (for example, *parasitology*); because the English language has a genius for assimilating newly coined words (for example, *dictaphone*); and, finally, because *culturology* is needed to distinguish the science of culture from psychological and sociological studies of human beings, its general acceptance and use may be confidently expected. *Culturology* was included in the *Dictionary of Anthropology* (New York, 1956) by Charles Winick, and one finds it occasionally in anthropological writings. Instances of its use will undoubtedly multiply in the future.

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Names for Binary Numbers

The reading of "A system of names for binary numbers" in a recent issue of *Science* [**128**, 594 (1958)] impels me to describe another system devised some 6 or 7 years ago by the late D. A. Flanders, in line with some suggestions made by J. W. Givens. At that time the AVIDAC for the Argonne National Laboratory and the ORACLE for the Oak Ridge National Laboratory were both in the early stages of their construction, and we felt some concern for the problem of becoming familiar with their arithmetic to the base 2. In more practical terms, it was a question of getting used to the base 16, since it was convenient to group the binary digits together into tetrads.

The Givens-Flanders system was simplicity itself: Vowels and consonants were selected, each to represent one of the four binary pairs according to the following scheme:

n	o	0 0
k	a	0 1
r	e	1 0
s	i	1 1

A consonant is always to be followed by

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a vowel to provide a pronounceable syllable. The sequence of vowels is obvious, including the single irregularity; the sequence of consonants is easily fixed by the mnemonic "ankers," although the reason for it, if any, I have forgotten. At any rate, the sounds were thought to be readily discernible. Since "no" is an obvious representation of zero, one counts: "na, ne, ni, ko; ka, ke, ki, ro; ra, re, ri, so; sa, se, si, nano, . . ." and the rest is surely obvious.

It was recognized long ago that the same numeral "6," for example, can represent six, sixty, six hundred, . . . , or six-tenths, . . . , depending on its position within a sequence of numerals; indeed, it is not uncommon to read "six-five-one" instead of "six hundred and fifty-one." It should be equally obvious that "no-point-sa-ri" should be a perfectly acceptable and unambiguous rendering of "00. 1101, 1011." The system is therefore logically complete as far as integers and binary fractions are concerned. For other fractions, a simple use of "over" is sufficient.

It is with no little regret that I report that although both Flanders and I (but especially he) practiced assiduously for some time our "no-na" arithmetic, and although we acquired a modicum of skill in addition, nevertheless we failed miserably with multiplication. The decimal grooves were too deeply sunk in our aging cortices, and we finally gave it up as a bad job. But if I can ever catch an innocent, unsuspecting 6-year-old—a grandchild, perhaps—when his parents are not looking, I hope to show that he can become an arithmetical polyglot without half trying.

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The requirements for oral communication of magnitudes are not the same as those for checking or transcribing numbers. An example will make this clear. To communicate the number 651000 one might call out "six-five-one-oh-oh-oh," and for checking purposes this is common practice. As Householder points out, the listener, on hearing the "six," does not know whether its significance is 60, 600, 6000, and so on. He has no information about magnitude until the decimal point is suddenly explicitly or implicitly reached, at which time he must have counted the number of digits expressed and have retained in his memory the digits of significance to him. If this were an easy task, words like *hundred, thousand,* and *million* would not be needed. Many users of computers have used a hexadecimal number system that adds the letters, a, b, c, d, e, and f to the decimal symbols already available. For checking binary numbers this system or that described by Householder are quite adequate.

Two requirements must be met by a system of names for communication of magnitudes: (i) The speaker and the listener must be free to express or accept as much or as little precision as desired. (ii) The most significant information must be communicated first. It should be borne in mind that numbers like 256 or 512 are round numbers in the binary system. To become conversant with binary magnitudes one must be able to express, for example, the information that a given vacuum tube functions properly with about "hi" volts on the plate or that the population of the United States is approximately "dagxi."

Real usefulness of the ability to communicate magnitudes by means of binary numbers, whether for pedagogic purposes or otherwise, can only be demonstrated experimentally. The response by educators to the publication of my proposal suggests that such experiments will soon be made. To encourage uniformity among experimenters who may need to extend the system, I have assigned the terms "lu = 2^{12}," "pro = 2^{16}," "ti = 2^{20}" and "xi = 2^{24}."

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