position, but what about the quantification of operational benefits in the navigation sphere obtained from installing more sophisticated equipment? Fewer collisions, less strandings and a more efficient 'watch' can all be claimed for computer based systems, not to mention benefits accruing from better track maintenance and more efficient helm control, and these must be quantified.

As the developers of a sophisticated project evaluation computer package which uses DCF techniques, we at Marine & General are very much aware of the use of NPV and internal rate of return calculations, but we feel that evaluation must be on the basis of a definitive project which looks carefully at all factors. Such a project is illustrated in one of our major studies on the economics of a shipboard computer, an extract from which has been published.[3] The realities of implementation were imposed on the more philosophical approach of the Manning Reductions article now under discussion, and the project was analysed on the basis of implementation in stages with consequent capital outflow at specific times within the 10-year project period. To have gone into this detail in the Manning Reductions article would not only have complicated the argument, it would also have given a spurious accuracy to an otherwise incomplete project. What we require is more, and more accurate, data to be able to approach a position where we can use DCF techniques. At that happy time we may have a specific project to evaluate.

REFERENCES

[1] King, J. (1971). A note on manning reductions and navigation. This *Journal*, 24, 556.

[2] McKenzie, J. S. (1971). Manning reductions and the cost of navigation. This *Journal*, 24, 123.

[3] McKenzie, J. S. (1970). The economics of a shipborne computer, *Shipbuilding & Shipping Record*, Vol. 116, No. 4.

'Manning Reductions and the Cost of Navigation'

P. T. Bingley

AFTER studying Captain J. S. McKenzie's very interesting paper on the above subject (*Journal* 24, 174), and recognizing the need for an improvement in the safety of navigation, it would seem worthwhile considering whether safety could be improved while still reducing costs.

Using Captain McKenzie's assumed costs, and his Table III as a model, the accompanying table shows the costs and savings for two versions of an all-officer bridge manning scheme.

Stage X—Total seven officers. The Master would carry out his duties in the traditional way, with watchkeeping duties carried out by six officers, viz. two officers in each watch. The radio equipment is automated and under the supervision of the bridge watchkeepers. Compared with the base this saves £40,000 over 15 years. If the Master undertook some watchkeeping duties, a full time radio officer could be retained and a further £25,000 saved by not automating the radio equipment.

Stage Y—Total six officers, the Master now assuming responsibility for one watch. Saving £168,000.

Although these savings appear small compared with those obtained under McKenzie's scheme, it would seem that the total cost of operating Stage Y might well be less than that for Stage II, and possibly also for Stage III. Under average operating conditions there would be many hours in most days when the bridge could safely be manned by one officer, freeing his watchmate for other useful work. Although the costs may be attributed to navigation, reductions in total ship expenditure might arise as follows:

(a) All radio communications would now be handled by bridge watchkeepers, and the cost to non-navigational users would be reduced by the amount allocated to the former radio officer (three-quarters of his services).
(b) The traditional duties of Master and Mates (shipmaster's business, cargo, stability, maintenance, upkeep of charts and navigational equipment, internal security &c.) would remain with the navigational staff. At

SUMMARY OF COSTS AND SAVINGS FOR MANNING REDUCTIONS
(Pounds Sterling)

	Basic costs	Stage X		Stage Y	
		Costs	Savings	Costs	Savings
ANNUAL COSTS					
Wages and wage overheads	37,600	39,200	—1,600	33,600	4,000
Victualling	7,890	5,388	2,502	4,619	3,271
Incidentals	1,025	700	325	600	425
Maintenance @ 10 per cent of investment	20,300	16,355	3,945	15,137	5,163
			5,172		12,859
Additional maintenance at shore rates		3,450		3,450	
Maintenance of additional equipment		1,000		1,000	
Net annual savings			722		8,409
Savings over 15 years			10,830		126,135
Capital Costs					
Accommodation	124,900	85,298	39,602	73,112	51,788
Wheelhouse and chartroom	25,000				
Basic navigation equipment	53,260				
Additional equipment*		10,000		10,000	
Total savings over 15 years			40,432		167,923

* For automation of radio functions.

This table is based on Captain McKenzie's Table III, the figures for accommodation and victualling being derived by simple proportion from the base manning of 10½.

McKenzie's Stages II, III and IV these would be progressively transferred to others, either on board or ashore, generating additional expenditure.

(c) Two watchkeepers would have sufficient capacity to carry out additional duties, such as the monitoring of engine conditions where the engine room is unmanned, further contributing to the reduction of overall costs.

The case for removing the rating from the bridge is not argued as it must be clear that for navigational functions he is not cost-effective. Any tasks which an officer might not reasonably be expected to undertake would be dealt with by day work ratings, working overtime as necessary.

The introduction of all-officer bridge manning on this scale might be quite difficult, and it may not be the optimum solution, but it would seem worthy of careful consideration and costing before embarking on the alternative course towards an all-electronic ship.

Some Thoughts on Marine Radar

Gregory Haines

1. THE MAN/MACHINE INTERFACE. People who design motor cars also drive them, but whoever heard of a radar design engineer who also had a Master's ticket? Of course, the designers of marine instruments do go to sea occasionally, but not for longer than they can help; sea-time is apt to interfere with the week-end. So it happens that the people who make marine radars are rather remote from those who use them, and from the environment in which they work, the sea. The engineer might argue that no two seamen ever seem able to agree on what they want, so the easiest thing is to decide for them, and that, in any case, it is only a matter of ergonomics. On the other hand, it may be that the people who write books on ergonomics have not been to sea either. Radars are used in the dark, as are motor cars, but the darkness of the bridge is not the same as night driving. The identification of controls in the pitch black night by position, shape or edge illumination; the best kind of lighting for the legends, and their grouping according to importance, are all matters that never seem to receive the attention they deserve. The calm of the middle watch is suddenly shattered by flashing light and strident buzzer and the hapless watchkeeper gropes for a torch to find out what it means. The function of a radar in its simplest terms is to measure the ranges and bearings of other ships, so the method of obtaining and recording this information would seem to be of the first importance, yet in the design of many radars it is treated as an after-thought. I have even seen a display that was apparently designed for operators with two left hands, since the controls for the bearing ring and range strobe were both on the same side of the PPI display. For my money these two most important operating controls should be of the spinning, dynamically loaded, type. To combine rapid traversing and fine adjustment, two-speed gearing is necessary. (Whatever happened to the main tuning dial of this type that was always used in the wireless sets of an earlier age?) The range and bearing read-outs should be in large digits with an illumination adjustment that is