The Word

By Bess Lovejoy

A measure of mystery

Where our words for mass, weight, and distance come from

THIS MONTH, the metrologists meeting at the 24th General Conference on Weights and Measures in Paris have an unusual responsibility on their hands. Their job is to consider redefining a word that people worldwide depend on for accuracy, even though scientists say it has been without a reliable definition for much of the past century. The word: kilogram. (Metrologists, in case you were wondering, are experts in the science of weights and measures—not to be confused with meteorologists.)

Of course, everyone understands what *kilogram* means in a general sense. The kilogram is a unit of mass, one of the seven base units in the International System of Units, a modern version of the metric system. But how much mass, exactly, is equal to one kilogram? Unlike the other base units—the meter, second, ampere, kelvin, candela, and mole—the kilogram is defined with reference to a physical artifact, created in the 1880s: a platinum-iridium cylinder locked in a vault in Sèvres, France. Whatever the mass of this object is, that's the mass of one kilogram. As with any physical object, however, the mass of this cylinder changes ever so slightly over time, which means that we only really know the mass of a kilogram at the moment that cylinder is being measured. For scientists making minute measurements, and for countries who want their official weights and measures up to snuff, that's a problem.

The redefinition of *kilogram* gives us a window into the unique place measurement words occupy in our language. Most of the time, at least in English, language evolves fluidly—there's no committee in flannel suits policing what we mean by "house." But because of their importance to science and commerce, many measurement terms are both everyday words and vital scientific tools. Increasingly, such terms are defined by national and international bodies, making decisions far removed from the tides of trade and immigration that usually shape our language.

All of this is a recent development. For most of history, people muddled along with measurement units based on the everyday world—often on their own bodies. The Sumerians used the length and width of various fingers, as well as the length from fingertip to elbow, which they called the *ku*. The Romans called this length the *cubitus*, from the Latin *cubitum* for "elbow." The Greeks used fingerbreadths (*daktylos*), with four fingers making a palm (*palaiste*) and 16 fingers, a foot (*pous*). The foot, interestingly, is a near-universal measure. By the early Middle Ages, it was standardized in Britain as having 12 parts—giving rise to our word *inch*, from *uncia*, Latin for "12th part."

Many of the terms we use in the United States today—the so-called "customary system"—retain this link to the natural world. The word *acre* once meant untilled land, but in Anglo-Saxon England it was the amount of land a yoke of oxen could plow in a day. *Gallon* is related to a French term for "bowl," and *yard* to Old English terms for "stick." Even our *pound* (from the Latin for "weight") is based on the measurement of 7,000 grains, with each grain originally being the weight of one grain of wheat.

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As technology advanced, we began to tie our measurement words to objects beyond the domestic sphere. During the French Revolution, scientists in that country developed the metric system, pegged to one of the most universal measures then imaginable—the size of the earth. The system's founders decided that the meter (from the Greek for "measure") should be one 10-millionth of the length of a quadrant of the meridian. Attempts to determine the size of the earth were riddled with error, however, and the unit has gone through several redefinitions since then. Since 1983, it has been defined as "the length of the path traveled by light in a vacuum during a time interval of 1/299,792,458 of a second"—a definition only possible once scientists were able to measure the speed of light.

Today, cutting-edge science often requires measuring things that are either very big or very small. Astronomers use parsecs (a portmanteau of *parallax* and *second*) to measure the distance between heavenly bodies; physicists use attoseconds (10^{-18} seconds) to measure events that happen so fast only other physicists can understand them. At the limits of measurement, there are "Planck length" (roughly 1.6 x 10^{-35} meters) and "Planck time" (about 5.391 x 10^{-44} seconds), the smallest units with any meaning under current models of physics. Max Planck, the German physicist who founded quantum theory, is responsible for both, as well as the Planck constant, which relates the energy of a quantum of electromagnetic radiation to its frequency. The Planck constant has a precise definition with a wild card: 6.62606X x 10^{-34} joule seconds, where that big "X" refers to numerals still being calculated.

Which brings us back to the kilogram. The proposal being considered in Paris would tie the definition of the kilogram to the value of the Planck constant—just as soon as scientists can figure out what that value actually is. For now, scientists have been unable to nail down that "X," which means that we can't even define the thing we're trying to use to define the kilogram. The metrologists hope to have the situation figured out by 2015. Until then, feel free to weigh yourself in kilograms instead of pounds—and then, in good faith, to declare the result meaningless.

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