Single-handed transatlantic races can however be so organized as indicated above, by choice of area of operation, mainly port of departure and port of destination, and certain precautionary measures regarding the pre-preparedness of participants, warning systems and surveillance, that the single-handed yachts will only constitute a risk towards each other and not towards others such as commercial small vessel operators.

For Imco and the National Maritime Safety Authorities the following attitudes are *not* possible.

(i) to officially exempt single handers without any restrictions.
(ii) to condone the single hander.
(iii) to negate the fact that single handed sailing means trespassing Rule 5 of the Collision Regulations.

What could be possible as an Imco/National Maritime Safety Authority attitude is:

a. to allow single-handed sailing and races in certain specified areas with low overall traffic densities.
b. To exert influence on the single-handed racing rules with regard to the preparedness of the participants well prior to the starting date.
c. To exert influence with regard to a surveillance and shipping warning system in order to alert shipping. It is realized that especially at night it is a tall order for commercial vessels to watch out for sailing yachts that may not keep a lookout. The best procedure would be to avoid the area where they operate. In reverse the yachtsmen, lookout or no lookout should, if at all possible, avoid the commercial shipping lanes.

Conclusions

1. The risk for commercial shipping is small.
2. Official authorization to negate Rule 5 of the Collision Regulations should not be expected.
3. All possible measures should be taken by the organizers of single-handed races to avoid interference with commercial shipping.
4. The risk for the single hander is strictly his own affair.

A New Navigation Computer

Michael Richey

THROUGH the mediacy of Professor Torao Mozai and the courtesy of Captain T. Iimura of Omron Tateisi Electronics, Tokyo, I was lent a prototype Omron 1052 NC Astro-navigation computer to evaluate during the course of a single-handed race in *Jester* from Newport, Rhode Island, to Bermuda and the subsequent voyage back to England. Although it has been developed as an all-purpose navigation computer, the particular requirements of single-handed oceanic navigation might, it was thought, provide a useful commentary on this kind of instrument; and the environment of a small boat, so close to the sea surface and inevitably

https://doi.org/10.1017/S0373463300038741 Published online by Cambridge University Press

inimical to electronic equipment, would be an austere test of the instrument's seaworthiness.

This note is intended for navigators and so far as possible computer terms will be avoided. (The instrument is named a computer by its makers and will be referred to as such, rather than as a calculator, throughout.) The computer weighs 2·5 kg. and measures 200 × 289 × 91 mm. It operates from either the mains or batteries, and can be used for 10 hours continuously without a battery recharge.

The instrument can be operated, at the turn of a switch, in any one of eight modes devised to solve problems corresponding to the following headings:

> NORMAL (i.e. arithmetic), DEGREES, CELESTIAL NAVIGATION (CN), TIME, COURSE AND DISTANCE (C-D), DEAD RECKONING (DR), GREAT CIRCLE (GC) and CLOSEST POINT OF APPROACH (CPA).

It embodies two memory registers. Arithmetically the instrument, which gives the usual trigonometrical functions, is more than adequate for all possible navigational requirements. The DEGREE and TIME modes deal in sexagesimal arithmetic and are useful for such day-to-day problems at sea as transposing time and longitude, averaging sight times and altitudes &c. COURSE AND DISTANCE gives, in terms of mercator sailing, the course and distance between one set of latitude and longitude coordinates and another and DEAD RECKONING the position obtained by applying courses and distances to the latitude and longitude coordinates originally entered. The usefulness of these two modes will be obvious, more particularly the latter under sail when so many alterations of course and speed are made at the command of the wind. The GREAT CIRCLE mode gives the initial course and great-circle distance between any two sets of latitude and longitude coordinates and will indicate the latitude of the vertex and proceed to recalculate should a vertex limit be entered. Great-circle sailing under sail is of course only possible on the assumption that the wind never heads. On the other hand, even when the distance saved is negligible, the initial course will often differ significantly from the mercator course and is a factor to be borne in mind. It is after all the shortest way. The CLOSEST POINT OF APPROACH mode requires information about the other vessel that can only be acquired by radar and so need not concern us here.

The most attractive, if that is the word, of the modes to the navigator is undoubtedly CELESTIAL NAVIGATION which allows the solution of the astronomical triangle without recourse to reduction tables. Given the DR position, Greenwich hour angle, declination and (corrected) observed altitude, the computer presents the intercept and azimuth. The course and distance (as speed and time) from the first to a second set of sights is then entered; with the same arguments, namely hour angle, declination and altitude, the computer presents first the intercept and azimuth from the second sight and then the latitude and longitude of the fix from both . . . and so on for as many sights as it may be required to combine. The position so derived is obtained using mathematical procedures such as least squares, although no details are given in the literature. Two points may be noted: (1) Greenwich hour angle is entered in arc as obtained from the almanac and must be converted into time by the depression of a button; (2) at the completion of any stage in the CN mode the computer may be used in another mode and then switched back.

In any of the programmed modes a flashing lamp indicates the data to be inserted and although the makers recommend the use of a sight form this feature alone, apart from the basic simplicity of the operation, makes such forms unnecessary. Some tabulation is desirable and my practice has been to head columns in the navigation work book across the page in the order: DR, GMT, H_s, GHA, Dec. Int & Az. This order corresponds to that in which the data are acquired rather than entered.

Before the voyage, to familiarize myself with the instrument's use and capability, I reworked a number of navigational problems from sight books going back over the years, covering a variety of reduction methods such as Hughes' tables, Martelli's, Burton's 4- & 6-figure tables, H.O. 214, AP 3270 as well as two mechanical solutions, the ARG 1 and the Bygrave slide rule. The computer of course works to a far greater precision than any of these methods but what was revealing (although on reflection obvious) was how insignificant the difference was.

During the race, which started on 16 June, when the use of computers was proscribed, I used AP 3270 (=HO 249) for all sights, repeating the calculations on the computer to get some feel for its usefulness. On two occasions the computer disclosed blunders in the tabular method, one comparatively minor, the other of plotting which no doubt would have become absorbed into a hitherto little-known current!

For the voyage from Bermuda to Plymouth, starting 6 July the computer was used for all navigation, the daily noon position being transferred to the 1:7½m scale chart of the North Atlantic only for the record. No oceanic navigational chart or plotting sheets were used.

The day's work (assuming a sufficient change in azimuth between 8 and noon, as obtained in lower latitudes) might present itself typically thus:

(i) In the TIME and DEGREE modes find the means of the times and sextant altitudes at, say, 0800.
(ii) In the DR mode, using the courses and distances sailed since the last position, find the 0800 DR position.
(iii) in the CN mode using the 0800 DR, with arguments GHA, declination and altitude, find the intercept and azimuth of the 0800 sight.
(iv) As at (i) find the means of the 1200 sight times and altitudes.
(v) Enter course and distance from 0800–1200
(vi) As at (iii) find the intercept and azimuth of the 1200 sight and, finally, depressing the END key, the latitude and longitude of the fix.
(vii) In the C-D mode find the day's run from the previous noon position.
(viii) In the GC mode find the great-circle initial course and distance to destination, and/or
(ix) In the C-D mode find the mercator course and distance to destination.

Whether this kind of solution is better than a tabular/graphic one must remain a matter for personal assessment. Before discussion it may be as well, however, to lay two ghosts which tend to obscure the navigational issues. First, electronic calculators are neither nearer first principles nor further from them than any other method of solving the astronomical triangle, tabular, graphic or mechanical. They are intended, as new solutions always have been, simply to ease the navigator's task in obtaining the information he wants. (Whether such an easy life for the navigator will lead to better or more negligent navigation is another matter that cannot be dealt with here.) Secondly, if this is the kind of solution the

https://doi.org/10.1017/S0373463300038741 Published online by Cambridge University Press

navigator prefers, then there can be no question but that the required reliability will be achieved, as it has been with battery-operated direction finding equipment, echo sounders, quartz crystal chronometers and so on.

In principle an instrument such as this would replace all nautical tables. Not only sight reduction tables, but the traverse table, meridional parts, speed, time and distance tables, functions of the angle, distance to sea horizon, and even logarithms would become superfluous. Indeed one of the advantages of a universal instrument of this kind is precisely that one is always in the right book, and at the right page. However this discussion will concentrate mainly on the use of the instrument for sight reduction.

Modern altitude-azimuth tables (typically AP3270) are cheap, simple to use and of adequate accuracy for all practical purposes at sea. Unlike methods which rely on splitting the astronomical triangle into two right angled triangles, they involve no special rules and the same method is used for all bodies. These advantages have not been obtained entirely free and the tables tend to be bulky, at least if the full range of latitudes is carried. To obtain a position the results must be plotted although (since the scale when astro is likely to be used will generally be unsuitable for plotting direct on the chart) what is required is simply a

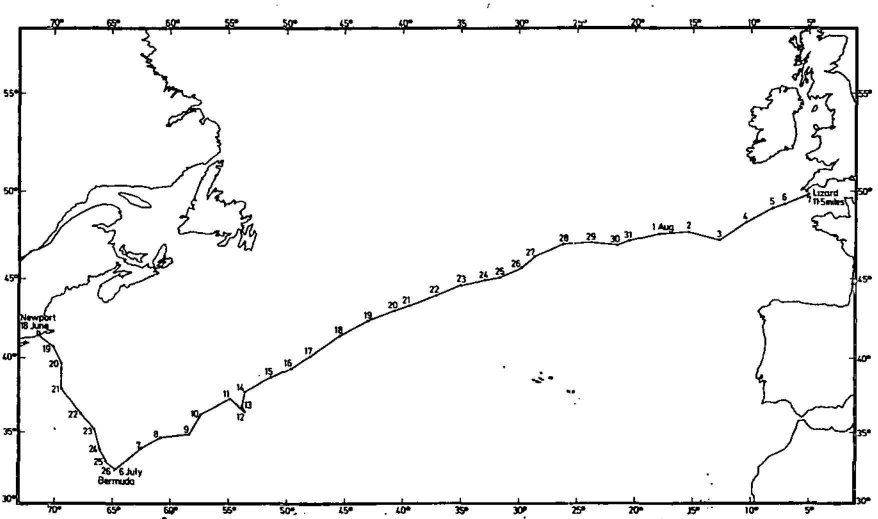

FIG. 1. Lester's 1977 track

latitude and longitude for transfer to the navigational chart. On the other hand an analysis of the plot, for instance by the method of bisectors, is the best method of establishing the most probable position from a fix, particularly where there are ambiguities such as can arise with a number of 'simultaneous' star sights; and also of detecting blunders. The computer too, however, gives the information from which the position may be obtained by plotting but it would seem unlikely in the normal course of events that much advantage would be taken of this facility although, no doubt, an unusually large intercept would be investigated.

Much play is inevitably made in the literature of the speed with which such an instrument can reduce sights. To anyone familiar with modern navigation tables this is not likely to be a decisive consideration. What is incontrovertible is the convenience with which a calculator of this type can both reduce sights and solve every other mathematical navigation problem. For self-contained navigation this should surely lead to the use of a great deal more information than is generally available at the moment. (One has in mind the calculation of the great-circle course and distance after each fix in the ocean, for example.)

Conditions in *Jester* were much as might be expected in the North Atlantic over a five-week period at that time of year (June, July), but with a larger range of temperatures than usual, During heavy weather in particular the atmosphere down below becomes unusually salt and dank. The computer showed no signs of flagging. A battery change was necessary after 27 days, during which it was used for all navigational calculations.

For general interest a track chart of *Jester*'s voyage showing the noon positions is given at Fig. 1.

English Channel Traffic Control

Ian C. Vendrell

(*Noratom-Norcontrol*)

WITH reference to Captain Emden's paper in the April 1975 issue of this Journal, in which he refers to the control and identification of shipping passing through the English Channel, and the numerous articles by Captain Wylie on the subject of computerized shipborne collision avoidance systems, why not adapt the shipborne radar systems for land based control of Channel traffic? A modified shore based system would, with present and predicted traffic movement, be ideally suited to this type of application. As to the problem of operator traffic identification and control, the present civil air traffic control procedures would seem to provide the ideal solution; if all shipping were required to carry dual channel multi-code transponders in addition to the current obligatory navaids.

With a shore based receiver/interrogator system coupled to a computerized collision avoidance system, such as the Databridge, I envisage the system operating as follows. The master, at an internationally agreed range from a particular area, calls the shore station on v.h.f., advises his position and ship's name (call sign) and requests shore station identification and permission to join traffic. On receiving this call the shore based controller would ask the vessel to transmit a selected code on his transponder and by means of a 'light pen' identify the vessel. Once identified the vessel would be tracked as normally seen on shipborne versions of these radar systems. However, once identified, the operator would also insert the target's name/call sign into the system and assign the target an 'ident'. The operator can then recall complete identification of any currently tracked target at will. Proven electronic hardware and computer software is available for such a system, the only requirement to make it a reality being to require all shipping to carry a cheap maritime transponder. I can see no objection from owners to such a small outlay for increased vessel safety through dangerous channels or entry into busy ports.

Rogues would no doubt continue to exist but there are many ways in which the craft dispatched to identify the rogue, be it ship or aircraft, can be presented on the system or PPI, allowing the operator to 'home' it straight on target.