Through Caverns Measureless To Man

"Man" said Protagoras (481 – 411 BCE), "is the measure of all things." In an ancient world where approximations of physical measurement were readily accepted, such a declaration would be tolerated both by the community's builders and those who reveled in metaphors. But by the 17th Century, scientific advances in physics and astronomy, augmented by the earliest stirrings of an industrial revolution, demanded more exactitude. Scientific instruments, for example, could no longer be constructed based solely on loosely determined, arbitrary criteria of length. The French astronomer, Jean Picard [1620 – 1682 CE] proposed that a more precise, more reliable measure of length be established. He recommended that this unit of measurement (to be called a meter, from the Greek *metron*) be determined by the length of a pendulum beating one-second at sea level, at a latitude of 45 degrees. And as astrologists and soothsayers were gradually replaced by astronomers, precision in measurement became an operative necessity.

It was not until 1790, after the onset of the French Revolution, that its National Committee appointed a study group to select which of three terrestrial criteria will be employed to determine the precise length of the meter: (1) the length of a pendulum beating one-second; (2) a specified fraction of the length of the equator; or (3) a specified fraction of the quadrant of the terrestrial meridian (a great circle of the globe passing through both poles and a predetermined point on the global surface). The commission voted for option (3) and a team of surveyors was commissioned to measure the meridional arc between Dunkirk, in France, to Mont Jany, in eastern Spain. The surveyors required seven years to measure the exact distance between these two chosen sites.

The Commission on Standards of Length broadened its assignment also to include measurements of volume and weight. They acknowledged that there were but three fundamental measurable quantities: length, mass and time; and from these three, all other quantities would be derived, such as weight, density and velocity. Two immediate tasks, however, demanded fulfillment. First, to establish and then maintain structurally reliable standards of reference, tangible prototypes that can be reproduced by predetermined criteria and then stationed in archival vaults throughout the world. And second, to seek out the most reliable means for the determination of the standard of length, weight or volume. And while some measure of experimental error is unavoidable, the needs of science and advancing industry demanded a slippage of no more than one part per one-hundred million. A new science, called metrology, was thus born.

A number of insistent questions arose: What social forces impelled the creation of metrology ? Why did it begin at the end of the 18th Century and not before? And why in France ?

The 17th Century confronted, and was forced to negotiate commercially with a confusing hodgepodge of weights and measures. England had its pounds and quarts; the Slavic nations had their idiosyncratic system; the Near East had measurements more of historical than rational meaning; and even the jewelers had their carats. Conversion from one system to another required the patient skills of a sober accountant. And as in theology, conversion became a hazardous enterprise. The world had been truly bereft of a transnational metric system that was both uniformly employed and rational in concept. But why did it begin at the end of the 18th Century? Certainly in response to the early globalization of social and colonial activity furthered by the growth of industrial power and by the parallel expansion of international commerce.

Why France? The tumultuous revolutionary forces unleashed in 1789 overturned more than the monarchy. The French even modified the Gregorian calendar, in keeping with the precept that a new France needed a fresh outlook concerning all physical and cultural aspects of life.

The first prototype standard of the meter was a brass rod meticulously fabricated in 1795. Brass, though, like all physical substances, expanded with ambient temperature. A search was made for metals with only minimal temperature-dependent amplification. Platinum and then a platinum-iridium alloy proved to be most suitable. This standard prevailed until 1960 when the meter definition was established as equal to 1,650,763.73 wavelengths of the krypton-86 atom – measured at zero degrees Centigrade. In 1983 this definition was further refined to: "The metre is the length of the path traveled by light in vacuum during a time interval of 1/299,792,458 of a second."

Few humans, at the onset of the 21st Century, will demand such exactitude in their daily activities. Most of us are satisfied with crude metrics such as "Third down and four yards to go!" or "Give me six yards of that fabric" or "I parked six blocks from the tavern." Truly, the sciences have bestowed upon us precise measures for length, mass and volume but no measurement yet to determine the magnitude of human anxiety or the depths of human depravity.

At the end of the day each human may confront the ancient question: How has your life been measured and by what ethical yardsticks? By coffee-spoons? By the time remaining on a parking meter? By the height of your aspirations? By the magnitude of your generosity? "Lord,", said the psalmist, "make me know mine end, and the measure of my days, what it is; that I may know how frail I am."

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