Units for the Crew of Spaceship *Earth*

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In the August 1998 issue of the *OAS Newsletter* its Editor (Ed Nelson) published an Editorial in which he deplored the glacial pace of adoption by the US of the "Metric System" — more properly, as Ed noted, the SI. Upon reading that Editorial, I immediately emailed Ed, applauded his comments, and asked if he would consider publishing some follow-up comments. After procrastinating for a year, I "followed up," but Ed thought my comments too long for the Newsletter and "too erudite for news"; he suggested publication in *POAS* as a Letter.

For most readers of *POAS*, harping on this topic is probably equivalent to the proverbial preaching to the choir. Therefore, I shall limit my comments to two areas: description of authoritative sources of information about SI, and what I see as the overriding reasons why the USA should "go metric" ASAP.

Definitions of the seven base units of SI change occasionally. For example, Ed referred to the original definition of the meter, and to a more recent definition in terms of the wavelength of a particular line in the spectrum of krypton-86. But *that* definition is now obsolete. The speed of light (in vacuum) is now fixed by definition (299 792 458 m/s, exact) and the meter is now defined as the distance traveled by light, in a vacuum, in 1/299792458 s, i.e., the meter is defined in terms of the speed of light and the second.

This is typical of changes in definitions. The defined speed of light corresponds to the value *measured* by several groups, with excellent agreement, using the old definition of the meter. But by now fixing the speed of light and defining the meter in terms of that fixed speed and the second, distances can be measured with much higher precision, because time can be measured with much higher precision than could distances using the old definition of the meter. As examples, consider measuring the transit time of a laser pulse from earth to moon and return, or from a modern laser-based surveying instrument to a reflector held at the one corner of your property, or of a radar pulse from ground to satellite (or vice versa) and return. The distance corresponding to a meter is, of course, unchanged — within the precision of the old definition(s).

Because such changes are not infrequent, one needs access to handy, authoritative references. Currently, the prime source is the Web site of the Bureau International de Poids et Mesures (International Bureau of Weights and Measures): http://www.bipm.fr/enus; BIPM is the international body responsible, under international treaty, for "the metric system" and SI. This Web site has much directly useful information. It also has a bibliography of BIPM publications and an online bookshop from which publications may be ordered.

A second top-level source is the Web site: http://physics.nist.gov/cuu/index.html, maintained by the Fundamental Constants Data Center of the National Institute of Standards and Technology (NIST). The "cuu" in the URL stands for "Constants, Units, Uncertainty"; the site is devoted to SI units, to values of the Fundamental Constants (molar gas constant, Faraday constant, Planck constant, mass of the electron, etc.), and to uncertainties in realization of the units and constants. The international body responsible for the assessment of all available relevant experimental data and assignment of "best" values to the fundamental constants is the CODATA Task Group on Fundamental Constants. That Group has just completed its assessment for data available at 1998 Dec 31 – the first reassessment since 1986 — and these latest values are provided on this Web site. The formal report by the CODATA TG is now, or will be, available in *Journal of Physical and Chemical Reference Data* 1999; 28(6), and in *Reviews of Modern Physics* 2000; 72(2); the

authors are P.J. Mohr and B.N. Taylor, both at NIST.

Now, why should the USA move to the SI as rapidly as possible? Because (1) it is in our best interest to do so; and (2) we owe that action to the international community.

It is in our best interest because everyone else on the planet — with a very few, very minor, exceptions — already uses SI. International interactions and international trade are increasingly important to our economy. Those interactions and that trade would be greatly simplified if we measured commodities in the same units used by the rest of the world. England was effectively forced to "go metric'' in order to participate in routine trade with other members of the European Union; if the USA doesn't adopt the SI voluntarily, we may well be forced to do so in order to maintain favorable trade relations.

In what sense do we "owe" the international community? Over the past 50-55 years English has become the recognized, accepted language for international interaction. Millions of people whose native language is not English have developed the ability to speak and understand English with a proficiency ranging from fair to fluent. Almost anywhere one travels one can converse in English with taxi drivers, hotel clerks, or strangers on the street. When Americans go to international conferences, they rarely have to be concerned about language problems; the standard language for such meetings is English. Similarly, the standard language for the Internet is English.

If the rest of the world can advance the cause of international interactions by adopting English as their second language, we owe the rest of the world some similar action in return. Adopting SI would make a major payment on that debt to the rest of the world.

Finally, I would quote the last paragraph of a Letter to the Editor of *American Journal of Physics*, in which I was responding to typical "units arguments":

SI units are not "perfect" – whatever that means. If the rules are interpreted reasonably, SI is quite convenient; it is the zealots who cause problems by insisting, for example, that all volumes should be in m^3 and all pressures in Pa. Even so, SI is the only scheme available for expressing units in a form that is likely to be understood worldwide. **The crew of spaceship *Earth* can operate more efficiently if all use the same units.**