The Future of the Knot as a Unit of Speed

G. J. A. White

STEWART[1] very rightly draws attention to the practical value of the knot as a measure of velocity. In so doing he underlines one of the defects of SI: the essential simplicity and uniformity so attractive when considered in abstract becomes rather blurred when put into practice. The knot falls completely foul of SI; neither the unit of length nor that of time is an SI unit. The practical application of both units illustrate the difficulties well.

The choice of a standard set of prefixes to units, each separated by a factor of 1000, is both logical and convenient. One need never write down a number less than unity or greater than 999·999. . . . If the number is 1000 or more, it is divided by 1000 until it does lie within these limits and the appropriate prefix added to the unit. If it is less than unity, multiplication is substituted for division. For length measurements one starts with the metre and goes up to the kilometre, or down to the millimetre, micrometre and so on. Perhaps the only person whom this does not suit is the astronomer who is likely to prefer the light-year (approximately 10^{16} metres, the index 16 being outside the range of prefixes) or the parsec (2·46 light-years).

The world, however, is not a linear one and difficulties start when one measures areas. The square kilometre, square metre and square millimetre are each separated by a factor 10^6 and so, to avoid having to write six-digit numbers, intermediate multiples of the unit are needed. Hence one brings in, in the lower range, the square centimetre—and immediately violates the 10^3 rule, for $1\ \text{cm}^2 = 10^2 = 10^{-4}\ \text{m}^2$. Nuclear physicists need the barn (10^{-24} square centimetres or 10^{28} square metres) and its derivate the millibarn (10^{-3} barn or $10^{-31}\ \text{m}^2$). In the higher range, the are or square decameter (100 m^2) has appeared, itself generating a higher value in the hectare or square hectometre ($10^4\ \text{m}^2$ or roughly 2½ acres).

Volume is not so intractable as it might appear. Whilst a factor of 10^9 separates the cubic millimetre and the cubic metre, the introduction of the intermediate units of the cubic centimetre ($10^3\ \text{mm}^3$) and the litre ($10^3\ \text{cm}^3$) brings back the 10^3 factor, though at the cost of introducing two non-SI units. Finally, naval architects and some engineers require to use a quantity called the second moment of area. This, being the product of an area and the square of the distance of its centroid from some given line, needs units of length to the power four. Even the use of both the centimetre and the decimetre cannot reduce the factor between these below 10^4.

For the measurement of time, no scientist would dispute the adoption of the second as the basic unit. Yet for centuries the basic unit of time for everyone has been the day. Whilst Palmer[2] points out that the measurement of the second is no longer related to the rotation of the Earth, the historical derivation interposes factors containing the number six and its multiples (so wisely chosen by the Babylonians and so foolishly discarded later in favour of that awkward number ten) between the second and the day. The present author has previously pointed

out[3] the impracticability of using 86·4 kiloseconds for the hour and 31·4496 megaseconds for the day.

Which brings one back to consideration of the knot; the use of this word must, in ninety-five cases out of a hundred, refer to distance covered in an hour or day rather than in a second. The owner needs to estimate total voyage time, the Master whether or not he will make a particular tide, the chief engineer how fast his fuel is being used. This suggests that Stewart's plea for more favourable treatment for the metre per second is not quite so attractive, since one needs immediately a a factor of 3·6 to make it kilometres per hour.

Despite its admittedly awkward terminology compared with the knot, one feels that the kilometre per hour is the only sensible unit. One must lump together the hour used here with the centimetre, litre, hectare and barn as units of practical necessity, accepting that they all fall outside the SI scheme and inevitably mar its neat and orderly pattern. One must have some sympathy for the student though; he has (no doubt thankfully) got rid of a lot of conversion factors, such as 144 square inches to the square foot or 550 foot-pounds per second to the horsepower, but in their place he finds factors comprising ten to some power: this power should, according to SI, be three or a multiple of 3 but in practice may be 2, 4, 5 or even 7.

REFERENCES

1 Stewart, Oliver (1973). The future of the knot as a unit of speed. This *Journal*, **26**, 123.

2 Palmer, Winslow (1972). Standard time. This *Journal*, **25**, 535.

3 White, G. J. A. (1969). The metrication of navigation. This *Journal*, **22**, 409.

from Oliver Stewart

It will be widely accepted that the closer the observance of the rules and recommendations of the *Système International d'Unités* the more valuable it will be and, conversely, the greater the number of exceptions and variations the fewer the advantages of abandoning the British imperial system in its favour. Mr. G. J. A White makes the strongest point against choosing the SI's metre per second to replace the knot when he mentions that the owner, the Master and the chief engineer must think in terms of the hour and the day and not the second. Nevertheless it must be noted that, when we are finally forced to abandon the altogether admirable knot, we shall weaken the SI if we take to the kilometre per hour whereas if we employ the metre per second we shall strengthen it.

It is most disturbing to notice the large number of authors who are now putting forward 'practical necessity' as a reason for departing from the SI. Professor A. J. Ede, in a book published for the Metrication Board, speaks of some of the refinements of the SI as being for specialist use only and of metrological matters which are outside the concern of the 'man-in-the-street'.

If the SI is indeed to be allowed to become the reserved province of the specialists and if the 'man-in-the-street' is expected to develop and to use his own private hotch-potch of measuring units, then the value of the whole of this promising reform will be completely destroyed. The urgent need at the moment is for the General Conference to look into, and if necessary to adjust, those units where 'practical necessity' is proving that it has the upper hand.