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OPERATIONAL RESEARCH FOR NATO'S NAVIES

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1. INTRODUCTION

The theme of the conference which has just been opened is "Maritime Operational Research in NATO: Requirements, Resources, and Results".

To a large extent, the thirty-odd speakers who will follow me, and the organizations from which they have come, represent our Resources. They are primarily national organizations, but several do owe their allegiance to the Alliance as a whole. One can identify the staff of Allied Command Atlantic, our hosts here today, the SACLANT ASW Research Centre in La Spezia, the SHAPE Technical Centre at The Hague, and some NATO bodies such as the Defence Research Group, which has sponsored studies in maritime as well as other fields, the NATO Naval Armaments Group, and the Special Panel on Systems Science.

It is a characteristic of the North Atlantic Alliance that its strength lies in its member nations. But many of the most serious problems of the Alliance are difficult to perceive, or at least to worry about sufficiently to really study, in a national capital. And as the military contributions of the nations to the Alliance become fewer, with more and more preoccupation with national problems and with economies, the tasks of NATO, SACLANT, SACEUR, and CINCCHAN become correspondingly

more difficult. If there is any military activity which must be coordinated to succeed, surely it is that of a dozen separate navies based in two Hemispheres. And if the smaller navies look to their major NATO commander for guidance as to future threats, future operations, and future equipment, he is going to need all the resources that he can muster to be able to undertake this task. One resource is operational research, and it may well be that NATO would benefit by a modest transfer of OR resources from the national to the central NATO agencies. However, until this occurs, we must face the fact that most of the resources are to be found in the national capitals, commands and establishments.

The next thirty papers will give us some interesting results, as did the thirty-five papers delivered at the first symposium two years ago on capability assessment as a basis for maritime force planning. And there is machinery for exchange of maritime O.R. results within NATO, including the recently formed Central Registry of Operational Research Reports and Studies. National security policy creates some barriers, but personal contacts allow good liaison to be maintained. The larger nations give more than they receive, but that is the nature of the alliance.

Because the third topic, Requirements, does not appear to be stressed in the papers, it will be the main subject of my remarks.

2. OBTAINING AN ACLANT OVERVIEW

The welding of an association of fifteen independent nations with very different characters, histories, and interests into a strong cohesive alliance may well pose the most difficult problem faced by political and military men in our time. The difficulties are especially prominent in matters of economics, such as rationalization of research, development, procurement, and production, and they are evident in questions of standarization and supply. On land and in the air, a remarkable diversity is eivdent in the balance and type of forces provided to SACEUR by the member nations. This is in sharp contrast to the Warsaw Pact, whose land and air forces appear to have been all ordered from the same catalogue. This fact must east the task of the WPO planners, unless it happens to be a poor catalogue.

What about the maritime forces of NATO? Geography dictates that some nations are much more dependent than others on the sea, so that diversity is to be expected. History has shown some nations such as the Netherlands, Portugal, and Norway prominent on the maritime stage to a degree far beyond their modest size. Perhaps it should not be surprising if SACLANT is offered national forces of great variety in composition, or if only three fleets of the fifteen nations make any attempt at an internal overall balance. This may not even be a handicap to NATO, and it may confuse the WPO. But it does pose SACLANT the problem of making up his team from fleets of very different capabilities and specialities. At least it is not too difficult

to assemble fleets from widely separated home ports. One hopes that enlightened self-interest has motivated the nations to select their fleets to perform well in the roles they will need to fill in waters close to their home bases. However, for effective performance of most of the major maritime tasks it has been demonstrated that several types of vehicles, sensors, and weapon systems need to cooperate in a carefully integrated manner. And for many tasks the presence of very expensive units, such as carriers, cruisers, or nuclear-powered submarines, may be necessary, but possible only if one of the few large nations possessing them is able to provide.

3. ROLES FOR NATO NAVAL O.R.

This situation has significance for operational research in ACLANT and the NATO navies. The OR in each nation will have the responsibility to keep abreast of developments in its own force, and to maximize the effectiveness of its own units. But where carriers, for example, are concerned, the OR studies in countries like Belgium, Germany, or Italy must rely on information from allies, and those in Canada and the Netherlands have only fading memories of national involvement. The conclusion could be that ACLANT has a need for a strong central O.R. facility, where these varied types of knowledge can be assembled, or, failing that, very close exchange of information and perhaps of personnel. Moreover, those large NATO maritime exercises, which offer the precious opportunity for the varied national

contributions to work and learn together, should be the subject of well planned and thorough operational research, both in their initial design and subsequent analysis.

Another vital role for operational research in ACLANT is in studies of fleet composition, both for planning of future construction, and for the assembly of task forces from existing ships. Both activities are, of course, fraught with political considerations far beyond the realm of science or even of the naval profession, and involve national objectives which may not be identical with the collective objectives of NATO. Nevertheless, it is highly desirable to have as a goal, probably an unattainable goal, an ideal fleet composition. Such studies need to be carried out with imagination, giving very full consideration to the objectives which NATO is trying to attain, and to the reactions of the enemy, who may at a future date oppose us with an unorthodox combination of tactics and vehicles. These studies must be cast some years into the future, when, for example, the USSR may possess a significant force of aircraft carriers, amphibious forces, and friendly air bases far from the Soviet Union, while NATO may have lost bases and overflight rights which she takes for granted today. Unfashionable scenarios may deserve consideration, perhaps including limited war at sea alone, economic blockade not accompanied by active hostilities on land, and a NATO unable to import oil.

An important class of study of future force composition is one which avoids the detailed analysis of existing units or

types, but seeks to establish the relative advantage for particular roles of broad classes of weapon systems. An excellent example of this is the analysis of the shallow water ASW problems sponsored by Panel VII of the NATO Defence Research Group, where a contrast is made between the success of many small and cheap units as opposed to few large and expensive ones of superior individual capability. We are to have a report of this project during this symposium. There are advantages in tackling such a problem in a NATO forum initially, where it may be difficult for vested interests to strangle unwelcome approaches at birth. But at a later stage it is highly desirable to have national agencies take hold of the many loose ends left hanging, in order to provide more rigorous substantiation of the findings.

Another type of study of future force composition which I would commend to your attention is one in which unconventional methods of conducting ASW operations are involved. Acoustic detection is still a poor best, and traditional methods of exploiting acoustic systems may have reached the region of diminishing returns. Perhaps we should turn our attention more towards the study of unconventional vehicles which may have a better chance of realizing the full potential of the advances which have been made in acoustic detection. For example, can the dramatic increase in detection range of RAP sonar be realized in operations if it is deployed from a vehicle other than a destroyer? What is the best way to get the most out of mobile passive arrays? Studies in which O.R. can contribute are now being done in these

areas and there is at least one paper in this symposium which falls into this category.

Related to studies of force composition are those of strategy and tactics of employment. These have been subject to repeated analysis at the detailed level of antisubmarine screens, datum searches, and convoy patterns. But there are large questions such as the relative advantages of concentrating antisubmarine defence around the ships to be protected, deploying it throughout an area, perhaps in lanes, or concentrating it along barriers. We may find our AS aircraft being engaged by missiles from submarines or surface vessels. Is the effectiveness of an SSK enhanced or degraded by causing it to work with other SSKs, with aircraft, or with ships? Is an SSN an asset in an antisubmarine escort role? What is the best way to protect a very large and valuable fast supertanker or container ship at sea, and do we need to devote comparable attention to its defence while moored and transferring cargo? For the protection of commerce, are we devoting adequate attention to air and surface as well as submarine threats? Problems such as these have received sporadic attention, often at the national level, but they probably deserve considerably more, and on an international basis.

The topics discussed in this section are likely to involve the interest and responsibility of high-ranking officers of ACLANT. After all, it is they who are charged with maintaining an overview of NATO's naval situation and problems. It follows that they should be the sponsors of this type of OR study and

should maintain close contact with the progress of the work. And they should be prepared to embark on investigations that could initiate profound changes in the composition of future maritime forces, not excluding important changes in the proportions of carriers, cruisers, destroyers, patrol craft, submarines, hovercraft, and hydrofoils, or of fixed-wing and VSTOL aircraft and helicopters whether land or sea-based.

4. APPLICATION OF OPERATIONAL RESEARCH TO MARITIME EXERCISES

In spite of its many ingenious extensions, such as simulation by computer, analysis of cost-effectiveness, or mathematical modelling, the basic roots of operational research, which gave it its name, lie in the study of actual operations. The operations most likely to yield information of high value for the improvement of the combat effectiveness of NATO's maritime forces would be operations of war against a well-equipped enemy. However, NATO has never gone to war. During the life of the Atlantic Alliance, several of her member nations have engaged in combat, and have gained practical experience in certain operations such as carrier-based air attack of land targets, sea support for land forces, neutralization of light coastal forces, or riverine operations, but the maritime operations have never attained the scale of combat against powerful opposing maritime forces that would characterize a full or even medium-scale war between NATO and the Warsaw Pact.

Thus, for a period of twenty-five years both NATO and its member nations have had to plan operations against

Warsaw Pact submarines, surface, and land-based air forces without the experience of actual combat against any of these forces. We have had to make do with three substitutes:

(a) operations of surveillance and tracking against real "enemy" units;

(b) deduction from intelligence and observation of their wartime strategy, tactics, and effectiveness; and

(c) conduct of NATO exercises in which an Orange force was supplied by our own units.

All three of these surrogates for operations of war are of some value, and a major task for operational research is to extract the maximum amount of useful information from them. However, we should never lose sight of their extreme limitations in forecasting the expected outcome of combat operations against the real enemy. There are likely to be many special tricks which a prudent enemy will not reveal in peacetime. Examples would be the use of more advanced forms of electronic warfare, or the extraction of the maximum performance in speed, altitude, or depth from ships, aircraft, or submarines. And it is quite probable that surprises are in store for us regarding the capabilities of enemy weapons and their modes of employment.

A special caution may be in order on the subject of impressions gained from NATO maritime exercises. Because the prime objective for most exercises is training, we tend to put

most of our best units in the Blue force, to simulate Orange by a meagre allotment of real strength perhaps fleshed out by imaginary units or magic powers of resurrection after destruction, and to design the exercise to ensure contact and practice for as many Blue units as possible. Moreover, for antisubmarine exercises we are usually short of submarines, use too few, and oblige them to operate in zones which limit their freedom of action. The operators of the detection systems are artificially alerted to the likely presence of submarines. Simulated attack by stand-off missiles will give no training to the crews of the simulated targets. To quote Captain R.H. Smith, USN:[1]

> "The effect has been to promote a narrow, distorted, and small-scale view of ASW. It has contributed to lulling us into an exaggerated sense of well-being concerning our detection capabilities, particularly on the part of the surface forces, which has played us poisonously false."

And, of course, the use of weapons and even some sensors cannot be realistically simulated in a peacetime exercise, and numerous safety precautions must be observed to minimize the danger of an accident. Moreover, the prosecution and attack of false sonar contacts, and expenditure of imaginary ammunition escapes the penalties that would be exacted in wartime.

The decreasing number of ships in the NATO navies and the increasing restrictions on fuel are likely to make these

limitations even more pressing in the coming years. A responsibility for operational research will be to contribute to the design and analysis of exercises so as to make the very best out of what we have and can do, but it must also be alert to the dangers of drawing unjustifiable conclusions from exercises that fall very far short of real combat against the full maritime strength of the Warsaw Pact.

Another disappointing feature of NATO naval exercises which does not seem to improve with the years is the perennial rediscovery with each exercise that serious difficulties arise from the misuse or neglect of the proper operational procedures, and from misuse or inadequacy of communications. Rediscovery of the problems does not seem to lead to their solution, and these problems sometimes prevent the carrying out of those tactical aspects of th exercise which constituted its main objective.

The long intervals between large NATO exercises and their varied type and scale make it difficult to maintain a continuous overview of progress - or deterioration. This difficulty is exacerbated by the turnover in personnel, which so often faces every exercise with the need to assemble a new team to conduct the analysis. One of the elementary requirements for good statistical analysis is to have homogeneous data, collated in a consistent and uniform manner throughout the entire period of the experiment. For a time-series to be valid, it is vital that the rules of data collection should not be altered.

In this connection I often remember the work of Mr. J.R. Vesey, who directed the Operational Research Section of RAF Coastal Command, for a period of twenty years. His determined support for land-based air earned him a certain opposition from the Royal Navy, and his holding of the same post for two decades may not have impressed ambitious upward-mobile officers and scientists, but Jack Vesey accumulated in one filing cabinet and without benefit of computers at Northwood the only consistent continuous analysis of airborne antisubmarine operations uniformly collected over a long period of time. It was a tragedy when his cabinet was destroyed in a fire, and the records lost.

A type of exercise analysis often overlooked is that of the WPO maritime forces. Whether our information is gathered from the overt presence of ships or aircraft, or by the non-intrusive means of submarines or earth satellites, it should be examined by the same personnel who analyse NATO exercises, and the conclusions fed to the operators.

In concluding these remarks about O.R. and maritime exercises I would like to commend the efforts of the Maritime Exercise Analysis Steering Group. There is reason to hope that steps recommended by this group, including the formation of a Permanent Analysis Team, may go a long way towards a remedy for the current deficiencies of exercise analysis in NATO.

5. OTHER TYPES OF MARITIME OPERATIONAL RESEARCH NEEDED BY NATO

We must be careful not to define naval operational research in terms so broad as to encompass all of naval science.

There are many important areas of strategic and intelligence studies, of the design of ships, aircraft, weapons, and instruments, of medical, psychological, and many other types of research applied to maritime matters that do not require the results of operational research. But O.R. can make a very useful contribution to intelligence, to the design of weapon systems, and to the choice amongst alternative systems. It has a prime role to play in the development of tactics and in the management of resources.

Although the collection and analysis of statistical data should never become the only activity of an O.R. section, an operating command is likely to encounter many problems for which this will be an important duty, and the O.R. section will often possess both the personnel and equipment capable of carrying it out. As a general guide, it is suggested that it is good practice to task the O.R. section with the examination of statistical data on a trial basis, or for a limited period. But if it becomes clear that a new series of data deserves to be collected and analyzed on a regular basis, the responsibility should be turned over to another part of the Command staff, with the O.R. section acting as a consultant if required. Examples could be collection of operational information concerning behaviour of WPO units, or records of performance of sonar or radar. They could also include statistics on miscellaneous items such as false sonar contacts, radar returns from icebergs, or reliability of wireless reception, together with analysis leading to convenient methods of predicting future performance.

There can be little doubt that electronic warfare is assuming much greater significance. Unfortunately, this is a difficult subject on which to do operational research in peacetime, unless NATO and the WPO choose to expose their measures and countermeasures. However, it is very important to obtain sufficient information to be able to construct mathematical models of EW, including its effects on existing sensor and weapon systems, so that we can make some sort of prediction of the results of the measures and countermeasures should battle ever be joined. It is also important to provide ourselves with a rapidly acting combat intelligence system to pass information on EW, both laterally for the immediate benefit of friendly units, and backwards for analysis by a central organization equipped to devise counter tactics and measures.

A related subject, overdue for attention, and to which operational research could be applied at any time, is acoustic warfare. This would include the planned and coordinated control of transmissions so as to confuse submarines about the location of ships in a group. And it would take note of another thought of Captain Smith:[2]

> "In our surface forces, long legatee of lack of imagination, we continue to proceed as if the surface ships could make no better contribution to ASW than by carrying a low-frequency high-powered sonar whose modest detection ranges are limited

by the same iron laws of refraction which bound the sonars of a generation ago; ranges that are miniscule compared to the distances which its sonar energy reaches out to alert the enemy submarines of both the presence and accurate location of him who transmits it."

If the submarine is prevented from completing his attack using passive sonar information only, he may offer additional opportunities for detection through his employment of active sonar, radar, wireless, or periscope.

Research is badly needed in torpedo countermeasures, and in countermeasures to anti-ship missiles. But in the absence of real use, this may have to be done in laboratories, and on carefully instrumented ranges.

"A recent study made by a group of officers at the US Naval War College, Newport, R.I., on possible future development in the US Navy, made the following interesting forecast. 'In weapons development there will be significant advances in laser weapons, liquid-propellant gun systems, gun projectiles with terminal guidance, micro-miniaturized avionics, high-strength and heat-resistant missiles, weather control, and remotely piloted vehicles.' The group expressed the view that the greatest potential lies in revolutionizing warfare by by the use of laser beams which will open up

vast possibilities for naval anti-aircraft, anti-missile and air-to-air weapons. In general they foresaw the development of smaller, faster, and highly automated warships austerely manned but having large fire-power."[3]

The development of technical advances such as these is not the business of operational research. But a vital area to which OR should be far more energetically applied is analysis of the cost, effectiveness, and optimum combination of sensors and weapons, both for offence and defence. It has been usual to concentrate on specific areas, such as guns, missiles, radars, sonars, jammers, and decoys. But the ship designers need to know the proper mix, taking into account underwater defence, acoustic countermeasures, anti-missile defence, electronic warfare, and other requirements as well as the primary systems for ASW and air defence.

Naval operational research is already well established in the area of logistics, including maintenance, repair and supply. There is probably no other area in which research can be more easily shown to be cost-effective. It should be pressed further back into the decisions regarding design of equipment and policy regarding the stocking of replacement parts, and it should be worked into all the calculations of life-cycle costing. The lack of recent experience with expenditure of ammunition and other warlike stores should not allow us to forget to make realistic provision for this crucial item.

The analysis of manpower supply is a subject worthy of operational research. Recruiting, training, posting, promotion, and retirement can be studied by mathematical models. This can permit the prediction of the implications in future of years of changes in personnel policy. An important requirement is to assign the mechanical tasks such as data storage and retrieval to the computer, but to reserve the personal consideration of individuals for human control.

Many of the mathematical techniques of operational research were developed in wartime naval applications.[4] It is desirable that these tools be kept sharp by use on practical problems such as the theory of search (at the base of the geometrical calculations for A.S. tactics), queueing theory (which is very useful for analysis of problems such as congestion of message traffic or of time delays in repair and maintenance) or the theory of games (which can be applied to the tactics of mine warfare).

However, the vital contribution of operational research will not be the mathematical virtuosity of its practitioners, but its ability to bring objective, dispassionate, thorough numerical analysis to those problems that really matter for the future of the North Atlantic Treaty's maritime forces, and consequently for the future of the Atlantic Alliance and the Western World.

6. REFERENCES

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(2) ibid p. 133

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