THE MOBILITY OF THE FLEET

BY

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'Mobility is one of the prime military assets'

Fleet Admiral King, U.S.N.[1]

'Strategy,' wrote Lord Fisher, 'should govern the types of ship to be designed. Ship design as dictated by strategy should govern tactics. Tactics should govern details of armaments'. Mobility is the lynch pin of the nation's strategy. This is a study of mobility at sea.

True naval mobility, the ability to remain at sea for weeks or months, or even years, is something we have lost in the age of steam and the internal combustion engine. Responsibility is spread right across the Admiralty Board. But no single authority is charged with the study of mobility. There is no Staff Division able and willing brilliantly to deploy the arguments for improving mobility; there is no 'school' where disciples can be given interminable training in mobility. Mobility in fact affects us all. But many of its constituents are dry as dust. There is little glamour in the study of the foundations on which mobility is built.

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[1]Report to Congress, 1945.

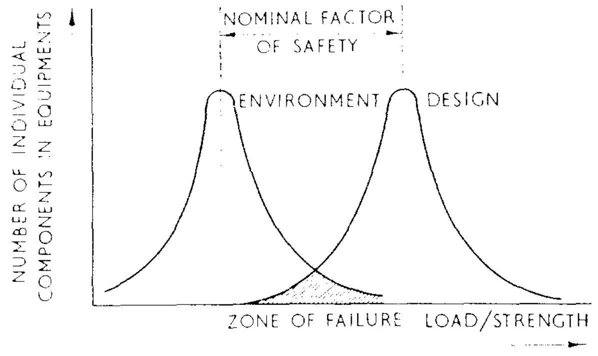

FIG. 1

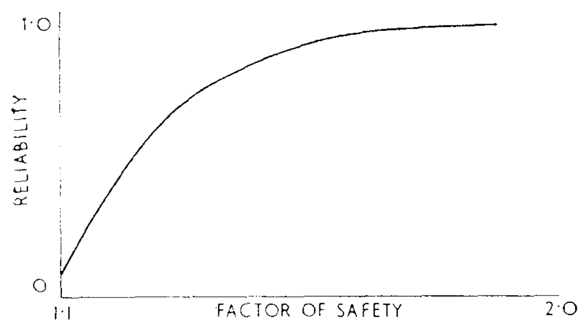

FIG. 2

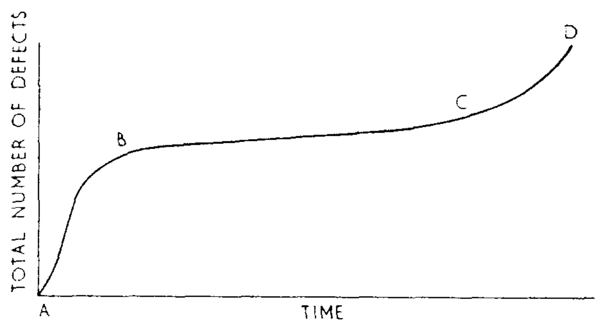

FIG. 3

We can afford only a small Navy. Not for us the lines of battle-ready reserve ships available to be plucked from the shelf when front line replacements are required. The great majority of our ships are already in the front line and there they have to stay, operationally available and fit for war for as long as we can make them. Ship for ship we probably already do better than any other navy in the world. Yet the task grows and our operational commanders become increasingly hard pressed.

In this cold war that we are fighting under our deterrent umbrella, no more positive way exists of reinforcing the Fleet than the achieving of real mobility at sea.

The true size of the Fleet is not the number of ships; it is certainly not the number of men at sea. In any one year it is quite simply the product of the number of our ships and the days on which they were operationally available. Of this concept Parliament, the Press, and the public are notably ill informed.

MOBILITY

Real naval mobility means three things:

(*a*) Each ship should possess, in whatever part of the world she finds herself, as near constant availability of matériel as can be achieved.

(*b*) When operationally available, each ship should be able to get under way almost instantly (ten minutes) and she must possess also a fast, long passage capability.

(*c*) Each ship's company must be always mentally alert, physically fit, and personally relaxed.

In this study of the 'make-up' of mobility which follows, discussion of armament readiness and weapons, and many other important items, have been omitted. But it should not be taken that what has been discussed is necessarily more important that what has not. Each is part of a whole. As St. Paul well observes in the XIIth Chapter of the Corinthians: 'The eye cannot say to the hand I have no need of thee: nor again the head to the feet I have no need of you. Nay, much more those members of the body, which seem to be more feeble, are necessary'.

The author has tried to concentrate on the facets which seem to him susceptible to immediate attack in the chase after true mobility.

CONSTANT MATÉRIEL AVAILABILITY

Reliability

The phrase 'constant matériel availability' is a bit of a mouthful; but it means what it says. Ideally the operational commander requires that all the matériel should always be available for him to use. His ships must be reliable.

Complete reliability can never be attained in practice and this can be seen in FIG. 1.

If all the possible variables in design and manufacture of a mechanical equipment are taken into account, most will be close to the average in strength. But some will be better and some worse, and this is shown on the right hand curve above. At the same time operational conditions (in the widest sense of the term) will also vary so that there are bound to be occasions when the equipment is overloaded and others when it is underloaded. Where these two curves cross (in the shaded area) failure will occur. The area of the shaded portion is a function of the factor of safety, and varies very rapidly between 1·1 and 2, after which it is virtually constant (FIG. 2).

Next, of course, there is the complexity factor as the chances of failure are directly proportional to the number of components in an equipment. Thus if the equipment is made up of 1,000 components, each of which has a failure rate of one in one million, the equipment failure rate is one in one thousand! Similarly, in a missile with between thirty and forty thousand components, each with a failure rate of one in 100,000, the mathematical chances are that one missile in three would be a misfire.

All these are facts which are inescapable in advancing military technology. They are facts which are obviously wholly unwelcome to the staffs who establish operational requirements and sometimes to the scientists whose job is to incite the staff always to push such requirements to the frontiers of knowledge. It is no wonder that the engineer is often an unwelcome bird. Reliability is becoming ever more costly and more difficult to achieve.

A typical trend of reliability is shown in FIG. 3. A–B is the primary development phase when the gross design errors are eliminated and the equipment developed to a state where it can be put into service. B–C is the running phase, normally used for statistical analysis and where there is a roughly constant incidence rate of random defects. C–D is the 'wear-out' phase where the equipment is reaching the end of its life and must be replaced.

Much of the above of course is culled from aircraft practice. However, it is now wholly relevant to the establishment of constant matériel availability in the Navy. But there is one other point, known as the 'operator variable', as important to the sophisticated aerospace industry, as it is vital to naval equipment. The 'operator variable' can make a complete mess of any analysis. Statistically, if there is a method of operating something incorrectly, someone will do so and, what is more, the incidence of his doing so is always such as to maximize the inconvenience caused!

Design—Operation—Maintenance

Matériel availability of the propulsion machinery and of all those other services on which the life of the ship and the functioning of the armament depend derives from a combination of good design, operation, and maintenance, and these three complement each other. Machines, like men, have lives; and well designed machines can be destroyed, as men can be destroyed, by being maltreated (or maloperated) or by neglect of essential rest and recreation (or servicing) periods. Really well designed equipment, like men who are blessed with really physically fit bodies, will stand up to long periods of maloperation and stress, or long periods without servicing, and will recover quickly when rested and serviced. On the other hand, less well designed equipment can also be made serviceable if the operators are superlatively trained and experienced and if the periods for servicing, inspection, and maintenance are frequent. In the first case the money goes into design and development and is saved on training and maintenance effort; in the second case money is saved on design but squandered in elaborate training and on too frequent maintenance during which periods the ships are not operationally available.

There is a third course—and this is the quick road to disaster: cheap design, poor training or lack of experience (and thus maloperation), and such frequent maintenance that operations are interefered with.

The difficulties facing designers will unfold; but increasingly, today, reliability comes from development. Nuclear and aircraft propulsion both demonstrate that 'reliability' and 'life' can be designed and bred into equipment *at a cost*. In both these cases there is a disaster element (radio-activity and aircraft engine failure), and so this cost has come to be accepted. The development cost of an aircraft engine may be as much as 500 times the production cost of one engine; for a marine steam propulsion set the best we have achieved is about twice the production cost. The first perhaps is too high: the second is undoubtedly too low. For naval machinery a figure of 25 times the production cost would be an economic investment in development.

Naval artificers (the toolsmen as Lord Fisher called them) have been among the greatest body of craftsmen that this country has produced. So in the past the low design and development cost of naval machinery was largely compensated by the standard of shipborne and dockyard craftsmen and by the experience and skill of the 'engine drivers', the stokers and mechanicians, and not least by the mandatory pause, every 21 days or less, for boiler cleaning. In the past (by today's standards) only a very little was demanded and much in the way of skill of operation and maintenance opportunity was provided. But even these meagre demands were not always met, and design failures frequently crippled the Grand Fleet with 'wrapperitis' and 'condenseritis'; and H.M.S. *Hood's* enforced refit in 1940 was a notable example of the latter trouble.

The Royal Navy finished the war with its machinery 15 years behind the U.S. Navy, as instanced by the difference in endurance of the two fleets. This gap the Engineer-in-Chief of the Fleet set out to close by turning to the advanced steam techniques prevailing in the power station industry, and the first of the new steam propulsion sets were coming out when the Korean War precipitated a rearmament programme before they were fully or even partially 'developed'. Much of our escort machinery problem since has stemmed from this fact. It has been hard to catch up the development period necessarily omitted. But fine machinery it is, with high potential performance, previously unheard of flexibility of operation and good endurance, occupying far less space and weight than ever before was deemed possible. Yet inevitably this has meant complexity, high steam pressures and temperatures, small high-speed machinery, and sometimes, due to all these, appalling physical conditions away from the actual operating platforms so that maintenance, inspection, or servicing at sea is exhausting or well nigh impossible.

Thus the Navy embarked (through no one's fault) on the second and less desirable cycle mentioned above, e.g.

(*a*) Inadequately developed machinery;

(*b*) A huge training bill;

(*c*) Too frequent maintenance (from the operational aspect);

and this cycle is difficult to break. Headquarters' effort is diverted to helping the seagoer, so new and future designs are neglected and equally undeveloped. We become self-consuming.

Unhappily, this is not all. The great tradition of the Engine Room Department, 'that the ship must go', has meant, (at the present operational tempo which exceeds anything known before in peace and probably war) an immense load on officers and senior technical ratings; not only on those whose direct concern is the propulsion machinery, but also those who operate and maintain the vast mass of associated electrical and mechanical equipment which supports the armament and the life of the ship.

The pace, perhaps, is getting too hot and so the re-engagement rate drops and the Navy slips into the third cycle. Inadequately developed machinery, in spite of more and more training, is looked after by inexperienced men, more and more headquarters' effort is diverted to helping the Fleet, less and less is available to vet the new equipment being designed by industry. This is the cycle which, if allowed to develop, will cause us to gadarene to disaster.

Thus the main problem is how to initiate and develop good design. There are many others.

Competitive Tendering

Competitive tendering is good discipline both for the customer and the supplier. The former has to state precisely what he wants, and once the tender is accepted, on the basis of his specification, by and large it cannot be altered. The supplier has to achieve the specified performance for a guaranteed period on the basis of a quoted delivery time and price.

For years after the war the Admiralty suffered from shipyards which were overflowing with profitable civilian work. The introduction of competitive tendering and the recent change in shipbuilding to a buyer's market have meant warships turned out sometimes in half the time (and a quickly built ship is usually a good one) and at much reduced cost. Though liability clauses are not usually part of government policy, the Navy Department has always been able to impose strict discipline on the shipbuilder by the ultimate sanction of exclusion from invitation to tender.

Like all good things there is a snag, indeed several snags, which militate against constant availability of material, against reliability. It is in the field of sub-contracting, for Admiralty supply items and equipment and machinery supply generally, that this otherwise excellent policy is likely to prove difficult.

Firstly, competition inevitably and rightly induces a tendency to design down to a price, and though specified performance is apparently achieved it is much more difficult to specify or obtain a trouble-free 'life' outside a minimum guarantee period. (The supplier will hold, reasonably, that the conditions under which the machinery is to be operated and maintained lie outside his control and cannot be guaranteed in any way binding on him.) So in fact the lowest tenderer may win his order by legitimately 'building-in' the shortest life.

Secondly, the inspection, choice, or rejection of tenders for complex and expensive equipments is a process calling for perceptive technical judgment in the assessment of technical merit against price. This is a particularly difficult problem in the field of mechanical and electrical equipment, for the judgment should finally be reached not only with knowledge of conditions in a warship at sea but also in the light of knowledge right back to conditions on the shop floor. The number of professional minds needed to reach such judgments are just not available to be able confidently and objectively *and quickly* to assess the relative merits of (say) a dozen tenders varying by under 5 per cent in £100,000. The time and effort essential to make on paper the necessarily elaborate technical case to exclude the lowest or several of the lower tenderers has always to be deployed at the expense of other pressing problems. If, and when, it is accomplished it may be that in the next tendering exercise, for the next year's ships, another competitor lowers his price (often though not always inevitably at the expense of operational life which cannot anyway be specified) and so a different brand of (say) turbo-alternator, or air compressor, or liquid oxygen plant enters the Navy.

The nightmare spare gear and logistic problem which all this involves, let alone the operational implications of designing down to a price, must be clear to all. Together they constitute one of the major headaches on the matériel side of the Navy.

The variety of different machines performing the same duty is legion, and is increasing. Standardization and competitive tendering, both in their own way splendid policies, conflict. A better path needs to be found through the maze.

Refit by Replacement and Spare Gear

This may mean different things to different people. In the context of this article it means the cataloguing of all machinery, equipment, assemblies, and sub-assemblies into certain classes and the subsequent action indicated below:

Class I Those bits which are small enough to be carried on board to replace others before service life is exceeded.

Class II Those classes of equipment which are larger and which must be held in depot or repair ships or in analogous shore installations (if any remain). Stocks of Class I and II should also be held by the Spare Parts Distribution Centre.

Class III Stocks of larger equipments which are held by dockyards (as well as stocks of Class I and II) for replacement in ships at specified refit intervals.

Class IV Major equipments or machinery installations held centrally to replace others if random failure occurs or is suspected to be imminent.

These principles of refit by replacement were first forcefully proclaimed just after the last war and a great central 'Inland Repair Yard' was envisaged, into which 'replaced stock' would pour to be serviced, refitted, repaired, or scrapped and replaced from the makers, or otherwise renewed, and reissued to the Spare Parts Distribution Centre, Royal dockyards, depot ships, or H.M. ships as appropriate.

In the financial climate of the time this great concept was, not surprisingly, stillborn. Lip service has been paid to it at times in the last 15 years and much has been accomplished on a piecemeal and *ad hoc* basis by the Royal dockyards and the Spare Parts Distribution Centre, the Admiralty machinery depots, and not least the makers. Indeed, between the four of them bricks are continually made without straw and near miracles have been accomplished. But new and more expensive and more complex equipment and machinery will need to be fitted in the future if real mobility is to be achieved and the cold war battle is to be won. The replacement situation today is not yet satisfactory and so constant matériel availability frequently suffers.

Refit and repair by replacement, if fully implemented, could be a great step forward.

Air Conditioning

There are two distinct facets to this essential requirement. Machinery and equipment, on the one hand, and men on the other, must both be able to work and fight in any climate in the world. Anything less implies a diminished mobility and must be deemed unacceptable.

Air conditioning thus means the creation of a suitable artificial climate within a ship, whatever the ambient conditions outside may be.

This is a major requirement and nothing like the performance demanded of naval air conditioning machinery has ever been considered in civilian life.

Much equipment and especially weapon equipment necessarily generates heat and at the same time is very susceptible to damage if the heat is not removed. The heat has to be removed into the sea and this is often very hot too. Weapon equipment also needs men who are mentally alert and physically relaxed if it is to be operated, maintained and properly serviced.

Bacteriological and chemical warfare is a threat well within the grasp of the poorer nations. The answer to it lies in the ability to 'shut down' the ship's company into a 'gastight' citadel and, by remote control, quickly to remove the ship from the contaminated area. This has implications in the choice of propulsion machinery and points to one which does not need air (such as nuclear power) or which needs separate air supplies. This can in fact also be arranged for steam, Diesel, or gas turbine propulsion, but with varying degrees of difficulty.

Air conditioning, therefore, is not a 'comfort' but very much a military necessity deriving from the needs of mobility. To achieve air conditioning adequately protected against action damage is another major technical problem.

Noise

The elimination of noise, however generated, is one of the preoccupations of all navies. It is a technical problem reaching deeply into all machinery and equipment design. Laboratory solutions are often difficult or impossible to engineer in full scale. There are vast areas of ignorance. Generally, solutions are difficult to implement and, if anything, by their complexity militate against constant matériel availability.

Quality Assurance and Control. Quality Engineering. Value Engineering

All these can make a powerful contribution to constant matériel availability by eradicating the dirt and filth of shipyards which quickly, and quite drastically, shortens the life of vital and valuable (usually rotating) machinery; by ensuring that specifications are rigidly enforced; by critical examination of each component to ensure it does not constitute the weak link which will wreck the whole equipment; and lastly by considering the prime purpose of each bit of machinery and making certain that money has not been uselessly expended on non-essential functions so that it may be available to spend where the military rewards are greatest.

But all this, if it is to be really effective, takes time and effort; often professional effort. Once more, as in so much of the search after constant matériel availability, the question if posed: 'Is it operationally more effective to spend money on good design and save it by reducing maintenance effort and non-operational maintenance time', or the reverse?

Ship Maintenance Authority

In establishing the Ship Maintenance Authority, the last Board of Admiralty created a most powerful instrument in the search for true mobility.

It is a fact-collecting body which collates, records, and analyses the reports from the Fleet and from dockyards concerning each and every equipment in service today. This is gradually enabling two things to happen. First the 'planned maintenance schedules', the daily, weekly, and monthly servicing is being reduced to the minimum consistent with the trouble-free performance of the equipment in question, thus deploying the minimum manpower most effectively. Secondly, those equipments which are apparently basically unreliable, the ones which, however careful the operation, however scrupulous the maintenance, continue to give trouble, are being remorselessly identified. In running ships, design modifications must gradually be implemented to cure these. In future ships, such equipments will be extirpated.

Furthermore, there is accumulating in this way a body of experience which will enable the designer better to understand the factors which govern 'life', and so the task of maintenance. Eventually, the operational commander, the nation's instrument who wields the fleet, will benefit too.

The 'Life' of a Ship

Traditionally, this has been about 15–25 years and is generally a bit more than 20.

One of the reasons for this tradition is that the Treasury has always been easier to 'touch' for money for modernizations than for new construction, and with a more or less fixed dockyard labour force the arguments for this course of action are fairly easy to deploy.

With the introduction of cost effectiveness and the proper application of value engineering, there are new arguments for suggesting that all escorts at least should be built with, curiously enough, a 13½-year average life. This would comprise six years' running with the minimum of dockyard assistance; 18 months to two-years' refit and weapon modernization, and a further six years' hard running, followed by the scrap heap.

What is needed to prove or disprove this theory is a reasonably precise assessment of the running and refit costs during the last ten years of the life of an existing escort. If these accelerate noticeably, then it is a sign that matériel availability is diminishing or the cost in money and manpower of maintaining it at a reasonable level may be uneconomic. All the essential data should soon be available for this evaluation.

QUICK REACTION TIME

The ability, on an alarm, to get under way quickly, almost instantly if need be, is one element of 'reaction time'. Another is the ability to reach the scene of the emergency in the shortest possible time. This is a function not only of the ability quickly to leave the starting post but also of the ability to make good a fast passage time, which means high speed for prolonged periods and the minimum number of stops for refuelling.

So there is a problem, primarily of the right choice of propulsion plant; the choice of the best method of converting the energy in a fuel into propeller revolutions. Discounting for the purposes of this article both fuel cells and MHD, there are four main methods today:

(*a*) To burn up a nuclear fuel and use the heat to change water into steam and drive a turbine;

(*b*) To burn oil and to do the same as (*a*);

(*c*) To burn oil in the cylinders of a Diesel engine and to drive a piston, and thus a crankshaft and propeller;

(*d*) To burn oil in a gas generator and thus to drive a gas turbine.

The two requirements (speed of starting and prolonged passage speed) have been explained above.

For the first requirement there is little to choose between the Diesel and the gas turbine. Probably the gas turbine is slightly the faster to bring to operational readiness, and with an aircraft gas turbine probably more horse-power would be more quickly available.

For the second requirement, of course nuclear nuclear fuel is the only satisfactory way of meeting it. With oil it is possible to go (approximate figures)

5 miles by steam turbine per ton of fuel

9 miles by Diesel engine per ton of fuel

4 miles by gas turbine per ton of fuel

though, of course, these figures vary with classes of ships and passage speeds.

From all this and discounting other considerations, and looking only for a quick reaction time, it is possible to conclude that the following order of merit emerges:

(*a*) A combined 'nuclear'-steam and gas turbine plant

(*b*) A combined Diesel and gas turbine plant

(*c*) A combined 'oil'-steam and gas turbine plant.

At the moment we have several ships with (*c*).

PEOPLE

The Sort of Men we Need

Lord Moran, surely an objective observer, has written of the Navy[2]; 'Where so much is slipshod and even humiliating, here, against a background of the rough sea, is a breed of men doing a man's job about as well as it can be done'. And later . . . 'Every rating is a mechanic, there is purpose in each day; he is intelligent rather than imaginative'. A Roman Catholic archbishop says,[3] 'There is a power of unyielding endurance which is common to them and a capacity for initiative which cannot be checked except by supine leadership. A self-confidence arises from a determination on efficiency. Beneath it all there lies an early self-reliance, a hatred of pomposity and of self-seeking, an intense desire for a much broken family life, and very often a dislike of the sea'.

These then are the sort of people we need and with all the qualities which are essential at sea in the Navy there must also be a sympathy, a feeling, for equipment and machinery. By and large this means more people from the technician class of apprentice.

The inbuilt opportunity which exists today for the naval officer or rating, through carelessness, worry, or physical tiredness, inadvertently to damage or altogether wreck a complex and expensive bit of weapon or propulsion equipment is nothing to the opportunities which inevitably must occur in the next decade. The cold war threats from air, surface, submarine, or mine, and our crying need for mobility, all predicate more and more complex and costly machinery and equipment. With the best 'inter-Service' will in the world, it is impossible to agree that the traditional officer/rating ratio or structure should continue to prevail in the Navy.

Put another way, is the machinery and equipment to be kept sufficiently simple so that it may be equated to the traditional manning pattern, which the Navy hopes to be able to hire and train, or are the men we hire to be equated in quality to the needs of the complex and costly machinery and equipment with which they will have to deal?

Of course, there is no black and white in this matter; but a clear trend exist towards a far higher proportion of highly skilled technicians than that to whicl the Navy has been used. It also suggests the final abandonment (started abou

[2]*The Anatomy of Courage*.

[3]*The Naval Heritage*, David Mathew.

1958) of craft skills and their replacement in the artificer training establishments over the next decade by a more diagnostic type of training.

But there are other and more difficult implications. It is often said today that half the television shops in southern England, B.O.A.C. and B.E.A., and the engineering side of the National Health Service are staffed by navally trained electricians, radio mechanics, engine room artificers, and mechanicians. If the Navy, is to keep these men, let alone increase its holding, then a complete new look at their conditions of service is necessary.

The Commission

One of the few relics of the late Victorian era, when the Royal Navy reached its nadir of efficiency, is the fixed commission. That is to say the induction into a warship, nowadays for a fairly short period (two years plus or minus a few months), of a number of officers and ratings, most of whom have never met each other before and many of whom who have never had to deal operationally with the type of equipment which confronts them.

In the staider days of the early 1930s when 'gun-layers firings over open sights' was still practised with 15-inch guns, the commission was a wonderful thing. It was never attempted in war-time, and today when we are at war it is a complete anachronism.

Much has been done by 'phased recommissioning' to ameliorate the virtual emasculation of the ship (operationally) which tended to occur in the more immediate past; but there is still a long way to go.

Admiral Cunningham once described[4] a certain cruiser as 'a highly efficient weapon with a ship's company with a grand spirit'. There are many such ships today among the Fleet. What a curious arrangement and surely how inefficient it is to break up such well-knit teams and disperse them.

Of course, with virtually all our ships in the front line and the need to try and give shore service or home sea service, there is little choice at the moment, especially with out huge training bill. But a limited study some years ago did suggest an alternative, which has long been partially used in both the submarine and air worlds.

In effect it is to borrow the regimental idea from the Army and to apply it to the Royal Navy.

If this were done, the Navy might be divided into:

The Carrier Fleet

Commando Ship Fleet

Large Escort Fleet

Small Escort Fleet

Submarine Fleet

Support Fleet

Royal Fleet Auxiliary

and within each fleet there would be a number of squadrons (battalions) of officers and ratings (the exact connotation and composition is immaterial at this stage). Each large ship or escort group of a fleet would have two 'squadrons' assigned to it. Always one squadron would be serving at sea, while the other squadron would be at home. The home squadron would:

(*a*) Give leave;

(*b*) Train new entries (fresh from basic naval training) and assimilate them into the squadron;

[4] *A Sailor's Odyessey*, H.M.S. *Naiad* was the ship.

(*c*) Carry out considerable artificial training ashore (with modern training aids and simulators)

prior to taking over at the end of a year *always the same* large ship or escort group from its opposite squadron.

The theory advanced by those who advocate this idea is that thereby:

(*a*) The great technical training schools which proliferate a sectional outlook and buy up vast numbers could be abolished;

(*b*) Squadrons which were not at sea would return always (for instance) to a carrier school (where their own experienced senior ratings would train the new entries from basic or basic technical training) or to an escort group training school where a similar process would go on;

(*c*) Every squadron would have its own quarters or houses near its parent 'school', men would be away only a year and return to the same place and to a settled family;

(*d*) A 'family' spirit would become established in each squadron to the betterment of its morale;

(*e*) Morale would also be improved because faith in matériel is one of the great morale boosters. Today this faith is often lacking and very few people take a really 'proprietary' interest in their equipment until a ship is well worked up; and then a new commission comes along;

(*f*) The load on the senior and experienced men would be reduced. Training by contact is good for senior experienced as well as junior non-experienced men;

(*g*) This routine would encourage a sense of stability now noticeably lacking. A greater sense of dedication would follow and many personnel ills, including the re-engagement problem, would cure themselves;

(*h*) The way would be open for 'type commanders' (as Flag Officer Aircraft Carriers and Flag Officer Submarines) and thereby much work would be removed from Headquarters to the eventual improvement of new designs;

(*j*) An all-round improvement in mobility would result.

Lastly, in addition to the fleets already mentioned there would be a

Basic Training Command

Basic Technical Training Command

Flying Training Command

and again much work could be removed from Headquarters.

The main objection, of course, is the manpower cost during the inevitable 'double stance' while the changeover was made from our present (over-trained) system to the system here proposed. Much emotion would also be created by the idea of abolishing a naval tradition almost as sacred (and as damaging) as rum.

Welfare

It is sometimes alleged when discussing re-engagement problems that the Navy's record of family welfare and benefits is atrocious compared to the other two Services. Certainly the Navy does not enjoy the delights of married life and duty-free cigarettes and drink in Germany. Certainly the housing situation is less good that the other two Services. This, though, is not to say that the Navy has been wrong and the other two Services right. To quote Admiral Cunningham once more, 'It takes 300 years to build a tradition'.

If under the impact of the national neglect of the Navy (which, historically, always seems to occur after every war) the Board, due to lack of resources, had wavered in its determination to maintain the matériel quality of the Fleet (and thus an up-to-date tactical doctrine) and had devoted instead a far greater proportion of its budget to family welfare, the Navy would not face either the present or the future with such confidence.

Mobility may be in danger at the moment due to the diminishing rate of re-engagement; it would be far more at risk if any less of our available resources had been devoted to the improvement in quality of matériel. Nevertheless, it is common ground that some greater degree of family stability would go far towards solving the re-engagement problem and it is difficult to see, except with the 'Regimental' idea, how such stability can ever be achieved.

SUMMARY

No firm conclusions can be derived from this brief summary of a few of the more pressing problems which relate to the achieving of true mobility. Many pressing problems have been omitted and a vast discussion could take place on:

Surface nuclear propulsion

The shortage of professional engineers at Headquarters

The role of the Royal dockyards

The rationalization of the 'Warship Group' of shipbuilders

The future shape of the underweight replenishment group

Naval fuel

and other matters of equal importance.

Nevertheless certain guide lines to true mobility, not all of which have been discussed, can dimly be discerned.

1. Large warships in future must certainly be nuclear propelled, but until reactors and containment are reduced in size and weight surface ships under 5,000 tons will probably have to rely on conventional fuels supplied from nuclear replenishment groups at least for the next decade.
2. Aircraft gas turbines seem likely to replace steam as the main propulsion units of escorts. Diesels may be associated with these for long passages. An alternative and cheaper but slower arrangement could be Diesel propulsion with aircraft gas turbine boost.
3. The variety of gas turbines and Diesels in naval use must be restricted. In every case they must derive from well proved commercial lines. The Navy can no longer afford to go it alone and develop single sets of anything except in the nuclear field.
4. There must be some relaxation in the rigidity of competitive tendering. Ships' services and weapon services, like main machinery, must be adapted from well proved commercial practice. Standard ranges need to be established, and once established must be adhered to for (say) five-year spans. It seems possible that the supplier could be contractually bound to keep dockyards and the spares organization up to a certain level of serviceable spares for this period.
5. Refit and repair by replacement must become fundamental tenets of matériel policy, This implies not only that replacements must be readily available worldwide, but also that ships must be constructed so that large components can easily be replaced.

6. A vast deployment of effort is needed to ensure that the full implications of air conditioning are understood and that the correct lines of attack are being established.
7. The cost effectiveness of a shorter life escort needs precise evaluation in the light of a realistic costing of the present life cycle of escorts.
8. Somehow, if mobility is to improve, men and machinery have got to be better matched. There is no sign of any diminution in the rate of technical progress and this requirement may mean:
   (*a*) A recasting of the whole officer/rating ratio as we now conceive it and the establishment of some technician grade with quasi-officer status;
   (*b*) The abolishing of the commission system and its replacement by some sort of 'regimental' or 'squadron' organization.

It was said recently when discussing our matériel failures at the Battle of Jutland that 'there existed no organization for systematic research into questions of operational technology'.[5] The Fleet, whether it is far above, just above, on, or under the sea, presents today one of the most complex systems engineering problems any organization has had to face. Aircraft, hovercraft, surface ships, and submarines properly to fulfil their role require a tightly knit complex of advanced weapon systems which can be separated or brought together at will. Our strategic situation demands that all these weapon platforms shall have superlative mobility.

Any search for a solution requires the establishment of some form of overall control which can fully comprehend the operational, industrial, scientific, engineering, and civilian and naval personnel, features of each problem, each in its baffling complexity, each in its baffling relationship to the other problems.

This calls for systematic research into operational technology in all its aspects. Finally, such a control must be able to sum up and suggest a small variety of viable options understandable by human minds.

This article is concerned only with mobility, and while we are setting up such a control we need at once to initiate a serious study into all the many ways in which mobility can be improved.

The task 160 years ago may have been simpler, but the means of accomplishing it (by today's standards) were childish; yet somehow they got much better mobility[6] when 'Nelson's far distant, stormbeaten ships, upon which the Grand Army never looked, stood between it and the dominion of the world'.[7]

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[5] *The Sword-bearers*, by Correlli Barnett.

[6] 'In close naval blockade . . . at least a fifth of the force should be refitting.' *Some Principles of Maritime Strategy*, by Sir Julian Corbett. 'The higher authorities considered that one fourth of the squadron should always be in port.' Captain Phillip Patton to Sir Charles Middleton, June 2, 1794. *Barham Papers* ii, 393. (N.R.S.)

[7] *The Influence of Sea Power*, by A. T. Mahan.

LETTER TO AN OFFICER ON FIRST APPOINTMENT AS MARINE ENGINEER OFFICER OF A SMALL SHIP

Dear 'Chief',

When we were talking the other day about the problems of engineer officers going to the their first small ship I was not quite switched on to the fact that you might be seriously seeking information. I think that I can remember sufficiently well my experiences when I went to sea in a small ship and I hope that this letter will be of some assistance to you.

On the technical side I think that the first and most important thing to do is to use your brains. You will find that all sorts of things are done which appear, when looked at critically, to be either superfluous or else done entirely wrong. There is nothing to prevent you having a really hard critical look at what is going on in your ship and altering it to accord to what you think to be right. With respect to many loyal and experienced officers, they are so busy doing their work that they have very little time at all to think about what they are doing and this is one of the functions of the officer when he does go to sea, after a spell ashore.

Next most important, in my opinion, is that the Engineer Officer should quickly establish the means and methods of procedure by which he intends to have his machinery operated. Often a whole lot of dubious practice is allowed to grow up, particularly in a ship which has been in commission for some time. This is mostly due to ignorance of the correct procedure, but some of it may be because it is easier and quicker for a lazy man to do a job in one way rather than in the correct way. You will find instruction books, with which small ships seem to be liberally supplied these days, to be a great help in operating the machinery correctly. There is a further reason for recommending these books and that is, should there be some slip up in the drill and you find yourself with an inquiry on your hands, it is a very good defence to be able to prove that you were operating in accordance with the written instructions and that any defect must be caused by them being wrong.

It has never ceased to amaze me the very large number of people who apparently are completely incapable of reading a set of printed instructions and then putting them into operation and this is a point that I think you will have to watch very carefully yourself. You may meet with a certain amount of resistance in putting this recommendation into operation and certainly the Chief E.R.A. will need gentle handling.

Third I would put familiarity with B.R.3000. When I was an officer under instruction, the Marine Engineering Instructor used to din into us that the *Engineering Manual* is first and foremost a collection of other people's experience, including their mistakes and disasters. Although I was not particularly convinced by this argument at the time, I have since learnt that it was absoutely right. To begin with the *Manual* is a document that carries the force of law, to disregard which can result in a court martial; I am thinking particularly of those sections of it which are concerned with safety and the various tests and examinations that are required to be carried out at specified intervals. Mostly these provisions are as a result of previous accidents, some of them fatal, and it is of vital importance that they should all be rigorously enforced, come what may, and at the considerable inconvenience to yourself and all of your staff. Please don't think that I am exaggerating in this; when I was at sea in a destroyer there were a number of fatal accidents in the Fleet, mostly caused by disregard of some particular safety regulation and it proved fatal to the prospects of the Engineer Officer as well as to the rating who disregarded the provisions. The only way in which you can cover yourself in this situation is to show that you are fully conversant with the safety regulations, that you promulgated them specifically and that the man concerned wilfully and without regard to the consequences disobeyed them. Apart from this, B.R.3000 contains a great deal of very sound advice. I can assure you that every article and amendment to the *Manual* is scrutinized extremely carefully within the M.O.D., at least up to Assistant Director level and that nothing gets into it without being given a great deal of thought; therefore profit by our experience.

You will find, as everyone does these days, a whole mountain of paper work to do in which you will be assisted by a writer who may or may not be of help, depending on his training and experience. My own opinion and experience is that it is only too easy to become mesmerized by the paper work and that the only solution is to dash it off as quickly as you possibly can. Those who spend hours and hours trying to refine their paper work usually produce no better answer than he who dashes it off rapidly. In this connection, please remember that a report which is short, pithy and to the point is infinitely preferable to one that contains pages and pages of waffle. On the other hand, you should not be so concise as to miss out matters of importance, and you must always make sure that your report is honest. If you have done something wrong, admit it and do not try to cover up by evasion and half-truths; almost invariably, the evasive report is obvious and the truth can always be ferreted out in the end, if your superiors are sufficiently determined to do so. Much that occurs in naval engineering is difficult enough to analyse without having to contend with inaccurate reporting as well. Quite apart from anything else, a dishonest report will always visit upon your head a much increased ration of wrath compared to what would have happened had you come clean in the first place.

As far as the ship as a whole is concerned there is only one hard and fast rule and that is that the Engineer Officer and the First Lieutenant must be friends. You may in your innermost private thoughts think him to be an ignorant boor and he may think you an affected ass or, of course, vice versa, but neither of you must let these thoughts come anywhere near the surface. It is much better if you can avoid even thinking them but, if you must think them, never utter them in public and never afloat and never anywhere where any part of them can get back to the ship. It is, in fact, surprisingly easy to be friends with someone with whom your future is bound up, given sufficient determination on both sides that friends you shall be; many a long-life friendship stems from just these circumstances. Conversely, if you and the First Lieutenant squabble the ship just falls apart. This is a thing which has happened to my friends and contemporaries and it has one invariable result, which is that it benefits neither the First Lieutenant nor the Engineer Officer; both are passed over and that is that. Of course most captains will see the way things are going almost before you do yourself and will probably warn you, but captains do get a bit tied up with their own problems occasionally and this can result in things slipping rather too far. So long as you and the First Lieutenant put a united front on things the ship will tick.

In your official relations with the First Lieutenant and the Captain, you must always remember that it is their only chance of gaining fame and promotion and that they have a very limited time in which to do it. You will have at least another shot provided that you make the grade in this job. Therefore I suggest that when it comes to a conflict between what you regard to be your interest and what you think that they regard to be theirs, you should give them the benefit of the doubt. This is not an open invitation to run your ship to death without protest, but one to be flexible where your vital interests are not involved and to keep your sense of proportion where they are. This will, in fact, benefit you in the long run as well.

As far as your relations with your Captain are concerned, whether he will listen to what you have to say or not will depend very largely on what his previous experience has been. The best suggestion that I can make to you is that you should try to reason with him and show him that you know what you are talking about and are not making extravagant demands, when, normally, he will be pretty sympathetic with your difficulties. There is a certain amount of suspicion that captains want to run their ships to death in the aid of their own careers and that they do not care what happens to the man coming after them. This may have been true at some time in the past, although, personally, I rather doubt it, but it is certainly not true today because the mechanical and physical state of his ship is one of the main factors on which a captain's efficiency is judged. He has his problems, lots of them, in connection both with operating the ship and with discipline, so anything you can do to lighten his burden he will be very glad to accept and once he trusts you, I have no doubt that he will accept everything you say without demur. I think that if you are running into a difficult situation, it is well to put your cards on the table straight away with the Captain, who can then judge whether he needs to ventilate it further. It irritates everybody on the operational side immensely if things go wrong, or are reported to have gone wrong, without any warning at all. They much prefer to be warned ahead of time that things are getting tricky so that they can plan an alternative action. In addition, if the Captain finds that you keep him in touch with what is going on, rather than regarding the engine-room hatch as a bastion beyond which he should be allowed to penetrate only at his peril, you will get much more out of him than if you take the opposite course. Mostly they are not interested in detailed technicalities but they do like to know the effect that everything is going to have on the operation of the ship.

Personally I think that the Engineer Officer's position when things are a bit tricky is on the bridge, where he is in a position to advise the Captain directly if anything goes wrong, or if there is some situation which needs his technical advice off the cuff. You will, however, have to square this with the Captain and with the *Engineering Manual*, but a decent captain will have thought that one out and will normally invite you to be on the bridge, when you think that this is a good place to be, and will support you if someone starts asking questions about why you weren't down below in the machinery spaces.

I am not up to date with the composition of small ships' wardrooms these days, but often the Engineer Officer is the second senior and second oldest officer in the ship after the Captain and that therefore what he does and says in the wardroom is extremely important. You will, of course, have to take second place to the First Lieutenant, who is by law the President of the Mess, but the way that you behave in the wardroom will have an enormous effect on the behaviour of the others. It is, of course, possible that you will find that all the other officers are also lieutenant-commanders but this, although it does happen, is relatively rare and most of the young officers will be pretty junior and fairly inexperienced lieutenants.

I am the first to admit that what I have written to you is out of date in that it is what I found to be the situation thirteen years ago when I went to sea in a small ship. On the other hand, what I found was very much what my elders and betters, who were in detroyers before the war, had told me I would find and so I expect that you will not find the basic rules fundamentally changed. I think that once you are used to it you will find being Chief of a small ship great fun. Certainly it is much less wearing on the nerves than being Flight Deck Engineer Officer of an aircraft carrier if only for the reason that your mistakes do not result in the instant death of air crew plus the loss of aircraft worth about £1m each. The worst that can happen is that you will come to a grinding halt in the middle of the ocean and lose a lot of face.

In conclusion, all I can do is to repeat the very wise words once uttered by Rear-Admiral Desmond Hoare: 'You may be a very good engineer but you will never be a successful engineer unless you are also lucky'. So there it is and the best of luck.

ex-'Chief'.

'BUT IT SHOULD GET US BACK TO GUZZ'

'I think the best way I can give you a turn-over,' shouted Lieutenant Spatchcock, the Engineer Officer of the Watch, 'is to tell you everything that's happened in the last four hours or so. That should put you in the picture.

'Right! Last time you were on watch we were probably on three shafts, with Y's main feed pump feeding X's boilers, and A's boilers shut down. Well, we soon changed all that!

'Shortly after I took over the watch a joint or something blew on Y's feed heater. Or maybe it was a drain line. Anyway, they wanted to work on it, so we flashed up A's boilers and shut down Y's.

'That means that A and X boilers were driving Y shaft, and B's boilers were driving A and B shafts. I think. Or were X and B boilers driving A and Y shafts, with B's boilers driving B shaft? Something like that. They're working on this thing in Y boiler room now; it's a bit of a bodge-up, but it should get us back to Guzz.

'Then some humourist shut the cannon valve in Y boiler room, so we had to shut down X's boilers and stop Y shaft. Luckily we didn't have to stop X shaft because it was stopped already. However, we de-isolated pretty swiftly and got Y shaft going on steam from A and B boilers. It was a nasty moment, but I think the Bridge hardly noticed! Of course, we lost a TG, so all the lights went out aft, and all the vent fans stopped—sorry if you found it a bit dark and stuffy in your cabin . . . having to shut down T air conditioner can't have helped. Yes, they're flashing it now, and I've told salt water Tanky to get all the hull and fire pumps on again.

'Feed is hell of a mess. There's a milky cloud in A's reserve that's hardly fit to drink, so we're feeding it into A's boilers, which are supposed to be U/S anyway. Using them just like big evaps. Hm! We haven't told the Bridge A's boilers are flashed, because we said we would only use them in an emergency and, well, it's hardly an emergency, is it? Yet!

'You probably saw them shifting a turbine rotor in the passage on your way down. Yes, it's B's extraction pump. You see, X's extraction pump rotor sheared—of course, you know about that—well, they've taken the good rotor from the one in B engine room and they're going to put it in X. Yes, it's pretty certain to fit! Meanwhile, they're bodging up X's rotor to put back in B; that's the one we had flown out to Karachi. No, they don't build rotors like they used to. Mind you, it will be as good as new when they've finished in the workshop. Anyway, it should get us back to Guzz. Provided we don't use it, that is. No, we're going to use the motor driven extraction pumps. We are using the one in B now. Well, yes, we were using X's but the turbo extraction pump suction valve leaked, so we had to stop and declutch X engine and . . . I say, that's odd . . . well, according to those gauges, we are steaming on A, B and X boilers. Oh! Is that what I said? Which shafts did I say? Y, B and A.? Right! Y, A and B it is. Well, I think that's about all. Any problems? It's more or less the same old routine . . . .

'Oh—by the way—Senior says he's to be shaken if anything unusual happens.'