the congested waters of the English Channel in bad visibility. A large tanker on a run from the Persian Gulf to the United Kingdom, with perhaps up to 20 days in clear weather with little traffic, can derive tremendous benefit from aids such as these. Not only is the expertise of the bridge watchkeeping officers and men increased, but when the ship does reach the Channel they are on their toes, mentally keyed to deal with any situation. Boredom and lack of enthusiasm, common features of present-day long sea passages, are eliminated.

3. BRIDGE MANNING AND LAYOUT. The scale of manning must take into account the four principal navigational situations:

(1) Open waters;
(2) Coastal waters;
(3) Pilotage waters;
(4) Berthing, unberthing, anchoring and weighing.

Each of these would in turn be modified by day or night conditions and good or bad visibility, giving in all a total of 16 possible situations, for each of which the manning requirement (including watchkeeping) should be analysed in the light of the type of equipment fitted and its layout on the bridge. By critically examining the bridge task an optimum manning figure can thus be arrived at, while the task of planning future developments in navigational equipment and bridge layout will be simplified.

4. CONCLUSION. Information and sea training bring about an improved level of competence which, together with safe operating procedures, will reduce groundings, collisions and contact damage and in this way increase safety, save lives and reduce pollution. The benefits are considerable for, given an operating life of 20 years, a ship runs the risk of being involved three times during that life in a grounding, collision or contact damage incident. The current average direct cost of repair or replacement would appear to be of the order of £40,000 per incident, a total of £120,000 in a ship's life, and much more than that for really large vessels costing perhaps 10 or 20 million pounds. When tankers are concerned there are the pollution costs as well; the *Torrey Canyon* settlement of £3 m. may well have been less than the total expenses involved. It is not unreasonable to suppose, therefore, that three accidents in the life of a really large vessel could well cost something of the order of a million pounds and perhaps a great deal more.

If the provision of aids along the lines put forward in this paper were to cut the accident rate by only 25 per cent, the benefit per ship could be of the order of £30,000, and even a quarter of a million or more for very large vessels, while a reduction in accident rates would be bound to have a stabilizing effect on insurance premiums.

Lateral Error on Airways

J. D. Proctor

A. WHITE's study of navigational accuracy near Strumble [1] is artificial and draws some wrong conclusions. He seems to assume that it is a crime to be outside the airway. But this airway is isolated, with no mountains near cruising altitude, and

no one infringed a neighbouring airway. In a terminal area I am sure accuracy is much higher, because it needs to be. Airway widths vary from one country to another and are unimportant and the boundaries are not evident to pilots, who try to stay not within the arbitrary boundaries but not too far from the centre line. The area just outside the official airway is just as safe and good as the airway, and indeed safer than the centre line where traffic density is highest and only an altitude mistake by controller or pilot is needed to promote a collision—natural dispersion is still safer than extreme accuracy. Crews generally fly only as accurately as necessary, reserving their energy for the most important tasks: the study of Strumble shows adequate accuracy. Incidentally routes and airways should follow the curved path of aircraft instead of the right-angled bends, for instance the standard inbound route to Gatwick: Lydd–Cliff–Mayfield.

REFERENCE

1 White, A. (1971). Air traffic control separation standards and navigation. This *Journal*, **24**, 443.

The Knife as a Compass

Fischer Heinesen

When our Norwegian ancestors wished to navigate in the open sea they could find their bearings by the Sun or stars if the sky was not overcast. In foggy weather they used the *sólarsteinn* or sunstone, 'a stone with which one could see where the sun was in the heavens'. A knife blade will do equally well as may be seen from Fig. 1. If you place the point of the knife on your thumb nail, as shown in the figure, on a sunny day you can easily see the shadow it casts; turning the blade a little one way or the other the shadow widens, but when the knife edge points towards the sun the shadow is reduced to a narrow line.

FIG. 1.

https://doi.org/10.1017/S0373463300040327 Published online by Cambridge University Press