WARSHIPS IN AD 2000+

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Introduction

The shape, size, and roles of the future navy will be determined by a number of national and international factors. Those charged with considering the future navy have first to decide, from these factors, which roles will be relevant. The life of a ship hull and some of the machinery may be of the order of thirty years. In many cases the roles of the ship can be predicted with reasonable certainty only for the first ten years from the conception. To cater for changes in national and international climates and technical developments presenting new systems, margins can be allowed in the design to enable changes in roles to be effected during the life of the ship.

It may not be possible to achieve a navy capable of fully meeting its predicted commitments when constraints such as financial limits or manpower shortages are taken into consideration. Thus, when a conceptual study begins on a new class of ship, there is a list of requirements and constraints which need to be examined and assessed for priority before the inevitable compromises are made in the design. All conceptual designs are different and what is a limiting constraint in one design may be of little importance in another.

However, some areas of engineering that may be important in a future navy are discussed. The views expressed are those of the author and do not necessarily represent official policy.

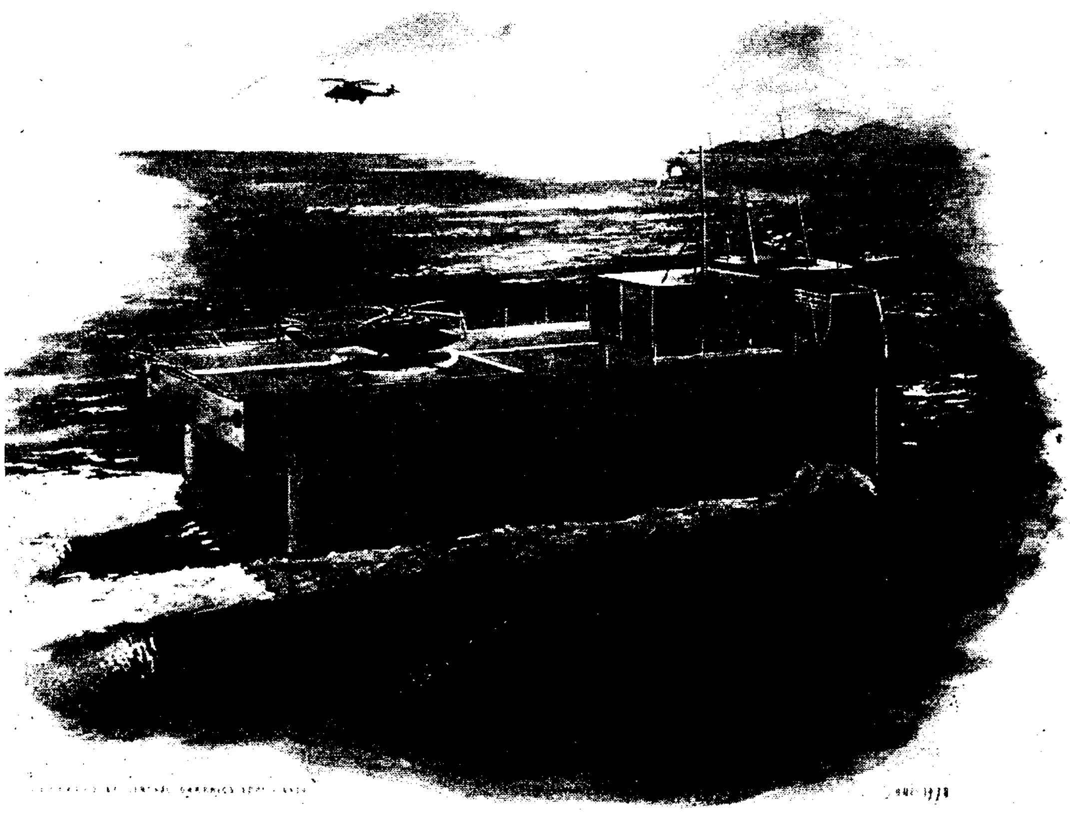

FIG. 1—A SMALL WATERPLANE AREA TWIN HULL (SWATH)

Ship Procurement Costs

The cost of producing warships continues to rise. TABLE I shows the increase in size, complexity (as reflected in the increased electrical capacity), and cost over the period since 1939. Allowing that inflation has raged over that period, the cost per ton has still increased considerably. This is not a totally fair comparison as the ships have different capabilities but it is indicative of the generally rising cost of ships. To try and counter this, the 'cheap' warship is being sought. Less conventional craft, e.g. hovercraft and hydrofoils, may provide a new answer to fulfilling certain roles and do so at less cost than a conventional hull form. However, in many applications, the conventional hull appears to be the best answer for many years to come.

TABLE I—*Increases in cost of warships over the period 1939–79*

Year	*Class*	*Displacement* tons	*Electrical Capacity* kW	*Order of Cost at Build* £	kW *per ton*	*Build Cost per ton* £	**Adjusted Build Cost per ton* £
1939	Flower	1000	15	90k	0·02	0·09k	0·91k
1945	Bay	1600	180	300k	0·11	0·18k	1·25k
1955	Whitby	2150	1140	3M	0·53	1·39k	6·18k
1965	Leander	2450	1900 2500	4·7M	0·77 1·02	1·92k	6·01k
Current	Type 22	3500	4000	60M	1·14	17·1k	17·1k

* Adjusted to 1978 value of pound sterling.

How then can such conventional ships be reduced in cost? FIG. 2, shows how, in a possible destroyer-sized vessel, the various components form the overall procurement cost. Reductions could be achieved either by reducing standards generally or by removing functions from the ship, e.g. limiting the weapon fit.

(*a*) *Reduced Standards:* Selected reductions in standards may be possible in certain areas. As the merchant shipping operators are very conscious of costs, their practices may be worth considering in a cost-reduction exercise. In the size of ship the Royal Navy is likely to use most frequently, the equivalent Merchant Navy vessel would probably be diesel driven and have waste-heat recovery, would possibly have a shaft-driven generator, and would doubtless employ other practices rarely used in the R.N. The adoption of some or all M.N. methods, practices, and equipment might make a slight initial saving in the cost of procurement but this would need to be balanced against possible disadvantages such as reduced manoeuvrability, greater space and weight, new logistic-support arrangements, new training courses, new maintenance methods, etc. Any advantages in cost saving offered by M.N. machinery systems, such as reduced fuel consumption, need to be very significant before they are considered to outweigh the disadvantages.

(*b*) *Reduced Functions:* A reduction in the number of roles to be performed by a ship could, however, provide a significant reduction in cost. Limitation of roles could minimize the speed range required, reduce the top speed, simplify the manoeuvring requirements, and ease noise-signature and magnetic-signature targets—all of which would affect the machinery systems and possibly the marine engineering complement.

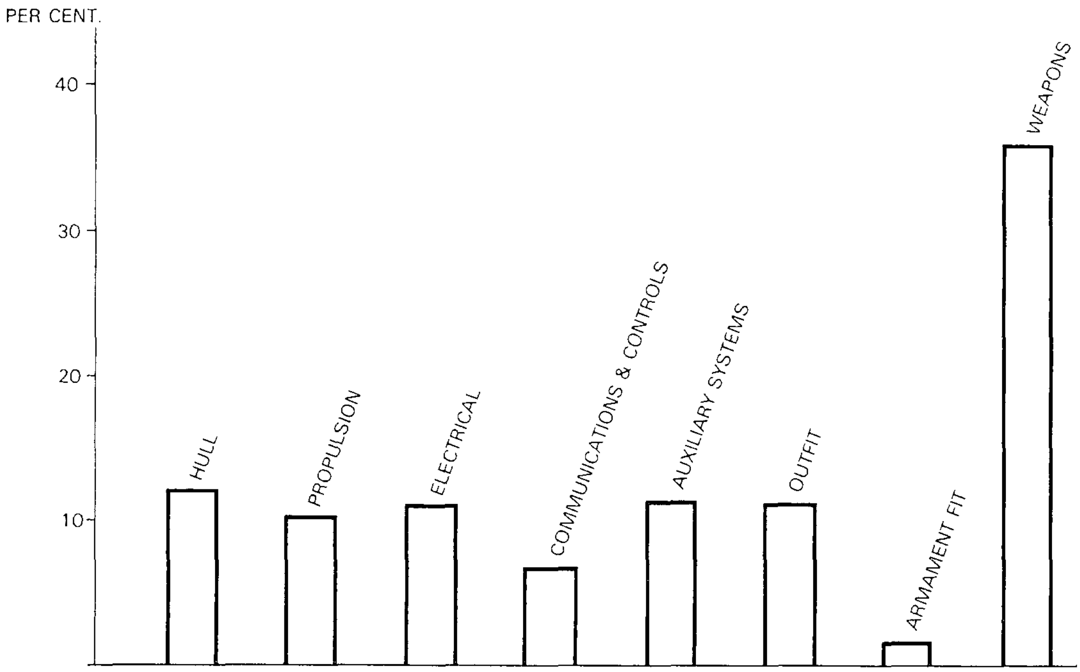

FIG. 2—TYPICAL AREA AIR DEFENCE SHIP COST

Before any reduction in standards or limitation of the number of functions to be performed is accepted, a careful assessment would be needed to ensure that the ship so produced was in fact cheaper overall and also that greater numbers of ships would not be required to compensate for either of these cost-saving methods.

Design and Build Contracts

The increased use of design-and-build contracts for warship production may be necessary to maintain a steady procurement of ships at a time when MOD resources may be cut as part of Government policy. This type of contract has been used successfully for most ships currently in service with the R.N. other than those for which major development was conducted in parallel with the ship design.

This type of contract requires that those preparing the Statement of Requirements, used as a basic contractual document, have a very clear idea of what is required to fulfil the specific roles planned for the vessels. Once the contract is placed there are usually heavy penalties in time and money for changes to the requirements.

A competent shipbuilder—and there may be a very limited choice for certain designs—should be given as much freedom as possible in the design so that the cheapest and most effective solutions can be reached. However, some restraints must be placed on the shipbuilder to ensure that support of the vessels is not excessively expensive. Some rationalization of the equipments used in the various designs will minimize spares holdings. Shock, noise, and development programmes may well also require the MOD to restrict the shipbuilder's choice of equipment. Monitoring such a contract is essential to ensure that the final vessel is a useful asset to the R.N. and that public money has been properly spent.

Currently our shipyards do not have the expertise in certain specialized areas of warship design. This may demand that the MOD designs the complete ship or invites the shipyard to design it totally or partially under MOD direct control.

Support Ships

The role of support ships run by the RFA service could change in years to come. The inclusion of weapon systems as well as helicopter operational capability may make the RFA vessel much closer to a warship than a merchant ship. The significance of the support ships' noise signature will assume new importance if they are to operate in close attendance on very quiet warships. Noise reduction in RFAs would present new problems which may require future vessels to move away from the Merchant Navy type of machinery packages normally employed and use naval equipment. This would necessitate the RFA crews who are employed under Merchant Navy regulations to be re-trained to operate and maintain naval equipment. All these measures imply increased cost.

The increase in the ships' warlike role and use of naval equipment provokes the argument that support ships should be manned entirely by R.N. and not M.N. personnel. Compared with R.N. standards of accommodation, RFA officers and crew enjoy very high standards. Single cabins for every crew member together with other luxuries never considered in warships can be very significant factors in determining the size of the ship. The arguments in favour of R.N. manning, however, must be set against the difficulty the R.N. already experiences in recruiting. Although civilian-manned RFAs can claim to enjoy easier rights of access to foreign ports than warships, this advantage may not be very significant in practice.

Fuels

Recent international problems with crude petroleum supplies have again focussed attention on the reliance placed on hydrocarbon fuels. While awareness of the current and predicted situations is essential and alternative methods of deriving power are examined, various factors do not make the introduction of novel arrangements into the R.N. an immediate problem:[1]

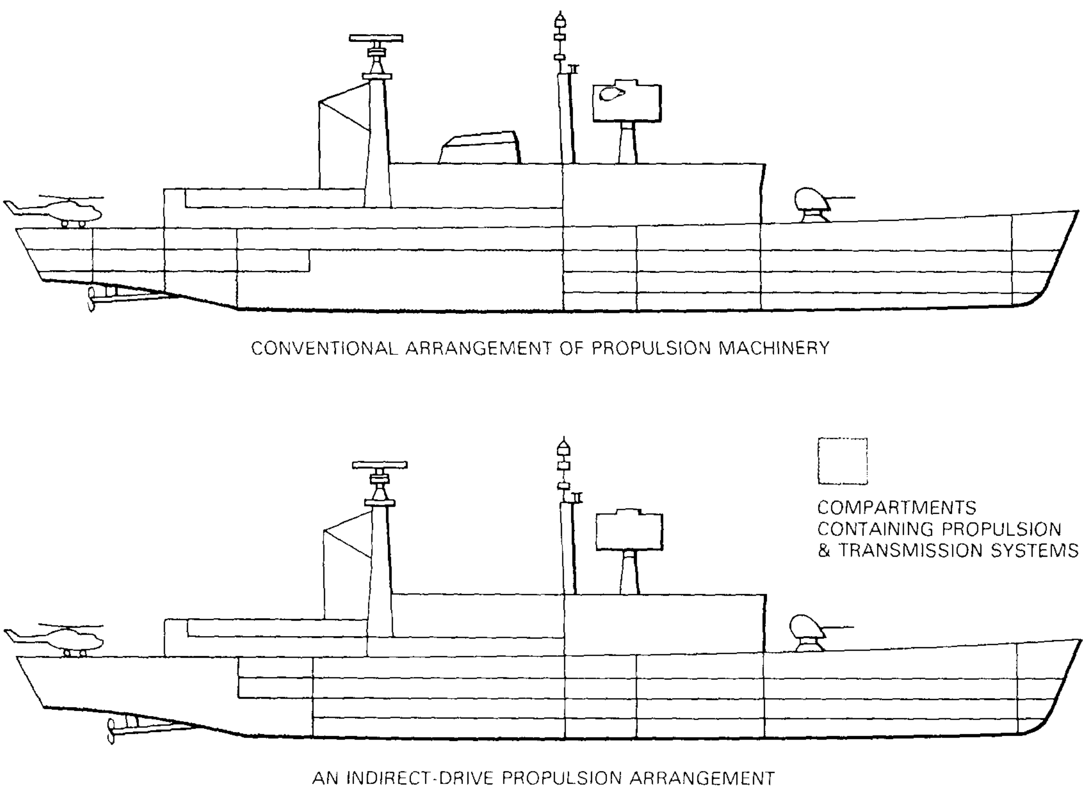

FIG. 3—COMPARISON OF VULNERABILITY OF DIRECT AND INDIRECT TRANSMISSION SYSTEMS

(*a*) The R.N. uses a very small proportion of the national consumption of fuels. In times of national difficulties, it may be assumed that the R.N. would not be restricted in its supply.

(*b*) While supplies will diminish and quality reduce in years to come, it is predicted that, at a price, sufficient quantity of suitable quality fuel will be available well into the next century.

(*c*) Development costs of alternative fuels would be immense and something that the R.N. could not afford to undertake in isolation. Any commercial developments that result in a product that becomes a proven system will be examined for naval use. When the use of crude petroleum products by the R.N. eventually becomes impracticable, commercial alternatives should be fully established amongst commercial ship operators and others currently dependent on these products.

Nuclear Power

Although nuclear power is currently used by the R.N., its general use in the surface fleet is unlikely due to its high initial cost. Larger surface ships may have a cheaper life-cycle cost using nuclear power if fuel prices rise faster than the cost of nuclear plant.[2] This would apply equally to R.N. warships and RFAs. The introduction of nuclear-powered RFAs would also introduce new training requirements for the merchant navy crew and in addition might bar such vessels from using certain ports. The present financial system which is far more concerned with initial costs than life-cycle costs would need to be overcome before a nuclear-powered surface ship could be acceptable.

Economy

The use of more economical forms of propulsion than gas turbines would provide some fuel saving. However, this saving is currently not without penalties, some of which can be very significant. Effort which is being concentrated on technical developments will reduce many of the major penalties. A time may come where the balance of factors used to decide a propulsion system will favour the introduction of fuel conscious systems. Thus we could see diesel propulsion in larger warships or steam systems designed to minimize fuel costs by improving cycle efficiencies and/or utilizing inferior quality fuel; features that could have been developed for commercial ship operators.

Waste-heat recovery may be feasible in certain cases but usually there is an associated increase in complexity and maintenance load, or, in applications where the heat source is frequently varying, there is difficulty in effectively using the waste-heat energy.

Indirect Transmission

For many years R.N. ships have, almost exclusively, used direct propulsion transmission systems, and on the whole this has proved a reliable and satisfactory arrangement. However, in conventional hull vessels, it does largely determine the position of the machinery spaces. Their location low in the central part of the ship is in an area which could well be used for other compartments which need protection from weapon attacks. The long length of such machinery spaces and their associated propeller shafts also increases the chance of action damage affecting the propulsion system.

Progress is being made with electric, hydraulic, and bevel-gear systems which may provide an opportunity to re-site certain main propulsion machinery packages at the after end of the ship and closer to, or even on, the upper deck. Such an arrangement would allow for shorter intakes and uptakes—particularly relevant in gas-turbine installations—and make removal routes shorter. In addition, by placing the main engines away from the waterline, some reduction in radiated underwater noise of machinery may be expected. Such a configuration of machinery could reduce its vulnerability (FIG. 3). This could be reduced even further by an additional independent, retractable, 360° vectoring thruster unit fitted forward. This effectively gives a second, independent, remote propulsion system.

SWATHS

A type of vessel which may appear in years to come is a Small Waterplane Area Twin Hull (SWATH). Several countries are exploring the use of military versions, and the U.S. Navy has a prototype under trial. These craft have the prime advantage of improved sea keeping over comparable displacement conventional hulls. This enables the SWATH to maintain higher speeds and operate in higher sea states than conventional craft. The arrangement provides a large open deck area suitable for low density payloads. The design is attractive as an aircraft operating platform or in an anti-submarine role (FIG. 1).

One of the main problems facing the designer of this type of craft is the propulsion system. A SWATH needs 10 to 20 per cent. more power than a comparable displacement monohull at fleet cruise speed. To fit gas-turbine main engines inside the submerged bodies is undesirable for maintenance, space, and noise considerations. Indirect drives would allow the main engines to be sited close to the upper deck. As in the case of the conventional craft with the main engines mounted aft, the SWATH engines would enjoy short ducts, easier removal routes, and an engine-noise source remote from the waterline.

Conclusions

The future will bring new problems and the earlier these are identified and solved the greater the chance of having suitable developed and proved answers. However, the accuracy of predicting the problems falls off the further into the future the predictions are made, and this can lead to nugatory work if answers to problems that do not materialize are progressed. With limited resources, a judgement must be made to balance these extremes.

The enormous number of potential problems makes it impossible for a short article to cover more than a sample of the possibilities.

Acknowledgement

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