A proposed system to produce true motion in relative displays (British Patent No. 838,256). History recording and display using photographic systems might be an alternative way to achieve the same aim.

The difficulty with the electronic bearing line could possibly be overcome by using hand or automatically operated mechanical cursor; unchanging bearing would indicate threat of collision.

A Note on Hariot's Method of Obtaining Meridional Parts

Jon V. Pepper

In an article in this *Journal* some years ago, the late Professor E. G. R. Taylor and Dr. D. H. Sadler drew attention to and discussed Hariot's calculation of meridonal parts.[1] The question was raised but not answered as to 'how Hariot discovered the extremely complex and far from obvious method' that he used. This note draws attention to a possible, and indeed a very likely, way in which the method may have been discovered.

The conformal property of the stereographic projection of the surface of a globe from a pole on to its equatorial plane has been known since antiquity. It is used in the design of the astronomer's astrolabe.[2] Hariot's manuscripts[3] contain in more than one place a diagram for a proof of the property. One of these is reproduced in a recent article[4] on Hariot. Halley, in an article on meridional parts,[5] says of the conformal property, 'But this not being vulgarly known, must not be assumed without a Demonstration'. From this result he obtains the formula for meridional parts, unaware that the same proof may have been used almost exactly a hundred years previously. In fact, he says, 'I hope I may be entituled to a share in the emprovements of this useful part of Geometry' on the basis of 'having attained . . . a very facile and natural demonstration of the said Analogy'.

Rhumb lines, which cut meridian lines at a constant angle, are projected stereographically into equiangular spirals, which cut their radius vectors at the same constant angle. If $r_0, r_1, \ldots, r_n$ are the lengths of equally spaced radius vectors of the spiral, then

$$\frac{r_1}{r_0}=\frac{r_2}{r_1}=\frac{r_3}{r_2}=\cdots=\frac{r_n}{r_{n-1}},$$

and hence

$$\frac{r_n}{r_0}=\left(\frac{r_1}{r_0}\right)^n. \qquad (1)$$

In Fig. 1, PNOS is a plane section of a globe of radius r_0, poles N and S, and centre O. P is a point on the surface through which the rhumb line passes, P* its projection on the equatorial plane, and A is the foot of the perpendicular from P

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on to the axis NS. ϕ_n is the latitude of P, ϕ_n' its colatitude, and $OP^* = r_n$. The triangles P*OS and PAS are similar, and hence

$$\frac{r_n}{r_0 \cos \phi_n} = \frac{r_0}{r_0 + r_0 \sin \phi_n},$$

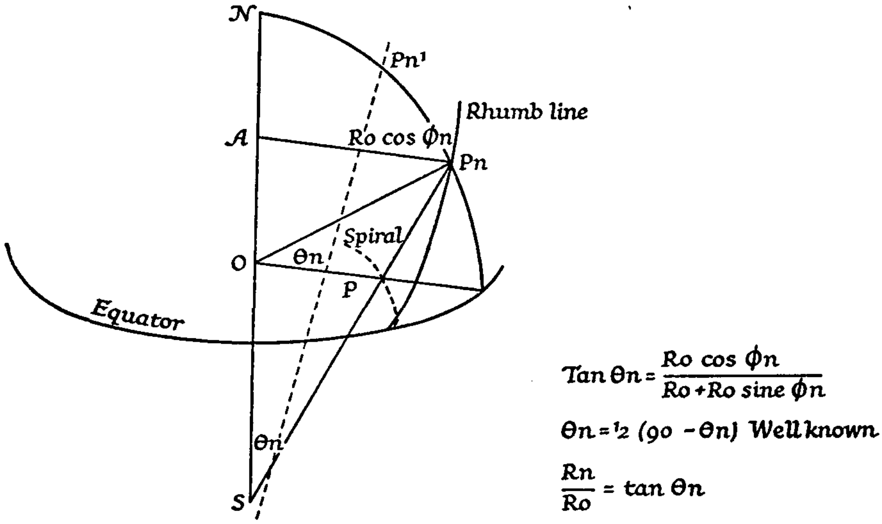

FIG. 1. Stereographic projection of the rhumb line

and so

$$\frac{r_n}{r_0} = \frac{\cos \phi_n}{1 + \sin \phi_n} = \tan\left(\frac{\phi_n'}{2}\right).$$

Hence

$$\frac{r_n}{r_0} = \tan\left(\frac{\pi}{4} - \frac{\phi_n}{2}\right). \tag{2}$$

Equations (1) and (2) give Hariot's result

$$\tan_n\left(\frac{\pi}{4} - \frac{\phi_1}{2}\right) = \tan\left(\frac{\pi}{4} - \frac{\phi_n}{2}\right).$$

The rather elementary calculations have been given in detail to show that the method, although very ingenious, is based on the traditional mathematics, and does not look forward to integration or logarithms. It is not, of course, certain that Hariot did use this method, but it is very likely on the evidence at present available.

REFERENCES

1 Taylor, E. G. R. and Sadler, D. H. (1963). The doctrine of nauticall triangles compendious. This *Journal*, **6**, 131.

2 Michel, H. (1947). *Traite de l'Astrolabe*, Paris.

3 Hariot, Thomas. British Museum Additional Manuscripts 6789, folios 17v, 18.

4 Lohne, J. A. (1965). Thomas Harriot als Mathematiker. *Centaurus*, 11, 19–45.

5 Halley, Edmond (1696). An Easie Demonstration of the Analogy of the Logarithmick Tangents to the Meridian Line or sum of the Secants: with various Methods for computing the same to the utmost Exactness. *Phil. Trans. Roy. Soc.*, **19**, 202.

Mr. Sadler comments:

I am delighted with Mr. Pepper's note and with his brilliant suggestion of how Hariot arrived at his method for the calculation of meridional parts. There seems little doubt that this explanation is correct in principle, though of course Hariot would not have followed precisely the line of argument given by Mr. Pepper. Incidentally, it might be helpful to point out that a sequence of latitudes ϕ_1, ϕ_2, $\phi_3, \ldots, \phi_n$ corresponds to multiples $1, 2, 3, \ldots, n$ of the meridional part at latitude ϕ_1, and thus to equal intervals of longitude; these in turn correspond to the equal angular intervals of the projected equiangular spiral.

I was unaware that Hariot had written on the conformal property of the stereographic projection and so could have deduced the relation (1); I am grateful to Mr. Pepper for pointing this out and also for quotation from, and reference to, Halley.

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