The ship is driven to the let-go position of the third anchor, the outer bower, and stopped. The tide and wind are then allowed to take the ship across to the position of the fourth anchor, assisted by engine movements if appropriate. This method may not however be compatible with the direction in which the ship is required when moored.

The operation of unmooring depends on the tide and weather at the time. The lee bower anchor is usually weighed first, paying out the weather cable and stern wires as necessary. This is followed by the weather bower anchor. The ship is then driven astern to recover the stern anchors in the appropriate sequence. In conclusion it must be pointed out that each operation has some unique feature. There is no such thing as a standard method of mooring; variations on the methods described above are possible and may be appropriate in a particular instance.

Operational Aspects of Ships' Bridge Design

A seminar on the operational aspects of ships' bridge design was organized in Liverpool on 18 January 1973 by the North West Branch of the Nautical Institute and the Merseyside Branch of the Royal Institute of Navigation. Points from some of the papers presented at the seminar are summarized below.

THE CONTRIBUTION OF ERGONOMICS. Mr. Malcolm Hatfield (P. & O. Steam Navigation Co., Ltd.) tentatively defines ergonomics as the optimal fitting together of the requirements of work and the abilities of people, based on controlled experiments in anatomy, physiology and psychology; it is more than 'the science of good seating'. In general the design of ships' bridges does not reflect the necessary coordination of these basic disciplines and, while manning scales must affect bridge design, the bridge layout also affects operational practices. A bridge is the working area for a variable number of people depending on the conditions in which the ship must operate. The present deployment of manpower is however largely based on traditional practices and, for example, lookouts as at present employed may contribute little to the safe navigation of a vessel; legal restrictions and levels of ability, as well as an innate conservatism, are bars to progress.

Turning to the overall shape of the bridge structure, the poor visibility from many wheelhouses is due to insufficient attention to the design of the bridge in relation to the rest of the ship particularly in VLCC's, where communication is also a problem; the bridge wings may themselves obstruct visibility. A primary concept in ergonomics is the work station, which is the man-machine interface for any particular operation with its associated controls and displays. The number and disposition of work stations should be based on an analysis of functions; one criterion of good design is how little the bridge personnel have to move about.

It is often stated that most accidents at sea are attributable to human error, but the ergonomic approach is to analyse the overall system performance to discover and remove the weak links in that system. Because men are involved in the system an engineering solution may be inadequate or inappropriate and a vital element will be the proper allocation of functions between man and machines. The navigator himself may not be the most appropriate person to conduct

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such an analysis because his special skills have become 'internal', rather than consciously thought out, and are difficult for him to explain. Nevertheless his full cooperation in any ergonomic study is essential and he can provide the needed feedback of information to the designer.

A NAVAL ARCHITECT'S APPROACH. Mr. G. R. Wilkinson (Vickers Ltd.) develops some of the points brought out in an earlier paper[1] in this *Journal*. He cites specific examples of deficiencies and errors inherent in the design of ships' bridges, including the presentation of information and the positioning of controls and equipment, which sometimes suggest a complete lack of understanding of their function by the designer.

The publication of the paper referred to above led to valuable contacts with overseas designers and research institutes and an interchange of plans and information from which a number of interesting innovations in bridge design are described. In one new Finnish ferry the design is based on an extensive study of bridge operation in similar vessels; each of the persons involved has a work place with a console providing the information, controls and equipment which he requires. This leads to a duplication of many of the primary controls but the added cost is considered justifiable.

Mr. Wilkinson also develops further his earlier comparison between the control positions in ships, aircraft and diesel locomotives.

TEAM WORK IN REDUCED VISIBILITY. Captain K. D. Jones (Liverpool Polytechnic) draws attention to the general absence of an organized division of responsibility between the members of the bridge staff of merchant vessels for the routines of navigation in reduced visibility. This contrasts with the organization in naval vessels and with the routines connected with the docking and berthing of the merchant ships themselves; it cannot be attributed only to reduced manning scales. A degree of flexibility is certainly desirable, but the absence of an established division of labour leads to unnecessary duplication of effort, an increased work load on the individual and to some parts of the task not being done at all. Thus during continued movement of a vessel in fog the Master may prefer to watch the developing radar situation himself and move between the radar set and the bridge wing, while the officer-of-the-watch does the same thing; but effective data extraction may also require a continuous radar plot. Bridge equipment cannot be logically sited until procedures are established.

The desiderata in equipment and layout for a single-handed bridge, when navigating by radar in fog, are then considered. With a properly organized team one man may become the visual sensor and another the radar sensor, while the third member of the team may be the decision maker. Here the form of the various data elements is critical, while the lines of communication dominate the bridge design; possible bridge layouts are illustrated. However, the requirements for the open sea and for pilotage may be significantly different and bridge design may be biased towards the latter situation as being the more dangerous.

A PILOT'S VIEWPOINT. Captain Tebay (Liverpool pilot), basing his remarks on recommendations of the Technical Committee of EMPA, the findings of Captain Holder of the Liverpool Polytechnic in consultation with Liverpool pilots, and on his own experience, reviews the siting and layout of modern ships' bridges and the organization of work on the bridge. While pilots appear to have adapted themselves to the practice of placing the bridge well aft, this often aggravates noise and vibration; efficient communication with the bows is essential, particularly in reduced visibility and when berthing, and with the stern for some manœuvres. Wheelhouse windows must be clear and well sited and the bridge wings should provide a clear view over the side. Manning scales are related to the increase in automation, but what may be adequate for the open sea may be insufficient for manœuvres and berthing unless there is a clear division of responsibilities. This division varies from ship to ship but should be reflected in the layout of the bridge equipment itself.

With increasing automation, the design and layout of the bridge is usually less satisfactory in large ships than in smaller ones, although some coasters are designed for one-man operation from a central seat which makes it difficult for a pilot to see the instruments and con the ship. Automation often leads to a proliferation of indicators and controls, not all of them relevant to navigation.

These criticisms lead to certain conclusions as to the layout most acceptable to a pilot; it should provide a choice of conning positions with adequate instrumentation including, on large ships, communication with the wheelhouse and v.h.f. facilities. The location of the helmsman himself is important and the radar controls should be simple and standardized. The ideal is a bridge that is acceptable to both the deep-sea mariner and the pilot.

REFERENCE

1 Wilkinson, G. R. (1971). Wheelhouse and bridge design. This *Journal*, **24**, 313.