The Darned Old Cocked Hat (DOCH) Part 2

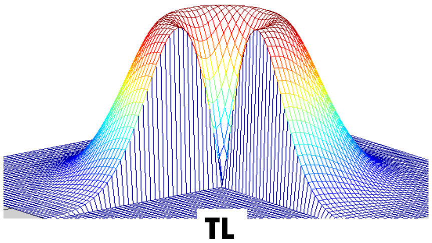


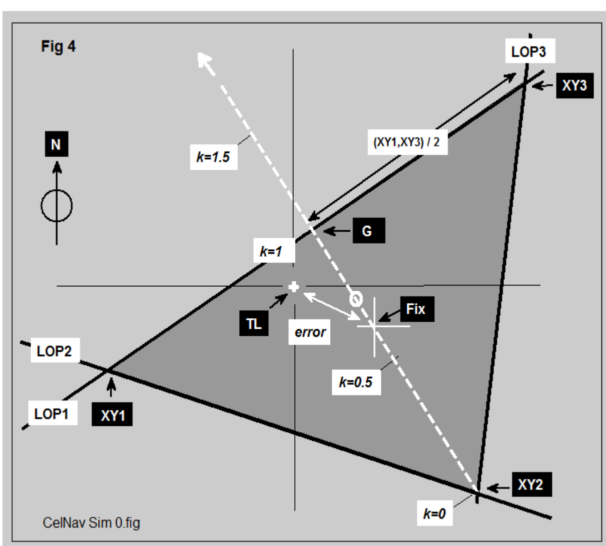
Fig 3 The Lon and lat components of a fix are each afflicted by independent errors that cannot be minimized simultaneously, hence the donut-shaped error distribution. -

Now to more important issues: Given 3 LOPs, i.e. a DOCH, can we find a better fix than with the standard 2 LOP fix? How? How much better?

I have implemented a simulation as a *FreeMat* program (FM is free on the internet; I'll send you the simulation program upon request).

Look at **Fig.4**: TL is a fixed point at (0,0). The six coordinates of the 3 corners XY1,XY2,XY3 are are randomly chosen from the same Normal Distribution, m = 0, σ=5 sm. 5 sm is an arbitrary distance reference. The longest side,(XY1,XY3), is halved by pt G. A straight line (white, dotted) passes through the apex XY2 and pt G. This line is marked with a scale: k=0 at XY2; k=0.5 halfway between XY2 and G; k=1 exactly at pt G and so on. We assume a fix is located on this line and identified by a specific k. We search now for an optimal value k-fix of k that minimizes the distance Fix-TL at least on average.

This model is arbitrary but it allows simulating fixes easily: By choosing k we move fixes from the apex XY2 through the middle of the interior of the DOCH, to its borderline (XY1,XY3) and beyond. If k-fix exists it might become apparent.



k-fix does exist! I simulated 150 steps of k from 0 to 1.5, 100,000 DOCH ea., 15 Million total. **Fig 5** shows the most frequent, i.e. most probable, Fix-TL for each step. *The minimum of all, 2.91 sm, occurs at k-fix=0.66.* Indeed, the most probable fix is located within the DOCH (white, fat "O", **Fig 4**) at least close to its CG.

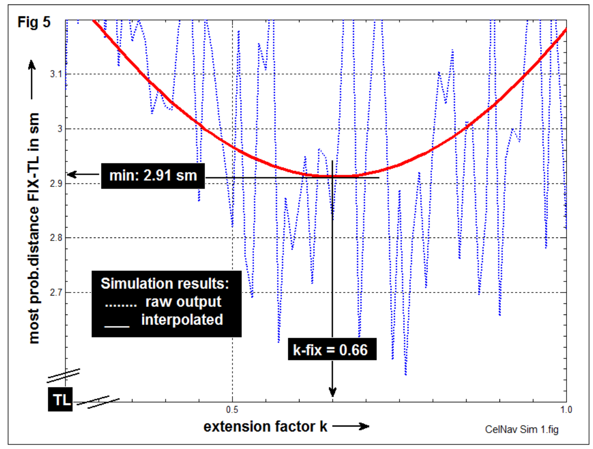
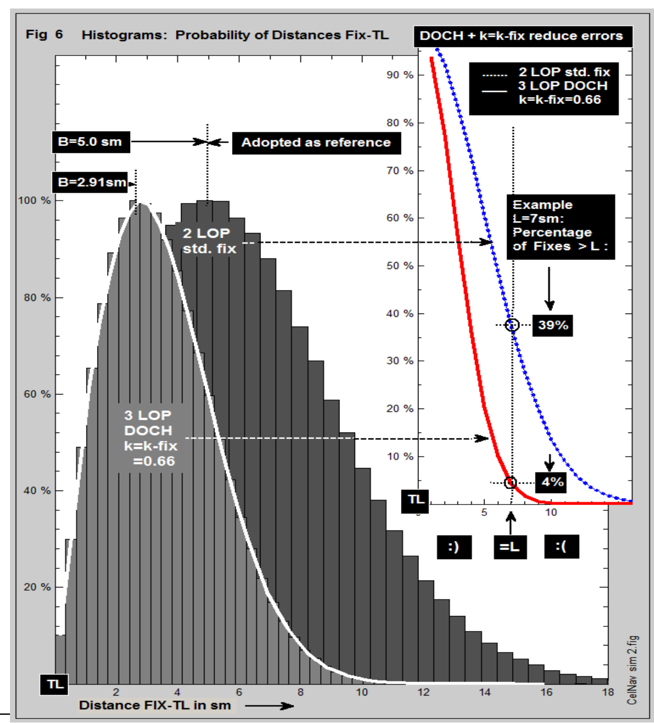


Fig 6 demonstrates how k-fix improves fixes: It reduces the most probable distance Fix-TL from 5 sm to 2.91 sm. But the real gain lies in the reduction of the probability of distances Fix-TL that are beyond 5 sm. In the side box there are 2 curves that show the percentage of distances greater than a critical distance L of your choice, say 7 sm : 39% of fixes made with the standard 2 LOP method exceed 7 sm whereas only 4% percent of fixes created with a DOCH and with k = k-fix = 0.66 exceed 7 sm. Accordingly:

** The CG of a DOCH is a solid approximation to TL.*
** DOCH/3 LOPs can reduce errors significantly.*

σ = 5 sm as a reference is a wild guess of mine. In multiple realistic situations you should find, modify and record your own values of σ. - The minimum of Fix-TL varies in proportion to σ, however k-fix = 0.66 stays fixed.



PS: We did not use the "Rayleigh Distribution" explicitely in this simulation, however it showed up again naturally in the histograms of **Fig 6.**