'The Cocked Hat'

from P. J. D. Gething

J. E. D. WILLIAMS, in a recent note to Forum[1], gives a simple argument to prove the result that the probability of being inside a cocked hat formed by three position lines is 25 percent. No doubt he is right that this result is well known to navigators, in spite of suggestions to the contrary by the BBC Open University. It is certainly known to many involved in radio direction-finding operations, where bearing lines take the place of position lines.

The essence of J. E. D. Williams' argument, which he says he has never seen in print, was given forty years ago by Daniels[2]. Daniels considered polygons of more than three position lines as well as triangles; his general result was that the largest closed polygon formed by n lines is a confidence region of probability P_n (expressed as a fraction) given by

$$P_n = 1 - \frac{n}{2^{(n-1)}}$$

Cocked hats may have their uses, but in this age of computers I cannot help commenting that they are 'old hat'. For DF fixes it has been the standard practice for many years to calculate and report a 90 percent probability region of minimum area, or a rectangular approximation to it, for every fix.

REFERENCES

[1] Williams, J. E. D. (1991). The cocked hat. This *Journal* **44**, 269.
[2] Daniels, H. E. (1951). The theory of position finding. *Journal of the Royal Statistical Society*, **13B**, 186.

from D. William Swift

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1. INTRODUCTION. I was delighted to read the paper by J. E. D. Williams[1] in the May 1991 issue of the *Journal of Navigation* because it addressed an area which has concerned me for some time. In particular I believe that it is essential that anyone trying to determine their position from bearings should have a good understanding of the level of uncertainty resulting; not to have such an understanding may be very dangerous. I especially liked the simple approach to the question of determining the probability of being within the 'cocked hat', since not all navigators (of small pleasure yachts for example) are technically well qualified, and it is important for all and not only the technically expert to have the understanding. I should note that this is now somewhat academic to many people because they will obtain their fixes from a box of electronics operating from satellites. What I have to say does not concern them, whether they be professional navigators or wealthy amateurs, but I am sure that there must still be a great many pleasure yachtsmen who rely on a hand-bearing compass. Probably few of them read the *Journal of Navigation* but their instructors in the navigational arts possibly do, and so it is to them that I address this brief contribution.