the usual errors in celestial observations. Like many others, he seems more concerned with the mathematics than with the process of determining an accurate position. Any navigator determining his position by so few observations would be deemed irresponsible. As I note in my paper, at least five observations before and after meridian transit are required to achieve any reasonable accuracy in determining longitude.

The geometric approach described in my paper achieves results similar to those presented, with a bit more manual work, but without reliance on batteries. I did a freehand fairing of author Ranta's data and found a maximim altitude of 18° 08·6′ – essentially identical to his published results. Author Ranta made my calculation of longitude simple by having equal altitudes before and after meridian passage – something I've never been able to achieve at sea. With these data, I calculated the time of meridian transit as 10-53-26. Author Ranta's results are scattered around this exact value, testifying to the relative accuracy of his statistical approach. Author Ranta may like to use the real data in my paper to further his study of this topic.

In summary, I think computers are wonderful, but I abhor their application to brute force solutions where fundamental methods apply. Author Ranta's is the fifth violation I have noted concerning this phenomenon since the publication of my paper. Further, I believe that authors should use real data to support their approach, since the use of hypothetical data to support a hypothesis results in another hypothesis, which makes the data irrelevant. I delayed publication of my paper until I had successfully used the method in both the northern and the southern hemispheres. That summarizes my faith in theory, especially my own.

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KEY WORDS

1. Astro. 2. Marine navigation.

from Dr Helmut Knopp

I would like to make the following comments on Professor Ranta's article which appeared in the May 1990 issue of the *Journal*.

1. There are basically three methods to determine longitude at LAN:

(*a*) the equivalent altitude method;
(*b*) to adjust each observation according to the movement of the ship and to determine the maximum of the resulting curve;
(*c*) to determine the maximum of the curve of the unadjusted observations and to calculate from this apparent culmination the time of the true culmination and hence the longitude.

All three methods, if used properly, give identical results. Ranta's method (*c*) is the most cumbersome of the three; it has no advantage over (*b*). Both (*b*) and (*c*) are suitable for curve fitting by a pocket calculator avoiding manual plotting, whereas (*a*) is essentially a manual method. M. Rogoff had already published in 1979 programs for the HP65 pocket calculator using regression analysis to determine LAN. The disadvantage of all three methods is the long observation period usually required (see below); in addition, in (*a*) one has to wait for the p.m. altitude to become equivalent or nearly equivalent to the a.m. altitude, hoping that no clouds intervene.

2. The equivalent altitude method is wrongly used by Ranta. He gives a longitude error of 75 miles for his example. This is only so if the movement of the ship is not taken into account. However, it was already known in the last century that this has to be done (see Cotter and Bowditch). Letcher (1977), Shufeldt and Newcomer (1980) and Knopp (1986) as well as Rogoff demonstrate with detailed examples that the longitude errors become reasonably small if the movement of the observer is taken into account.

3. In Ranta's example, an observation period of only 75 minutes is used. This is misleading and it works only because he uses a fictitious example with zero observation errors. As a rule of thumb for the necessary observation period Letcher gives $4.(\phi-\delta)$ minutes, Shufeldt and Newcomer recommend azimuths of 140°/220°. This leads for the example to an observation period of about five hours, which would be prohibitively long. Employing regression analysis may shorten the time a bit, but not much, because the long period results from the observational inaccuracy which is not improved by regression. In the example, and generally always in higher latitudes, it would be much easier to calculate classical LOPs sufficiently long before and after culmination. These long time periods are also the main reason why the method disappeared from praxis many years ago.

4. Of course, statistical methods like averaging and regression should always be used if possible to enhance accuracy. The best method I am aware of is by Morrison, who calculates traditional LOPs and determines from them a most probable position considering both stochastic and systematic errors, all that on a pocket calculator and without any plotting. It may be worthwhile to reprint his article in the *Journal of Navigation*.

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