For an updated, expanded discussion see Sec. 11.28 of *Celestial Navigation, 2nd Edition* by David Burch.

17.6 Celestial Nav by Calculator?

There is good reason that experienced celestial navigators use a calculator whenever possible. A main reason is the time you save. With a calculator you can do in 10 minutes what it would take an hour to do by traditional table methods. It is reasonable to take pride in knowing the traditional methods of navigation that do not require calculators, and it is even prudent for safety to have this knowledge. But in practice at sea, there are other chores to attend to besides navigation. With limited time available at the nav station, it is better to figure out where you are as quickly as possible, and use remaining time for gathering and thinking about weather patterns, planning your routes, and so on. Unnecessary time spent on position fixing takes valuable time from other important tasks of navigation.

Besides quicker, calculator navigation is also "easier." You don't have to unstow and stow large books, and you are less likely to make errors because you don't have to look numbers up in tables and the arithmetic is all done for you in the computer. Furthermore, when doing things like route planning (great circle and mercator sailings), the calculator becomes particularly valuable because the proper ways to do this planning without calculators is involved, requiring special tables or charts, and the procedures are not covered well in text books. With a calculator, you push a few buttons and the answer appears. The Starpath StarPilot is especially convenient in this application.

The biggest advantage of calculator navigation, however, is the end product. You will inevitably end up with more accurate navigation when using a calculator than when doing it "by hand." There are several reasons for this. One is the more sights you take, the more accurate your navigation will be. With a calculator to quickly reduce the sights, you will do more fixes, and each fix you take can include enough sights for an accurate result. Accurate fixes require multiple sights of several bodies. In short, routine fixes can all become optimum fixes, something you cannot do without a calculator because it simply takes too long to reduce them.

Another advantage that leads to better navigation is the very method that calculators use to carry out the sight reduction process. When using the traditional table method of celestial navigation, each sight must be reduced from a separate assumed position. With a calculator, all sight reduction is effectively done from a single position, usually an appropriate DR position. This results in smaller intercepts that are much easier to interpret and evaluate, and also much easier to plot, if you care to carry out this extra step, although it is not actually required in most cases.

Celestial navigation by calculator therefore allows for a much more convenient interplay between DR and position fixing, which not only leads to more accurate fixes but it also provides a convenient way to test the accuracy of the DR position itself. In the long run, it is the ability to do accurate dead reckoning that leads to the most confidence in navigation. You could do excellent celestial navigation for an entire crossing, for example, but if it is overcast on the last few days, your landfall must be done by dead reckoning. The calculator that facilitates DR in the best manner will be the one that serves you best in the long run.

To reap the benefits of this important advantage of calculator navigation, however, the calculator itself must be programmed with this approach in mind. The StarPilot excels above all others in this important design feature. The nearest to it is the Merlin II calculator, but this is no longer on the market.

Finally, assuming the computed almanac data is correct and the sights themselves are accurate, the final accuracy of a celestial fix ultimately hinges on how the motion of the boat is accounted for during the time the sights are taken. If it takes 30 minutes to take a round of star sights and you are traveling at 8 knots, then you have moved 4 miles during the time you are figuring out where you are. If you wish to know your position to a precision greater than 4 miles then you must correct the sights for this motion. This correction is a tedious process when done by hand plotting. A calculator can do it automatically.

The same problem arises during the day, since most daytime position fixing is done by running fixes of the sun — you take one set of sun sights; carry on for a few hours or so; take another round of sun sights; and then advance the first set to the second for a running fix. This involves careful analysis, DR, and plotting to do by hand, whereas a computer can do it automatically. Furthermore, to properly evaluate a series of sights, they must be compared after the time span between them and the boat's motion have been corrected for. In short, you must reduce every sight and advance it to a common time before a series of sights of the same object can be compared to decide if poor sights are included. This is very tedious and time consuming to do by hand. Again, the StarPilot excels in this fundamental task of computer navigation. If this process is not well organized in the calculator, the apparent precision of the results can be very misleading.

In a nutshell, celestial navigation by calculator is faster, easier, and more accurate than possible using traditional methods with tables and plotting. Calculators are also typically more convenient than using conventional PC software — they are certainly more easily protected at sea.

Later we will add a detailed comparison of various calculators on the market.