must have had, naturally, a capital influence on the education of their children, and it seems to me likely that the Queen must have imparted at least to her three eldest sons, Edward, Peter and Henry, some of the cultural interests she may have acquired from Chaucer.

The happy and eventful marriage of King John to Princess Philippa, who bore him, among a generation of illustrious Princes, the great leader who became known in history as Henry the Navigator, born at Porto on 4 March 1394, was one of those portentous twists in history which may determine the fate of a nation and influence for ever the course of all mankind. No man was ever more influential in the geographical discovery of the world. It was thanks to the inspiration, devotion, tenacity and impulse of this great leader, the son of a Portuguese King and an English Princess, that the ground was prepared for the voyages of Diogo Cão down the African coast to 21° 47′ S., of Bartolomeu Dias round the Cape of Good Hope, of Columbus to America, of Gama to India and of Magellan across the Pacific.'

Portuguese historians have today no doubt that the process of navigation by the observation of heavenly bodies with instruments on board ship, which led, towards the end of the fifteenth century, to the development of astronomical navigation, with the preparation of quadrennial tables of solar declinations and to the modern art of navigation, began under the leadership of Prince Henry after he sent his first caravels to Madeira and beyond; first by observing equal altitudes of a star, forerunner of the altitude-distance method, which with improvements culminated in the modern art of navigation—the instruments were improved but the fundamental principles are the same.

That is why it seems to me appropriate to recall on this occasion—when you honour a Portuguese historian of early cartography, navigation and discoveries—the name of that most illustrious Prince, half Portuguese and half English by blood, who more than any other man helped Europe to move into the Renaissance, the antechamber of modern times.

I ask you again to accept this expression of my deepmost gratitude.

'K's and F's'

from Commander W. E. May

I AM indebted to Captain Duncan M. Henderson (*Journal* 27, 536) for causing me to seek further than I had done previously to enable me to prove that 'F' in old log-books stood for fathoms and not fractions.

I would quote the following authorities who all state definitely that the 'F' meant fathoms and that there were usually eight fathoms to a knot, at any rate in the eighteenth and early nineteenth centuries. They are:

Wilson, 4th ed., 1741
Adams' edition of Atkinson, 1782
Hamilton Moore, 8th ed., 1784
Malham, 1790
Wales' 6th ed., 1796, and Gwynne's 7th ed., 1805 of Robertson

Raper, 1st ed., 1840
Mrs. Taylor, 1843

Although a log-line should be marked in knots every 51 feet, it was common to mark it every 48 as this had the advantage that ship was always astern of her reckoning. When the log-line was hauled in after being streamed, the distance from the rail to the next knot outboard was measured in fathoms against outstretched arms in the traditional manner, though some ships are said to have had the lengths marked on the taffrail. It would be quite incongruous to expect a seaman doing this to report so many fractions when he had measured in fathoms. I have examined many of the log-books of ships of the Royal Navy and quite a few of East Indiamen in the period referred to and have never found an entry in the 'F' column above 7, indicating that they were all using eight fathoms to a knot.

Raper definitely states that this was Royal Navy practice and that its ships only entered the fathoms to the nearest even number. His emphasis on Royal Navy custom seems to indicate that it was not universal. The following authorities state that the log-line was measured in fathoms of five feet so that there were ten to a knot:

Atkinson, 1718
Harris, 1720
Mountaine's edition of Atkinson, 1740
Hamilton Moore, 17th ed., 1807

In addition to these, Riddle, 1st ed., 1824, and Norie, 11th ed., 1835, give eight or ten fathoms to the knot as possible alternatives, while Escott's 7th edition of Riddle, 1871, gives ten fathoms to the knot, but while the others head the column in their specimen log pages 'F' he heads his 'tenths'.

In September 1850 the Admiralty introduced a new form of log-book in which the columns were headed 'Knots' and 'Tenths'. Raper reported this in his 4th edition of 1852. He gave two specimens of log-book layout, one the new naval log-book and the other that commonly used in merchant vessels. In the latter he still gave 'K' and 'F' columns and this practice is continued at least as late as Hull's 19th edition of Raper, 1891.

It may be remarked here that in 1840 steam-vessels of the Royal Navy used a special form of log-book in which there was a single column headed 'K' in which the speed was entered in knots and quarters.

To revert to earlier days, at the end of the seventeenth century log-lines were still in use with only 42 feet between knots, so that there were only seven fathoms to a knot. This practice continued into the next century and is described by:

Newton, 1715, who nevertheless shows entries as high as 9 under 'F' in his specimen pages.
Wilson, 2nd ed., 1723, in whose specimen there are three columns headed 'K', '½K' and 'F'.
Kelly, 1724, who also says that he thought a 50 foot knot would have been better.

Wilson was not the only man who went in for half-knots. Barrow, 1750, and Haselden, 1774, showed no 'F' columns, replacing them by 'HK' while Patoun in his first edition, 1851, and eighth, 1870, headed his two columns 'K' and '½K'.

I think that I have written enough to prove that I was correct (27, 116) in stating that the 'F' in a log-book column heading stood for fathoms. Even Saul in his 17th edition of Newton, 1921, says that sub-divisions of the knot are called fathoms!

from Charles H. Cotter

PROMPTED by Henderson's comments[1] on May's contribution[2] on the log-books used by the East India Company, I examined a manuscript log-book in my possession belonging to an un-named vessel, but evidently one of John Company's, covering the period 26th April to 31st December, 1791. The log-book is ruled and captioned in manuscript. The six columns are labelled, H. K. F, Courses, Winds, Remarks, and the log-book is laid out two days to a page, each page measuring 13 in., by 8 in. The paper carries an interesting watermark—a medallion of an enthroned king, the medallion being surmounted with a handsome crown. Some sheets carry the watermarked name 'I. TAYLOR'.

It needs to be said at the onset that the 'F' in the early log-books stood for 'fathoms', as Commander May indicated: the common-log being marked by knotted cords, spaced at a uniform distance which, compared with the length of a nautical mile, gave the same ratio as the running-time of the log-glass to an hour.

The correct spacing of the marks, or *knots*, on the log-line was a matter of considerable urgency right up to the time when accurate knowledge of the Earth's size—and particularly the length of a minute of arc of a meridian, which is the basis of the nautical mile—had become available. A brief discussion of the problem of marking the log-line appeared in a recent volume of the *Journal*,[3] in which the work of Richard Norwood is described. Norwood found the length of a minute of arc of the Earth's surface from a route-survey between London and York coupled with accurate knowledge of the latitudes of the end points of the route. His aim in undertaking this formidable task was to determine the exact spacing of the knots on the log-line. In his remarkable book, *The Seamans Practice*, first published in 1637, he described his survey and concluded that the spacing of the knots should be 51 feet for use with a 30-second log-glass. Hitherto the custom had been to space the knots 42 feet, or seven fathoms, apart.

The technique of measuring a vessel's speed using the common log would appear to have been to measure with the outstretched arms, when heaving in the log, the number of fathoms of line from the point at which the line was 'stopped' at the instant the glass ran out, to the first knot arriving on board. It became customary, therefore, to express the ship's speed in knots (Ks) and fathoms (Fs). This being so, when using a 30-second log-glass with a log-line having knots spaced at seven fathoms, the highest number to appear in the F-column of the log-book would clearly be 6. For log-lines marked according to Norwood's suggestion the corresponding highest number would be 7. A search in the single log-book referred to above reveals that the highest number appearing in the F-column is, indeed, 7.

The conservatism of seamen who had been accustomed to using log-lines with the knots spaced at 7 fathoms resulted in their continuing to use this spacing but employing log-glasses having a running time of 27- or 28-seconds instead of 30-seconds. This appears to have been the practice right down to the time, in the early twentieth century, when the common log became obsolete. Nevertheless there was considerable scope for variation. John Hamilton Moore, for instance, whose navigation manual[4] was popular during the late eighteenth century, after describing Norwood's experiment, explained why, with a 30-second glass, the knots should be spaced at 51 feet. He then added:

> 'But as for the most part, the ship's way is found, by experience, to be really more than that given by the log, and as it is safer to have the reckoning before the ship than after it, therefore, 50 feet may be taken as the proper length of each knot, *and these knots subdivided into ten fathoms, each of 5 feet* (italics mine C.H.C.) which is certainly the best adapted for practice, and will correspond with all the tables and instruments used in navigation, as they are decimally divided, and, consequently the ship's run determined with greater ease and certainty . . .'

The idea of dividing the distance between consecutive knots into tenths appears, therefore, to have been practised before the end of the eighteenth century, and this may have been the origin of the decimal division used in the vessels of the Cunard Line referred to by Henderson. But long before 1838, when Samuel Cunard instituted a steam passenger and mail service on the North Atlantic, mechanical logs had become popular, and such contrivances, I feel sure, would have been used on the Cunarders from the beginning. In this connection it is interesting to note on the predecessor of the *Cherub* log by Thomas Walker, which appeared in 1884, a dial on the recorder which gives tenths of a mile; the *Harpoon* log, also by Walker and patented in 1861, carried a dial graduated in ¼-mile intervals. But to return to John Hamilton Moore: continuing his remarks on the log-line, he wrote:

> 'But some experienced commanders find, that the allowing 50 feet to a knot generally makes a ship a-head of the reckoning; and to avoid danger mostly divide the log-line into knots of 7 or 7½ fathoms 6 feet each, to correspond with a glass that runs 28 seconds. Others again divide the seconds the glass runs by 4, and take the quotient for the distance in fathoms between the knots; which of these methods are best, I leave to every captain's own experience to determine; but certain it is, that whatever length the knots are, the most convenient way is to divide them into tenths . . .'

In those early days technology had not reached a stage for it to have been possible to manufacture dependable log-glasses which ran out in exactly 30 (or 28) seconds. Moreover, in Moore's manual we are told that in hot or dry weather, the glass runs out faster than in moist or rainy weather—a reminder of the origin of the expression 'warming the bell' to signify speeding up the watch by warming the watch-glass and striking the bell before time.

An error in the spacing of the knots; an error in the running time of the glass; and a combination of these errors, were the three cases of correcting the distance, or speed, observed. The rules for these cases were:

I. As the seconds run by the glass are to 30 so is the distance given by the log to the true distance.
II. As 50 feet is to the distance measured between knot and knot, so is the distance run by the log to the true distance.

By compounding Rules I and II we get the rule for the third case, viz.:

III. Multiply thrice the measured length of a knot by the distance run by the log, the product divided by 5 times the measured time by the glass, will give the true distance run.

Raper, in the first edition of his classic work,[5] tells us that:

'The knot is supposed to be divided into eight equal parts, or fathoms (which they are very nearly). In the royal navy the even fathoms only are reckoned, for the convenience of adding up the distance in the log-board.'

To this remark he added the following footnote:

'It would, of course, be more systematic to divide the knot or mile into tenths, as in the Traverse Table, instead of eighths; but single tenths and fathoms may be used for each other without sensible error.'

Raper had some interesting remarks on 'The Ship's Journal' in which he has shed light on practice in both Royal Navy and Merchant Service.

In the Royal Navy time in the Journal was reckoned from midnight, and corresponded with civil time-keeping. But in the Merchant Service it was the custom to begin the day at noon, and the hours were carried on to 12 at midnight. Hence, in the last day of the harbour log (which was kept in civil time) it was customary to add the remark:

'this day contains 12 hours to commence the sea-log.'

In Raper's view consistency would require that the Course column should precede those giving Speed (the K and F columns) because course is always spoken of before distance. He considered it desirable that a systematic method of keeping ship's logs should be universally employed. He pointed out that it is needless and perplexing that 'forenoon should be Saturday and the afternoon of the same day Sunday'. The astronomical day (which is reckoned in this way) has for its beginning the time of Sun's meridian passage, and when astronomical observations were made they were referred to the astronomical day. But there was no satisfactory reason for using astronomical time for civil time; and, as Raper remarked:

'. . . perplexing the common transactions of life by considerations which have nothing whatever to do with them . . .'

It was not until 1925 that ephemeral data in the *Nautical Almanac* were given in terms of civil time, and the confusion, which gave Raper cause for comment, ceased.

At the time Raper wrote (1840) it seems that the common practice in merchant vessels was for the log-book or journal to be marked every two hours. Much, therefore, was left to guesswork in cases of alterations of wind or course. But this was not the worst part of the system; for, as Raper wrote:

'. . . instead of writing against the hours the *distance run*, the rate for the two hours is written, so that instead of adding up distances with a reasonable chance of some compensation of errors, the rates are multiplied with the certainty of doubling the error upon each hour's run . . .'

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An Examination of Criticisms of Automatic Radar Plotting Systems and their Advantages in Relation to Manual and Semi-auto Systems

J. C. Herther and F. J. Wylie

THE remarks of Mr. Harrison[1] under the above title demand some further comment. One can certainly agree with his substitution of 'prediction' for 'plotting' but not with his deletion of 'supposed'. The latter begs the whole question whether the operator will be dangerously deceived and this is far from proven. The latter part of his second paragraph is a generality; there will be many combinations of range and speed in which the result will not be satisfactory.

Mr. Harrison implies, although he does not come right out and say so, that errors arising during 'classical' manual plotting are 'operationally' acceptable while the errors in automatic plotting are unacceptable. Such a conclusion is illogical if one is willing to concede that any manual plotting procedure can be automated by the use of a digital computer. To examine this assertion in greater detail one may consider the automatic plotter to be made up of a data extraction section and a data processing section.

The data processing section should cause no difficulty, since anyone familiar with computer usage would admit that any manual plotting method which starts with values of range and azimuth can easily be automated. In fact, the speed and accuracy of the computer allow the use of sophisticated data processing methods such as Kalman filtering, least squares fits &c. Further, all the data from every scan can be utilized. If desired, even a scheme such as that suggested by section 7(iii) of Mr. Harrison's paper[2] could be accomplished.

At this stage, one must confess that one does not know to what computer programme Mr. Harrison is referring. His suggestion that the programme be re-written 'to achieve acceptable operational accuracy', if directed to Sperry, Iotron, Norcontrol and other manufacturers of automatic plotters, implies that he has knowledge of the programmes used, which would seem very doubtful.

The position is, therefore, quite clear with regard to data processing. By handling data in the same manner as in manual plotting equivalent accuracy is obtained, with greater convenience and speed. By using more sophisticated methods greater accuracy can be obtained.

A simple example may help to make this point clear. Figure 1 shows range and azimuth data on a target derived from the sequential scans of a radar. When