voyage) were completed within the first three years of the nineteenth century which entire period is covered by my paper. In referring to the great amount of material Flinders brought back after his release from Ile de France in 1810, I felt that justice had been done in a brief paper covering such a long period of hydrographic activity.

Flinders' surveys were omitted in the diagram, for by 1855 many of these areas had been surveyed in greater detail by Blackwood, Owen Stanley, Lort Stokes and King, all of whose names are shown.

That I do not ignore Flinders' great part in the history of British hydrography is clear from my book *The Admiralty Chart*, where I have devoted two chapters to his work, and have traced the 'tuition chain' down from Cook, through Bligh and Flinders to Franklin, just as Fancourt has done in his interesting note.

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# 'The Metrication of Navigation'

*from* D. H. Sadler

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In his note (*Journal* **21**, 81) on this subject, Ronald Turner says 'No longer will orbital periods of the rotation of the Earth on its axis be measures of time'. This is not so, either in general or in the particular case of navigation.

Universal Time (U.T.), which is the generally accepted name for Greenwich Mean Time (G.M.T.), continues to be *essential* for all purposes (in astronomy, geodesy, surveying and navigation) for which are required astronomical observations related to the precise position of the observer on the Earth's surface. *The Nautical Almanac* must continue to tabulate the positions of the Sun, Moon, planets and stars with G.M.T. as the time-argument; and observations should be timed in a time-system related to U.T., such as the broadcast time-signals of Coordinated Universal Time (U.T.C.).

U.T.C. is actually based on Atomic Clock Time, obtained by the integration of the reciprocal of the frequency of the caesium resonance transition that now defines the second in the Système International des Unités; but it is at present adjusted, under international control, by both offsets of frequency and small discontinuities, so that it does not deviate from U.T.2 by more than about $\pm 100$ milliseconds ($0^{s}.1$). U.T.2 is a measure of time defined by the rotation of the Earth; it is obtained from the observed time at any place (U.T.0) by the application of small corrections, not exceeding about $\pm 70$ milliseconds, for the motion of the pole of rotation (local corrections) and for seasonal variations in the rate of rotation. Thus the navigator and the topocentric surveyor can use U.T.C., instead of U.T.0, without appreciable error; the astronomer and the geodesist, who require greater accuracy, can afford to wait to reduce their observations until definitive corrections to the broadcast U.T.C. are published by the Bureau International de l'Heure in *Bulletin Horaire*.

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Many physicists and radio scientists interested in precise measures of frequency, rather than time, are demanding that U.T.C. shall be replaced by Atomic Clock Time without offsets of frequency or discontinuities; and this demand has been accentuated by the adoption, by the Conférence Générale des Poids et Mesures in October 1967, of the definition of the second in terms of the caesium transition. The two time-scales are at present diverging by about a second a year.

However, owing to the unpredictable variations in the rate of rotation of the Earth, predictions of the divergence of such a time-scale from U.T.2 could well be in error by several seconds in the two years (minimum) between preparation of *The Nautical Almanac* and the dates to which it refers. The deviation is of little importance for civil purposes, and corrections can be applied in arrear for precise observations; but how can the correction be communicated to the navigator and surveyor?

Broadcast time-signals related to the rotation of the Earth, such as those provided by U.T.C., would seem to be absolutely necessary for navigation; but there seems no overwhelming obstacle to their being combined with, or superposed on, a time-scale based on Atomic Clock Time.

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