THE ROYAL NAVAL ENGINEER OFFICERS' CONFERENCE

STANDARDS OF ENGINEERING—THEIR FITNESS FOR WAR AT SEA

The Engineer Officers' Conference was held at the Royal Naval Engineering College, Manadon, on 27th April 1979. The theme of the Conference was 'Standards of Engineering'.

After a welcome to the College by CAPTAIN P. G. HAMMERSLEY, O.B.E., the Chief Naval Engineer Officer, REAR-ADMIRAL L. S. BRYSON, gave an opening address. This was followed by a presentation on standards of engineering in the Fleet introduced by REAR-ADMIRAL D. O'HARA, CSO(E) to Commander-in-Chief Fleet, and supported by CAPTAIN J. JACOBSEN, CSO(E) to FOSM, CAPTAIN A. W. WHEELER, CSO(AE) to FOF3, CAPTAIN J. M. L. HUGHES, FWEO, and CAPTAIN E. MACLEAN, FMEO. Flag Officer Sea Training, REAR-ADMIRAL A. J. WHETSTONE, supported by his CSO(E), CAPTAIN J. P. EDWARDS, M.V.O., then spoke of standards achieved during sea training, and the presentation was concluded by REAR-ADMIRAL O'HARA.

Subsequently, six separate seminar groups were convened each under the chairmanship of a captain at which the following subjects were discussed:

Seminar A—CAPTAIN E. MACLEAN—Do we procure the right equipment for the Fleet?

Seminar B—CAPTAIN A. SHORT—Are our upkeep philosophies about right?

Seminar C—CAPTAIN J. M. L. HUGHES—How can we ensure high weapon effectiveness?

Seminar D—CAPTAIN M. F. SIMPSON—What challenges lie behind the changing face of the Fleet Air Arm?

Seminar E—CAPTAIN P. G. HAMMERSLEY—Is our officer manpower well founded for the future?

Seminar F—CAPTAIN J. S. GROVE—Is our rating manpower well founded for the future?

During the afternoon session, the Conference was re-convened for each chairman to report on the deliberations of his seminar and for open discussion on each subject.

The conference was concluded with remarks by the Chief Naval Engineer Officer.

The addresses, presentation, and seminar reports and discussions are reproduced below.

OPENING REMARKS BY THE CHIEF NAVAL ENGINEER OFFICER

REAR-ADMIRAL L. S. BRYSON

I imagine there are few people here this morning who will doubt the relevance of the theme for our Conference today. The Royal Navy's business is to wage war at sea and to be prepared and ready at all times to fulfil this mission: its ability to do so is directly dependent on its standards of engineering, and their fitness for the task is fundamental. We have also of course to use our equipment as effectively as possible—it is no good having equipment designed and maintained to a high standard if it is not used with knowledge and intelligence. High standards of engineering and skilled operation must complement and support

each other. For the marine engineer operation is an integral part of his task—not so for the WE or the AE, and we must bear this in mind.

What, you may ask, do we mean by Standards of Engineering? The Institution of Electrical Engineers' Merriman Report published last year talks of professionalism as 'an almost indefinable but readily recognizable set of personal attributes which characterize an engineer's ability to master the changing environment of his work'. Something rather similar might be said of standards of engineering. They are not all fully and readily definable, though many are; yet generally we cannot fail to recognize them and their importance as a whole to the achievement of that fitness to do our task. They are a very extensive framework embracing material, personnel, organizational and other considerations; design, production, some operation, maintenance, training, practice, competence, discipline, and so on: there are innumerable and complex interrelations, and they are affected by a wide range of factors, many of which are continually changing. In the whole they amount to much more than the individual parts, and are an embodiment of our total engineering activity—of what it should be and what it is—and it is in this sense that we want to examine them today. And I hope 'Standards of Engineering' may be a theme which will not be forgotten at the end of the day: we should be conscious of it and looking at it in this sense all the time.

By giving ourselves such a theme we invite criticism and self-examination and this may be something of a novel approach to one of these conferences. Another novelty is the introduction of seminar groups. Apart from avoiding the rather tedious business of sitting in this hall all day, we hope this will give a much greater opportunity for people to make a real contribution to the conference, and to find out your experiences and views, which is one of the important aims.

After an opening scene-setting session which is rightly being presented by the Fleet, we will divide up into six seminar groups. Each of the subjects directly affects or is affected by standards of engineering: they have been carefully chosen to cover a wide range of important topics—there are of course many others we could have taken, but I hope we have made a good selection.

In the afternoon, we have twenty minutes on each seminar subject: five to seven minutes for the Chairman to report on what emerged from his seminar, and the balance for comment by the other five-sixths of the audience.

Are we being a bit over ambitious? Better that way than the other, and time will show. I hope it will give us a more lively, interesting, productive, and useful conference: and we will certainly welcome views on whether it is a successful experiment that we should repeat.

Time will be short, so please be brief, concise, and explicit: If all that emerges at the end of the day is a catalogue of gloom and doom then we shall have failed. Try to take a positive approach and suggest ways in which we can overcome difficulties within the inevitable constraints we face. Let your criticism be well-founded and your comment objective and above all constructive.

FLEET PRESENTATION

Introduction by Rear-Admiral D. O'Hara, CSO(E) to C.-in-C. Fleet

Before we can discuss engineering standards sensibly, we have to know what we are dealing with.

It is our purpose in the next forty-five minutes to tell you: firstly, what the Fleet is now and what it will be in the near future; secondly, what are its strengths and its weaknesses. I will cover briefly the first aspect and then turn to others of the Fleet Staff for the second.

Let me start by saying that the Fleet has a purpose, which can be phrased in a simple manner as follows:

to meet the threat by providing effective fire power at sea.

A simple statement—the engineering of it is the difficult part!

The principal threat we speak of is that of Soviet sea and air power. It consists chiefly of high-quality missile-carrying surface ships and well over 300 submarines—nearly half of them nuclear powered.

We meet this threat with a mixed bag of ships and weapon types. This is hardly surprising when one remembers the overlap of old and new and the length of ships' lives. However, you should also take account of three events:

(*a*) The Defence Review of 1966—when the decision was taken to phase out the carrier force around which previously we had formed seagoing task groups.

(*b*) The Defence Review of 1974—when the decision was taken to concentrate our attention on the East Atlantic and the Channel where we could make our most effective contribution to NATO.

(*c*) NATO Strategy—at about the same time this was changed from the 'trip wire' concept of massive nuclear retaliation to one of flexible response. Flexible response requires the capability of meeting the Soviet threat at every level.

The implications of these events are far more extensive than might at first be thought. Consider how they affect our ship needs.

In time of tension the task which would exercise us most is likely to be that of ensuring the reinforcement of Europe across the Atlantic. The prime role of the R.N. is therefore an antisubmarine one.

Remember, however, that in addition to the AS fit our ships need to be provided with adequate weapon systems for their own defence and that most attacks will culminate in some form of air-flighted missile whatever and wherever the launching platform may be.

Thus we have a requirement for a ship/weapon fit covering both low and high levels of activity and intensity.

At the high quality end of the range we have nuclear powered submarines and the ASW cruisers. At the low cost end we have Off-shore Patrol Craft and the like.

Our middle range of capability—the DD/FF force—presents a major problem in the balance of quality versus quantity but in spite of ever-rising costs we have so far been able to maintain a force of about sixty-five ships all with the potential to contribute significantly to the higher level of ASW operations.

I would not be forgiven if I omitted to mention the CVS and amphibious lift forces (albeit a secondary NATO role) represented by *Hermes*, *Bulwark*, and the LPDs.

These, like many of the ships in the Fleet today were in being before our role was redefined following the 66/74 Defence Reviews and as illustration of this I make the following three observations:

Firstly —It takes thirteen plus years to design and produce even a frigate.

Secondly—The last four DLGs—designed specifically to provide AA defence for carriers—were accepted into service after the decision to phase out the carrier force. And let us not forget H.M.S. *Bristol.*

Thirdly —*Bulwark's* recall to service is a typical gap-filling exercise—one which becomes necessary when the building rate doesn't match the scrap rate.

But what of the future—what is coming to the Fleet?

The nuclear submarines will continue to roll off to a pedestrian building programme—but with steadily improving designs. The patrol submarine of conventional ilk is a bigger gleam in Daddy's eye than for many years.

The T21s are already with us as good medium quality frigates.

The T22s are the next step up the quality ladder equipped with Seawolf, two Lynxes, and better sonar. *Broadsword*—the first of class—is now with us.

The T42s now joining the Fleet and armed with Sea Dart as an area defence weapon are looked on as the replacement for the DLGs. A stretched design is to follow.

The T43 should be mentioned as the successor to the T42.

I have already referred to the ASW cruisers with their Sea Kings, Sea Harriers, and SAM systems.

I cannot over-emphasize the importance of the MCMV task and we look to the promise of *Brecon* and her Class as they slowly replace our old TON Class in this role.

The off-shore tapestry has given rise to the ISLAND Class as a very successful stop gap and we expect to see very soon a better and more purpose-built edition on its way. In the same scenario we need a replacement for the TON Class.

That Gentlemen, is our Fleet and the future Fleet. A mixed bag, as I said earlier, and with every newcomer more variety and greater complexity. It provides a challenge to all of us to make it function to its maximum capability. Manpower problems exacerbate any material shortcomings and make the challenge that much greater.

If the Fleet is to do its job under these circumstances we need to be able to procure and maintain ships which not only meet the required fighting characteristics, but which also withstand the closest scrutiny in the following:

Functional performance including ease of operation.

Reliability.

Maintainability, which covers all aspects of support including man and his training.

Surviveability, in action.

Adaptability, meaning ease of updating—of growing importance in the face of the rapidly changing threat.

This is where we apply our engineering. Good engineering gives you these qualities at a high level. Bad engineering gives you a headache.

The Submarine Command—Captain J. Jacobsen, CSO(E) to FOSM

The primary weapon system deployed in the Submarine Command is the Strategic Deterrent Polaris. The outstanding overall performance of this system has been achieved by massive expenditure and effort in comparison to that available for tactical weapon systems but there are many valuable lessons that can be drawn from our Polaris experience to improve the fitness for service of submarines and their tactical weapon systems (at modest expense). I would like to draw attention to some of these lessons, including those derived from nuclear propulsion disciplines.

Reliability

It is not necessary in this forum to emphasize the need for quality of material; nevertheless I will do so. Many of our weapon and ship systems are of fundamentally good concept but the quality of component design and manufacture is inadequate for service conditions in some cases. Examples in the submarine service are various—torpedo dispensers, S Class torpedo tubes, wireless and radar masts, joints in steam and fluid systems, balance of rotating machines, insulation of primary electrical generators, corrosion resistance of sea-water systems, etc. In the Polaris weapon system it is noteworthy that great care is taken to obtain quality assurance at the appropriate level for the duty of the component equipment or system. This does not mean first level quality assurance procedures for the Captain's toaster but it does entail a realistic appraisal of the

duty of each equipment and the application of appropriate quality procedures at all stages of life from design to disposal.

Our reliability data is limited but a look at the operational days lost in the Flotilla during the past year gives a clear picture. The majority of time lost is due to major defects from material design deficiencies and inadequate standards of refitting and manufacture. The recent failures of conventional submarine main engines demonstrate that our ability to refit and maintain these units, demanding as it does somewhat old-fashioned skills and experience, has fallen off, and we are paying a heavy penalty.

Operability

Standards of operation required are clearly defined for the Polaris weapon system, submarine nuclear propulsion systems, and submarine command and control. The area where we need to make improvements in our standard of operation is the handling, preparation and firing of the tactical weapons. The WE branch has only relatively recently taken full responsibility for tactical weapons and we still suffer from the lack of experience during the transition phase amongst the WE officers and ratings involved. With the advent of computerized tactical data handling and sophisticated torpedoes and missiles, we are introducing more formalized tactical weapon instructions and operating procedures based on Polaris practice. The definition and imposition of weapon system readiness states with appropriate regular performance checks and operational readiness inspections are significant advances which we hope will reduce the current incidence of personnel failures responsible for unsuccessful firings of torpedoes.

In the training field it is my belief that we have reached the limit in the proportion of most men's careers that we can spend in training of the individual ashore. I believe we must maintain the operation training emphasis at sea, and extend it in the tactical weapons area. But the drive will and should be on team training, doing the basic training ashore in simulators such as the NUSCOT, SCTT, Submarine School, FASMAT, and the Polaris School and the continuation training both in these facilities and at sea. In this respect there is a need to provide built-in training simulation in many of our weapon sensor, tactical data, and fire control systems.

Maintainability

The maintainability of submarines is a nightmare—cramped conditions of work, the aggressive environment and inevitable work in wake often make submarine maintenance a trying chore. The designers do all in their power to ease access and minimize maintenance but the dice are loaded against them. All in all, the maintainability of the modern nuclear submarine strikes a reasonable balance between the constraints of payload, equipment design, and available space. Certainly great attention to this aspect is paid at design stage by use of mock ups, maintenance demonstrations, and the specification of major maintenance procedures. There is a continuing and constant need for feedback from the Flotilla to the Ministry.

Ease of modernization is not a characteristic which is easy to build into a submarine. Nevertheless, we continue to modernize submarines successfully albeit at great expense of resources and time in refit. It is in the field of ease of refitting that significant advances can be made in future design. The inside of a submarine is not a suitable place to carry out high precision work and in future designs great rewards in operational time, cost of refit, and quality of workmanship (and hence reliability) will be gained by designing more readily removable openings in the hull for upkeep by exchange and repair ashore under propitious conditions.

The logistic support for the Polaris Force is not equalled by that for the SSN's which currently suffer from shortages of spares of all kinds, particularly the large expensive items of ships service and weapon equipments where the usage outstrips the rate at which these items can be processed through the repair chain and re-supplied to the Fleet. But, of course, if these components were of higher quality the incidence of defects would be less and the current provisioning would be adequate. Again one comes back to quality and the prime value of expending resources on matching the quality of material to its duty, or in other words, 'getting it right first time'.

Performance

The culminating attribute in assessing fitness for service is performance. The role of the Submarine Flotilla is defined in the concept of operations. In peacetime the submariner is fortunate that he can practise all but his shooting ability in contact with potential adversaries. The training patrols which are currently undertaken indicate that U.K. submarines are indeed fit for service and their performance matches that of other nations. A U.K. submarine recently completed an unalerted dived patrol of sixty-five days during which it travelled 10 000 miles. Amongst other contributory factors to this success was the high standard of engineering in the design, construction, support, and operation of that submarine.

The Fleet Air Arm—Captain A. W. Wheeler, CSO(AE) to FOF3

In 1961, when the first frigate fitted to operate the Wasp went to sea, we had eight air-capable ships. Today we have 103. At the same time the number of trained men in the Fleet Air Arm has fallen from about 11 000 officers and men to approximately 5800. By contrast the number of aircraft has increased from 259 to the current front and second line strength of 281. Most of those aircraft are deployed in small units varying from single aircraft flights to four aircraft detachments. Gone, for the most part, are the days of large embarked squadron units, of long continuous deployments, of extensive support facilities and air engineering teams capable of sustained independent operation.

Now, we have to be able to mount short-period detachments to a variety of host ships, deal with the extra support and logistic difficulties this entails, and compensate as far as possible for the wide dispersal of support manpower. Such are the principal problems confronting the Fleet Air Arm today in maintaining its engineering standards.

The success of the Air Arm must be measured ultimately in terms of weapon system performance and reliability, but the mission must first of all be flown and this depends, among other things, on how efficiently we service, maintain, and repair the aeroplane, and on its own inherent reliability and maintainability.

First, then, a brief look at the aircraft themselves from this point of view:

(*a*) *The Wasp:* Thirty-six flights are formed but will reduce with the introduction of Lynx. Its projected service life is impressive. Introduced in 1961, ten aircraft are still planned to be in service in 1990, twenty-nine years later. A tribute to their design perhaps, but most certainly a challenge to the maintainers. It is generally well suited to its environment with a good corrosion record. It has proved reliable and easy to maintain but one must bear in mind that it is a relatively simple aircraft with a limited capability.

(*b*) *The Wessex 3:* This is the aircraft deployed in the DLGs and there are five flights formed. It is single-engined and therefore vulnerable to action damage, ice, and salt accretion. It has a magnesium alloy skin and so is not well suited to the marine environment. Its avionics tend to be unreliable and expensive to maintain.

(*c*) *The Wessex 5:* Two squadrons of twelve aircraft are in being for troop lifting in the commando role and there are three single aircraft to provide the RFA helicopter delivery service. It has the advantage of twin engines, although their in-takes are close to the ground making them less than ideal in the snow and ice they encounter in northern flank operations. It is a simple aircraft with good maintainability. Its principal operational drawback is its inadequate pay-load and some are soon to be replaced by an adapted version of a Sea King with over twice the lift.

(*d*) Moving on to the Sea King, this is the standard ASW MK II version of which there are thirty front line aircraft in five conventional squadrons. There are few corrosion problems but zinc based aluminium alloys are used extensively and while they have good strength/weight ratio they have poor fatigue strength, are easily damaged, and are prone to stress corrosion. Its complex mechanical and avionic systems, and its sensitivity to wear and tear from vibration make this an expensive aircraft to maintain, but it is a good work-horse and well suited to its task.

(*e*) Turning to the new aircraft, firstly the Lynx. It first entered service last year. Twelve flights are now formed and eighteen are planned by the end of this year. The build-up of Lynx will continue well into the mid 80's when some fifty flights will be deployed. There are inevitably teething problems with this new aircraft but the point to be emphasized here is the fact that maintainability and reliability have formed a major feature of the design. The Lynx promises to be substantially better than most and, despite its greater complexity and greatly superior performance, it is comparable in terms of its support bill with its predecessor, the Wasp—and that includes the flight complement.

Notice in passing, the comparative cost of the Wessex. Almost half of this is attributable to corrosion. The problem of the Sea Harrier is plain to see. This will be especially acute in the CAHs where there is insufficient space in which to accommodate the number of maintainers this figure suggests that we need. Thirty-four of these aircraft are on order and there may be more yet. It is planned initially to deploy ten in *Hermes* and five each in the CAHs. The R.N. IFTU forms in June of this year. Some marinization has been undertaken—in particular the elimination of magnesium alloy from the engine—but the airframe is little altered from the earlier generation R.A.F. version, so maintenance costs in this area at least are expected to be high. By contrast the avionics are of modern, integrated design and the prospects for reliability are good.

So much for the hardware. It is a significant fact that since the early 60's we have increased our output in terms of flying hours and reduced the accident rate —this with 45 per cent. fewer men. Not all of this can be attributed to improved reliability, though to be fair we are dealing for the most part with simpler aircraft than the large fixed-wing types which predominated formerly. There can be no doubt that better manpower utilization accounts for some of the gain.

The maintenance teams of the small ship flights have in general performed exceptionally well. Considerable delegation of engineering responsibility has been necessary and this has clearly paid dividends. Despite the lack of the engineering hierarchy and material support enjoyed in the large ships, there is clear evidence that small is beautiful. There is a strong team sense and closer identity with the task which is reflected in the care and pride with which these small teams maintain their aircraft. But you should not run away with the idea that they are left to their own devices. Far from it. Comprehensive rear-echelon support is provided and this includes an elaborate system for monitoring maintenance standards and exercising tight control over the whole maintenance process. The flights are also inspected frequently. Indeed a study of one LEANDER

Class frigate showed that her flight underwent either a formal or quasi inspection about every two and a half months by one authority or another.

Perhaps big brothers are rather too much in evidence, but you may still conclude that we have well-motivated people endowed with ample guidance and support based on sound principles of flight safety and good husbandry. But is this guidance and support not the very prop which is likely to be knocked away in wartime? In peace we try to eliminate the need for local engineering judgement and improvization. In war, those are the very qualities we are going to need. How best to develop those qualities or to compensate for the lack of them, must form a prominent part of our forward thinking and I hope that they will engage your attention in seminar this morning and in later discussion.

The Surface Fleet Weapons Systems—Captain J. M. L. Hughes, FWEO

The Fleet Weapon Engineer Officer reviewed the performance of weapon equipments currently at sea and emphasized that performance must be looked at as a whole against a realistic war environment; results achieved in the more limited scenario of exercises must be examined critically and not always accepted at face value.

Much of CAPTAIN HUGHES's remarks were of a security classification which does not permit publication in this *Journal*. However, it can be said that he considered at length the strengths and weaknesses of current weapon equipments and the difficulties that occur in the new classes of ships when less experienced personnel are required to operate and maintain increasing numbers of more sophisticated equipments.

There are encouraging signs in the increased reliability of the newer equipments entering the Fleet and weapon improvement programmes are achieving similar gains for existing equipments. It was suggested that big financial savings and improvements in availability are there to be gained if we develop more accurate methods for predicting the requirements for equipment spares.

Present estimating for spares is based on random failures and yet current analysis in the Fleet shows that random failures only account for 10 per cent. of the spares usage. Is the answer to extend the basis for the initial estimate of spares? Is there a need for closer monitoring of spares usage in the development stages? Should stock buys be based on supply or demand? How can errors be more rapidly eradicated from the system? Could feedback from ships to DGST(N) be improved?

What of Fleet Engineering?

Performance

This last year has shown that the engineering resources of the Fleet when properly applied can lift the weapon performance some way above the datum performance set by the NSR with the possibility of even greater improvement next year. This despite 50 per cent. of the artificers (70 per cent. of CEAs) being in their first sea job. This improvement has come about by application of good engineering principles and discipline.

Maintenance

A better maintenance regime is yielding considerable improvements in increased availability, reduced work load, and reduction in spares usage.

The regime has been in being in the WE world for just over two years with the introduction of performance servicing logs and will be recognized by all as 'maintenance by condition'. It acknowledges the need to:

(*a*) monitor performance;

(*b*) reduce stress, temperature, voltage swings, corrosion;

(*c*) measure wear and replace worn out parts.

The Fleet is starting to ask itself how can systems be maintained in War?

Self help is the order of the day. Young WEs are coming to realize that millpond-still water is not a prerequisite for setting gyro rates. Stars, moon, and sun are distant objects and can be used to check the alignment of weapon systems.

The Fleet is devizing means of analyzing its own firings, becoming more self-critical and seeking solutions to its own problems.

Much engineering capability lies dormant in the Fleet and is not stimulated by reliance on the MOD and industry to solve its problems.

Certainly the true measure of the problem is only finally exposed at sea in the operational environment and naval engineers must continue to study war at sea, actively seeking solutions to the many engineering problems that it poses, and remembering that engineering solutions must be adequate and timely, at minimum cost.

Intelligence

In much that we do, there is a need to identify the intentions and capability of the enemy. Are we as naval engineers adequately aware of the need? For not to know the true requirements of the market place is the likely recipe for disaster when launching a new product.

Up-date of Capability

Another feature of warships, as vital as their capability to fight in war, is the ability to maintain their credibility. It is important to be able to modernize warships to match the threat. Current warship design is a major factor in the time taken to achieve weapon update.

Summary

The Fleet would expect further improvements to the overall fighting capability of its surface warships to result from continuing attention in the following areas:

(*a*) achievement of more balanced weapon fits;

(*b*) adequate engineering (particularly system engineering);

(*c*) design and management of software;

(*d*) update capability of warships.

Although it is clear that our design authorities are aware of the problems, the Fleet needs to be reassured that appropriate action will be taken in the right time scale.

Marine Engineering—Captain E. Maclean, FMEO

There is a tendency to imagine that the problems which we face in the sphere of engineering standards, reliability and effectiveness are unique to today. However, in recent history, events show that in 1875 Disraeli concealed from the House despite pressure from the First Lord—GEORGE HUNT, a farmer—that:

> 'The majority of our most powerful battleships and cruisers are in various stages on the stocks, whilst the ships which have returned from foreign service with rotten boilers, broken down machinery, obsolete armament and shipwright defects to be made good are blocking our harbours waiting for repairs (which were indefinitely postponed for economic and party purposes), the annual amount voted being altogether inadequate to the completions of the ships building and the requirements of those standing in need of repairs.'

The First Lord's relief, W. H. SMITH of *Pinafore* and neswpaper fame, inherited a Navy in which Admirals believed that this craze for iron ships would eventually give way to common sense and English oak. Smith knew from his commercial experience that following the introduction of steam and iron ships nothing would

ever be the same again. By 1876, the *Warrior* built and gunned for £376 000 had already cost in repairs and maintenance £125 000. This was a fantastic sum since six of Nelson's wooden walls could have been built for the former price.

And so since starting upon this presentation I have moved from the 'all is lost' stance to feeling that perhaps we have the concepts right, but that the engineering detail and the back-up deserves our vigorous attention, and that life in the Royal Navy which is an on-going thing has ever been thus. However, at what would a latter-day W. H. SMITH—an ARNOLD WEINSTOCK or FREDDIE LAKER—be looking? The 'down time' of ships, the causes and prices, on the assumption that in general on the mechanical and structural sides ships would be meeting their design requirement. Probably they would also be looking at the methods employed to meet the design requirements to see if these were the most effective —again a matter of engineering detail. It is after all possible to shut the door of a house hydraulically, but with what benefit, when the present simple well-proven means are quite adequate.

I intend to look very briefly at the middle ground of marine and hull engineering and suggest those areas, the proper investigation of which could yield the greatest benefit assuming of course that, with engineering still an unfashionable profession, we have the human resources to do so.

Reliability

The LEANDERS, 50 per cent. of the surface fleet, are mechanically and structurally reliable. They have to be. They are well proven in their operational time—such as it is—but with weaknesses which we as yet have failed to cure. Are we aiming for the moon in expecting a class of ship to be troublefree? I think not. We should not be deluded by 'time taken to refit' which has political as well as military significance and I believe that refitting times in hand are quite capable of being shortened and indeed the maintenance package itself reduced.

Typical examples of engineering which could well stand improvement in LEANDERS are:

(*a*) turbine gearing couplings;

(*b*) feed regulators;

(*c*) steam alternator governing and auxiliary drives;

(*d*) TWL feed pump;

(*e*) boilers—safety against explosions.

Remember of course that although reliable, these ships are still demanding in terms of the load upon artisans and we can only measure reliability taking the availability of the artisans into account.

In the Type 21s/42s—good runners they tell me—we have seen problems in the major areas of:

(*a*) gearing—tooth failure and rim bolt slackening;

(*b*) CP screws—dirty systems and screw failure;

(*c*) D/G failure—fuelling problems in general and our failure perhaps to appreciate the running hour problem;

(*d*) Auxiliary Boilers—again running hours.

Hulls—in terms of reliability—are good but who really wants to water ballast and do we really need such demanding painting and preservation schemes? Attempting to put a quart weapon into a pint weapon pot has not helped the ballasting problem.

Operability

In general our ships are capable of being operated with reasonable effort but each class has its own specific problems and diversity of ships at the moment

causes heavy training loads. The man who makes the steam—the POMEM—still carries a disproportionate share of the overall operating load and his re-engagement rate bears this out.

It is encouraging that the ME world when monitored at Portland shows consistently that its operating standards are higher than in other branches. The fact that it *has* to perform, undoubtedly helps this.

Maintainability

Leave aside the Health and Safety at Work Act and Asbestos Regulations which clearly have in themselves made maintenance more difficult overall, the maintainability of the Fleet in the Steam Navy has seen no radical change over many years. If anything, it has become less maintainable because of increasing reliance upon U by E spares, the reduction in onboard machine tools and the increasing complexity of equipments. Has this increase in complexity, much of it associated with improved power/weight ratios, been justified? This we can consider at the seminar.

The new generation of COGOG ships have shown a marked change in maintenance problems—no steam leaks and the mention of feed loss causes not a flutter in the MEO's pulse. But I have seen in the COGOGs a welter of gadgetry, filtration interlocks, and the like all of which may or may not be essential and all of which require maintenance. Certainly there is bad engineering in the designs and we know this and hopefully will get on top of it. The principle of maintaining the plant has changed too and is now that of 'pick it off the shelf and fit it'. Just as well perhaps because we carry too few men onboard to make it and fit it—even if they could make it. But bearing in mind the fact that my WE colleague tells me that there is no such thing now as the 'near miss', perhaps in halving the number of men at risk at sea the MEs are in the van!

Performance

Ships in general perform well if we consider performance to be the ability to meet the laid down criteria for speed, range, and sea keeping. We have adequate occasions on which to monitor these criteria and, although we have a few ships with downrated machinery, most come up on time with their full power trial reports. But how easily do they achieve this? Can we do better? If so, it is design and good engineering to which we must look for this improvement.

And so Gentlemen, I intend to lead my seminar into the theme:

'Do we promote the right hard/software for the Fleet' on the basis that our concepts in the propulsion and structural worlds relative to Staff Requirements—and many would query these—are right but there are areas to which we must devote resources in order to put the gloss on what we already have before we leap off to the next generation of equipment.

I look forward to a vigorous if orderly representation of your views.

And finally may I quote LORD MELVILLE, the First Lord of the Admiralty who said in 1828 that, 'Their Lordships felt it their bounden duty, upon national and professional grounds, to discourage, to the utmost of their ability, the employment of steam-vessels, as they consider that the introduction of steam is calculated to strike a fatal blow to the naval-supremacy of the Empire'.

Be comforted by the fact that few engineers have ever been that wrong.

Sea Training—Rear-Admiral A. J. Whetstone, Flag Officer Sea Training

Let me say, first, how privileged and honoured I am to be invited to join such a vast and august array of engineering talent to discuss fleet engineering standards. Like myself, my window is small, for example the view does not embrace more than one at a time of my old war-horses—and sometimes the one is no more than a tiny and elusive German U-boat. The big ships too tend to

stay clear of Portland if they possibly can. But I do now see most of the surface fleet at one time or another and a goodly proportion of the surface fleets of some of our major European allies as well. The Dutch, the Germans, and now the Belgians believe Portland gives good value for money and indeed more than pay their way.

In the next twenty minutes, with the help of my Chief Staff Officer (Engineering), I hope to give you a peep of what we see through our Portland window. An all round look in low power. Thanks to our submariner friends, we will also attempt to peep out of CSST's periscope from Faslane. There is never a dull moment and, like Billy Butlin, we keep our customers happy by keeping them occupied! We run a variety of holiday packages to suit our customers and the choice varies from a seven-week basic operational sea training (BOST) for the luckier ones, to a meagre one or two-day staff-covered OST for those who are too busy to come and savour the delights of Portland for longer.

The continuation operational sea training (COST) is our newest offering and we believe it is proving to be successful in helping to raise fleet standards—and that includes engineering standards. All too often in the past, ships heaved a sigh of relief after completing their BOST and then the rot set in—at least as far as standards were concerned. Now, they come back again to us, some more often than others, for a re-assessment of standards and a re-charge. But if ships are to achieve any benefit from the COST period, it is important that they arrive in a fully-operational state, both materially, organizationally, and with regard to personnel training.

Our European friends need the re-charging of a COST even more than we do. In the Federal German Navy, for instance, the changeover in their junior rates, the vast majority of whom are conscripts, is never less than 25 per cent. every four months and sometimes higher. We in the R.N. should count our blessings. The remarkable thing is how keen and efficient our allies are despite this handicap.

Portland has its drawbacks as I'm sure you all appreciate. Situated where we are in the busy Channel and where the weather is often lousy and all too many training serials are lost because of either the weather or one of the many other environmental features which increasingly plague our programme. But even so despite these constraints I still see through my window what probably no other Admiral sees and that is the whole ship enacting its various roles from the simplest harbour exercise to the ultimate test in a multi-threat environment, albeit a limited one. All are convinced in what are, as near as we can make them, war conditions. We see the British and Allied ships operating and learning to operate, to common standards and uniform proceedings. In our assessments we stick rigidly to fleet standards, in fact I regard myself as one of the Commander-in-Chief's guardians of operational standards, but of course there are lots of others involved in the standards game as well as FOST.

Now for the crunch, how well do we meet these standards? Are we getting better or worse? How do we compare with our allies?

Our main areas of concern are: above water warfare, underwater warfare, and action information organization. A cynic might say we are good at everything except fighting! Why are these areas our Achilles heel? Perhaps the answers have already been given to you in the preceding presentations but without going into detail these are my views—you can thrash this around in the seminars afterwards.

Firstly, the equipment does not appear to be reliable so that far too many training serials are lost because the equipment is down or degraded. It is a fact that in my five months at Portland, I have only twice seen the Mark 8 Gun fired and for the rest of the time the serials have been lost because of defects or because of weather conditions. All too often too, I'm afraid, for similar reasons, sonar performance has not been what it should; there is, by the way, still a lack

of awareness of ship or first-stage noise effects on sonar performance and much of it could be easily avoided—such as hull outfits and adjacent compartments being ill-secured against noise. Is this a lack of attention to basic engineering standards?

The second reason for AWW, USW and AIO being areas for concern is that our officers and men lack experience. Gone are the master gunners, the GIs ana the TASIs; now we have PWOs, the Directors and Controllers, mostly as green as grass, battling with speed situations of a complexity which did not confront their experienced and deeply specialized predecessors. The lack of experience is compounded by the effects of trickle-drafting and low retention.

Thirdly, the new breeds of operators and maintainers have yet to achieve the necessary rapport. The operator does not appreciate what performance standards he can expect and the maintainer is all too often reluctant to tell him or help him. There are other reasons too, such as the variety of equipment systems and layout, complicated procedures, and of course the lack of continual practice.

But perhaps most important of all is the weakness of the design, the man/machine interface, the ergonomics, call it what you may, where increasingly equipments and systems are being produced which cannot be operated or maintained by the standard of man available to us. Our operators are not all multi-digitate geniuses, they are ordinary people who cannot work miracles and who need all the help they can get—your help, both as designers and diagnosticians. What I and my sea riders try to do is to help to weld operators and maintainers together into a team, given the ships as they are. And to tell you in more detail about the engineering state we find them in, here is the head sea-riding plumber, my Chief Staff Officer (Engineering), CAPTAIN EDWARDS.

Standards Achieved in Sea Training—Captain J. P. Edwards, CSO(E) to FOST

I would like to start by defining as simply as I know how, and with apologies for plagiarizing ADMIRAL JACKIE FISHER, the role of the Engineering Departments in war:

> 'To provide the highest standards of operation and maintenance to enable ships to hit first, hit hard, and to keep on hitting.'

We like to think that when ships leave us at Portland they have been brought as near as they will ever be to those standards.

But let me start at the Portland base line, the staff sea check. This is our first and necessarily quick assessment of the material state and efficiency of a ship. The accent at this stage is on ships and personnel safety, on administration, and organization. If these are satisfactory or better, then there is a good chance of the ship being able to achieve maximum benefit from operational sea training. It is at the staff sea check that, from time to time, we have to say that a ship is not fit to start her operational sea training; she is, at the worst, returned to her base port or, if we feel there is still hope, is given a short spell alongside our Portland garage—the FMG—which like the Windmill Theatre of old never closes.

The staff sea check strips the ship bare and the flannel can no longer conceal the true state. Invariably, there is a resultant string of new OPDEFS and all too often these are accompanied by such excuses as 'it was alright yesterday', or 'I didn't think it was important enough to report', or 'we intend to put it right today'.

If we consider the standards achieved by the ME and WE departments of R.N. ships which completed BOST and COST in 1978—a comparison of their standards at staff sea check and at the final inspection—the figures suggest that the standards achieved by the WE departments are lower generally than those achieved by the ME Departments. AE standards are high and getting better all the time. The trend of the ME standards is certainly encouraging but there are,

of course, many things which still cry out for attention. I have time only to mention three matters in the marine engineering field:

Firstly, generators. The possession of a full set of operational and reliable generators on arrival at Portland is vital. All too often ships arrive with generator defects which should have been put right long before they get to Portland. Diesel generator reliability must remain a particular concern.

Secondly, we find that system knowledge and knowledge of machinery operation procedures is low in COST ships suggesting that insufficient drill periods are included in ships' programmes.

The third ME criticism is the perennial one of cleanliness, and this applies to the WE Department as well. There is a general lack of appreciation of husbandry and safety standards. If there were a plea that I could make to the ME and WE officers here today it would be this:

> Take a leaf out of the disciplined approach to husbandry which is a way of life with your air engineering brethren. Tool control is one example where the AEs are streets ahead; cleanliness is another and, in my book, tidiness in engineering is next to godliness.

The fact, however, that machinery spaces are so grubby is not entirely the fault of the ships' companies. It is a pity that in comparing the new British and Dutch warships we find the latter free from clutter, easier to keep clean, more clinical, functional and less decorative. They have spacious machinery spaces with uninterrupted passages around machinery and auxiliaries so that cleaning and maintenance is not the frustrating chore it is in many R.N. ships.

But back to the WE problems, for this is where, believe me, attention is needed more than anywhere else. Much of the blame for the poor standards achieved in above- and below-surface warfare during operational sea training is attributable to lack of system availability. Ships are therefore not in a position to train their warfare teams. The material weaknesses are generally well known and I hope that our Headquarters Departments are doing what they can to eradicate them. We all hope too that the Way Ahead Committee's studies on manning and automation will point a realistic way ahead for those concerned with the introduction of future generations of automated ship and weapon systems.

Meanwhile we have to do the best we can with what we have. Our *bêtes noires* at Portland are the MRS3, the Mk 8 gun-mounting, our old friend the teleprinter, and, perhaps above all, the 692/CUJs (if only we had the UHF equipment fitted in the new Dutch ships). But what can be done to raise standards given the difficulties with which we are faced in regard to unreliable equipment and the retention of our senior ratings?

I've mentioned the high standards of the AE departments in frigates and destroyers—how do they achieve it? Firstly, the flights have gained experience: the senior maintenance ratings all know now what it takes to run a small ship's flight. CAPTAIN WHEELER has pointed out that they are small and small is beautiful, but the point is that the flights, like the SSBN's, also enjoy a rear echelon for inspection and support which is not yet available to ME and WE departments of surface ships, but which I hope is on the way with the creation of Fleet bases and the devolution of Fleet Engineering Staff. I would like to think that the devolved staffs, together with the staffs of the FOFs and Captains D, will start demanding the same standards as those we set at Portland. The rear echelon must be geared to provide the support that small ships will always need: to diagnose the most difficult problems, to winkle out unavailable stores, and to help with repairs when ship's staff cannot cope. One could argue that in the AE world the number of authorities involved in the inspection of ship's flights present a daunting array, but the system, over-elaborate and in need of rationalization as it is, produces the goods. One might argue that ME and WE inspections and assessments are neither sufficiently frequent nor sufficiently rigid. Engineers must be disciplined to carry out performance assurance checks,

to strive for Fleet Standards and, where they are not the operators, to assist the operators to obtain optimum performance from their equipment. The organization now exists: planned maintenance, PSLs, SOCs, Fleet Standards, etc. What is needed is disciplined application.

At the same time, let us guard against engineer officers being bogged down with paper work. What we would like to see is more urgency being shown by EOs in addressing themselves to seeing that the correct reactions to defects are taken. All too often do we hear frustrated Captains say that although their ME or WE departments appear to be working hard they never seem to catch up. We find that in some cases this is because the MEOs and WEOs have erroneously perched themselves on a remote managerial pinnacle and are reluctant to home in on important detail. In a few cases the Captains themselves are to blame for we find that instead of sending for the WEO, say, they ask the Deputy or even the Section Chiefs. However, the growing appreciation by commanding officers of both performance and engineering standards is an encouraging trend, and they know that the key man in matching weapon system performance to availability is their WEO. Inescapably now the WEO is as much concerned with operational standards as he is with engineering standards. He has, you might say, entered the same ball park as the MEO.

On the role of the Engineer in War and our ability to cope, if ships are going to cope when the war starts, and to keep fighting when damage or degradation occurs, they will need all the fat they can get because that might be all they have to live on. It is therefore important in peacetime that standards are kept at a high level. But at the same time there must be a flexibility in outlook so that ships can cope with situations when system degradation occurs: so that they keep moving, keep fighting, keep firing—even if they are down to the last mounting, or even the last barrel.

Bearing in mind that ADMIRAL WHETSTONE is a submariner and that there are a large number of submariners in the audience, we thought it appropriate to sound out Captain Submarine Sea Training and we are grateful to CAPTAIN DINGEMANS and his MEO, COMMANDER PEZZEY for giving us their up-to-date views. The plain fact is that there are two sets of standards for submariners—those for the nuclears and those for the SSKs and nowhere is this more apparent than at the end of a refit. When they arrive for work-up, the SSKs are either very late or in an unreliable state or both. But all submarines arriving for work-up suffer common problems, such as bilge cleanliness, poor preservation, and lagging defects and, like surface ships, noise shorts galore. The SSKs suffer in addition from low main power installation standards and one-man control system faults. The general lack of quality control achieved in SSK refits could be partly attributable to the inexperience of engineer officers in refit and on this note of lack of experience I now hand you back to ADMIRAL WHETSTONE.

Conclusions by Flag Officer Sea Training

The problem of inexperience is one which bedevils the operational sea training both of surface and sub-surface fleets. In the latter, over the last few years, the level of experience has dropped alarmingly. It is now common for a submarine to change 50 per cent. of its ship's company every year. The real effect of this inexperience is most keenly felt in the operational and ship control fields of submarines and, as I've said before, in the Warfare Departments of surface ships. The Germans, by the way, overcome the problem of inexperience in their U-boats by manning them with officers and senior ratings only and keeping them all in the same boat for at least four years. I agree with CAPTAIN JACOBSEN that in the future we shall undoubtedly need to place even greater reliance on simulator training so that ship's companies can take advantage of every possible opportunity to practise and maintain their skill and, above all, to develop team

work. But ultimately, to work-up the whole ship, there is no practical alternative to own-ship training.

In the end, what matters is the operational standard achieved by the ship or submarine as a whole. This achievement, in turn, is very much affected by the engineering standards set and achieved in design, in build and refit, in training ashore and afloat, in engineering support generally, and above all, perhaps, in the standards obtained by the officers and men of the engineering departments in each individual ship and submarine.

Some of you may think that we have made some harsh comments about standards. But it is my business to try and get the surface fleet to achieve the highest possible standards whilst they are at Portland and to try and impress upon them the need to maintain these standards after they have left us. Our bark is, however, far worse than our bite. I am in fact enormously impressed, all the time, with the skill, enthusiasm, and dedication of our officers and men. In general, standards are on the up, but we have our worries still in above- and below-surface warfare and in the Ops room. It is in these areas, I believe, that there is the greatest need for attention from not only the operators but also from the engineers.

My CSO(E) had discussed the importance of detailed attention to the ordinary everyday standards, not only of engineering, but also husbandry and safety. That is what work-up is about, learning to apply the correct standards so that men and machines can advance safely in harmony to reach the peak of efficiency. Both are highly stressed in the Navy, they always have been and that is why our predecessors placed such great value on getting the drill right. Our aim must be to ensure that, whenever they are required, *our ships sail on time with all systems working*.

That, gentlemen, is what standards are all about.

Concluding Remarks—Rear-Admiral D. O'Hara

It is never easy in peace to prepare for war, but this we must do, this is our purpose.

You have listened to us talk of the task, the present situation, and the near future.

We are dealing with a continuing, and increasing, complexity and diversity of equipment. Currently, some of it is accompanied by problems of reduced reliability but it also contains the promise of astonishingly high reliability, particularly in the electronics field.

In dealing with this we will be bedevilled by manpower shortages and problems characteristic of democratic societies in peacetime and those of our own country in particular.

Engineering Standards in the Service (and in the nation for that matter) were never under more pressure.

Our purpose today is to address ourselves to the question of maintaining our engineering standards—the quality of engineering and the manpower to sustain it—and finding ways of improving those standards and with them the Fleet capability.

Remember—MAN is the vital statistic—after all it is he who does the engineering.

HOW to be ready for war is the central issue for the discussion groups to bear in mind.

That concludes the Fleet Presentation.

SEMINAR REPORTS AND DISCUSSIONS

Seminar A—Do we procure the right equipment for the Fleet?

CAPTAIN MACLEAN (*Fleet Marine Engineer Officer*)
said that the main message from the seminar was that it would indeed be a pipe dream to imagine that there is an easy solution to the procurement problem, and that this applied to all areas—surface, sub-surface, and in the air. The picture came across that procurement was subject to a great deal of over-control with lines of communication within the procurement world being too long, too tortuous, and perhaps over cautious. There were too many committees involved, and engineers in projects tend to be distracted from their engineering task by being obliged to force their way through the various stultifying administrative channels. Perhaps there were not enough small, dedicated or positive teams in the procurement game, and the Bath/London split was quoted as not helping.

It was felt that we attempted to impose our ideas on Industry when, in fact, industrial equipment would in many cases have done perfectly well for our task. We often failed to give Industry a clear lead when they needed it, and we failed to stress the need to be able to maintain and support the equipment easily. The very clear message came across that we needed to strengthen the partnership between the Service and Industry. What is good for one side is good for the other in terms of 'profitability' so that our aims and those of Industry in procurement would appear to be inseparable.

There was a strong suggestion that there was not enough engineering input at the highest Service levels and it was accepted that the Naval Staff, though receptive, have their weaknesses. There was, however, a tendency to blame the magic 'they' when many of the issues were 'in-house' to the engineer—chilled water being a typical example. Nevertheless, a better liaison is needed and, on the basis that you get what you deserve, he wondered whether we, as a Branch, push our own case strongly enough and stress the importance of the value of our professionalism to the Navy. Perhaps we let the Service down by not seeking hard enough to influence the Staff Requirements in procurement areas. Perhaps we need also to breed our engineers to think in these terms, and in this context it is interesting to note that, when asked the question 'How many present have any training in the financial/accountancy area?' only two hands were raised and indeed the number was the same when asked 'Who has been specially trained in specification writing?'. Should we be thinking towards this sort of thing in the Manadon course?

The matter was raised of stability of personnel (particularly engineers) in jobs as opposed to our present 'two-year-amateur-at-work' system. In this context, one must think of ADMIRAL GORSHKOFF who, presumably through his efficiency, has held down his post as Head of the Russian Navy for fifteen years. There was a suggestion that we ought to expand the influence of the naval engineer in project management and that there was nothing in our procurement process to allow the engineer to introduce simplification—rather the reverse, the tendency being towards complexity. Nor was there anything to make the engineer aware of scarcity in human and material resources. There is, after all, no point in elevating the level of technology if this is not needed or if the manpower to meet the higher level is not available.

There was also a need to build ships and equipment that can be easily updated (step by step if necessary) so as to avoid the vandalism which seems to be necessary during the modernization of a present-day ship. Yet again we come back to the concept that nothing can ever make up for errors that have taken place in initial design, and it is to this area that we should apply all our efforts.

In summary, the broad picture was that it is good reliable equipment and weapons that kill the enemy and not polished procedures.

COMMANDER MIDDLETON (*Staff of DNMT(E)*)
said he believed we should not be complacent about the standard of our warships and that there were a number of deficiencies that could comparatively easily be remedied. He gave some instances that seemed to be reasonable grounds for concern. Do we give enough design effort to winterization and the feasibility of prolonged operations in heavy weather? Is our heavy investment in air-conditioning machinery consistent with the anticipated war task? The fuel endurance of our surface ships is by no means generous, yet this is at a time when the Fleet train is more vulnerable than ever because our ships are lucky if they can achieve their own point defence. Young sailors want to go to sea, older sailors do not—yet the design of modern warships increases the requirement for senior ratings; and when they get there they frequently find that their equipment is not repairable at sea anyway, especially in the propulsion field. We may ask why the Type 21/Type 10 commercial designs attract so much approval compared with our in-house designs. We may ask whether our NBCD scenarios, and hence design more generally, have taken account of the revolution in modern missile hitting power and accuracy. Are we still fighting World War II? We may ask whether or not shock resistance is a role requirement. Of all the parameters, this appears to be the one most compromised as the design progresses, and yet its inclusion in the initial naval staff requirement doubles the cost of much of our equipment. When do we really start taking through-life costing seriously? Why can we not design our refits? And, finally, is it really necessary to take thirteen years from concept to commissioning of a ship? He suspected that the answers that the audience themselves had supplied to these questions would make them feel as uneasy as he was himself. He contended that these symptoms were not only a lack of confidence by the design agencies at Foxhill and Ensleigh but also of an overall organization of ship design which is not satisfactory. He said that he was, of course, referring to the split in design and responsibility between Bath and London, and that he was worried about the lack of engineer officers and constructors within the Naval Staff.

The staff approach to design should be overhauled to allow a continuously updated concept of a design to be kept in being. Armed with this, class design project teams also operating from London will assemble the class requirements. This seemed to him of sufficient importance to the concept of design to warrant being presented to the Admiralty Board at regular intervals. To terminate the dichotomy between Bath and London will need reorganization with migration in both directions, but this was an essential precondition of being able to define clearly the purpose for which ships are being designed and to tailor the design in a timely fashion to that purpose.

REAR-ADMIRAL BRYSON (*Chief Naval Engineer Officer*)
said that he thought that, when talking about the split between Bath and London, people were really talking about the fact that the requirements to a large extent are decided generally in London and the method of meeting the requirements stems from Bath. All the pressures appeared to him to be such that the only way to improve matters was for the method of generating requirements to be done in Bath rather than London, because the pressures that push that part in London are increasing and he could see no way in which they will decrease.

He wondered whether ADMIRAL HORLICK would like to comment on the very general question, 'Have we got the general specifications for our ships right, i.e. are there certain things to which we do not give enough attention and other areas in which we are over-designing?'

VICE-ADMIRAL HORLICK (*Director General Ships*)
said that he was not quite so sold on the disastrous dichotomy between London and Bath as was COMMANDER MIDDLETON, but he might change his mind in

the course of the next year or so. He had a great sympathy with nearly every point that he had raised, some of which he thought were more germane to the moment than others. He liked the idea put forward that there should be, hopefully, an ongoing concept of design. If he understood him right, this was that we should try and set a baseline that takes us, shall we say, one quarter of the way into the design of a new ship for a start. When required, this would be taken off the drawing board or the specification book (because we should all have agreed that that was what was wanted) and the specials would then be added.

He thought it very difficult but certainly it was fundamentally something for which to aim. That particular issue is one that runs right across the support field, the design field, and the operational requirements field. There is a very real virtue, if it can be done, in designing ships that, in this age of rapid technological threat and rapid technological response to meet that threat, can be readily updated. That is what we are hoping to address ourselves to in the Type 43. Fundamentally, he believed that this meant building a larger ship.

COMMANDER BOWEN (*Hull Systems Design, Bath*)
said that, as the designer responsible for chilled-water systems, he was well aware of the drawbacks in the Type 42 and other current classes and also of the lack of flexibility, shortage of capacity, and extreme vulnerability of that in the Type 42 in particular. He was also well aware of the political pressures that were exerted at the time of the design and which had some influence on the packing density of that ship. As ADMIRAL HORLICK has said, one hopes that in future classes there will be less density of machinery packing and therefore we can have more flexibility in the design. Having been aired at the symposium, this system will hopefully get better publicity than in the past and maybe the next class of ships will get a better chilled-water supply for their weapons.

Concerning COMMANDER MIDDLETON's point about air-conditioning plants, the Naval Staff still requires world-wide capability for our ships although we are assigned to the northern flank of NATO. In fact, we have to build in the capacity that will take us to the tropics in comfort. Should the Naval Staff wish to cut that capacity, the first thing would be to cut also the world-wide capability of the ships. Secondly, we have air conditioning for NBC reasons, and where our ships have to be deployed these are not decreasing. The closer to the U.S.S.R. and the northern flank, the more vulnerable the ship is to NBC attack.

COMMANDER RYDER (*SWEO, Frigate Squadron*)
said that software in the Fleet at the moment is unsatisfactory. There were a number of reasons for this; they included poor specifications and lack of quality assurance in design and manufacture, a very poor standard of documentation, and no strong criteria upon which to accept the systems. Will this situation improve in the future? The Dutch were well ahead of us.

CAPTAIN MARSH (*Director Weapons Co-ordination and Acceptance*)
said that the R.N. had been first in the field of these digitally-controlled systems and that the Dutch had learnt much from our mistakes in achieving the correct solution. At the time of our first attempts to produce digitally controlled systems, it seemed better to go for centralized computation as the most economic way of meeting the computational requirement in our ships. As a result, we have run into an increasing capacity problem which has meant that we have had to programme in terms of software writing. We work in very complex and detailed machine code language and this has created problems. The Dutch learnt from this and realized that the application of higher level languages that were much easier to implement, much easier to document, and much easier to change, was the way ahead. We have started moving in this direction; quite a lot of programmes in submarine equipment is now produced in a higher level language than that used in our surface ships. The technology has also made a very

significant change in the sense that the cost of the processor itself and the cost of data storage is very much lower than it was at the time the decisions were made for the Type 42 and the AIDA and CAAIS systems. This will allow us to use more distributive systems which will separate the software much more precisely than has been possible in the past.

This will also enable us to use these higher level software languages thus permitting us more easily to write the programme in the first place, and more precisely to document it and give it more flexibility.

CAPTAIN MACLEAN (*FMEO*)
summed up by saying that as so many of our problems stem from the material which we procure we needed to be more discerning customers than ever before. Whatever these problems, he was certain that the seafarer remained as subtly aware as ever.

Seminar B—Are our upkeep philosophies about right?

CAPTAIN SHORT (*CFM, Rosyth*)
said that because of the number of related and relevant philosophies discussed in a very short time, no conclusive answer had been reached. The four principal subjects were 'preventive maintenance', 'upkeep by exchange', 'maintenance skills and manning levels', and 'maintenance facilities'. The discussion on preventive maintenance could best be divided into four sub-headings, namely 'condition monitoring', 'philosophies in wartime', 'documentation', and 'usage upkeep cycles'.

Firstly, condition monitoring: although a considerable amount of equipment performance assessment was already being carried out, there was a need to extend our ability to monitor condition if optimum use was to be made of our limited resources. There were some misgivings which centred on the importance of correct instrumentation and the provision of basic data. Condition monitoring tended to be dominated by vibration analysis and performance checks; it was just as important to develop techniques to monitor systems, pipe work, and hull states, etc. In summary, the general feeling was that a great deal more work on instrumentation needed to be done.

Secondly, philosophies in wartime: there was much discussion on what might happen to our maintenance philosophies in time of war. The views of an officer on the staff of DNAP were of particular interest and these are summarized subsequently.

Thirdly, documentation: there was some dissatisfaction about the volume and complexity of existing documentation. Mention was made of seventeen BRs for one type of diesel engine, and an AE officer said that in some areas in the Fleet Air Arm the documentation tail was beginning to wag the dog. The performance and servicing logs used by the WE department were reported to be working well. It was suggested that, with an improved approach to the design, maintenance, and usage of instrumentation, such a policy could usefully be adopted by the ME department.

Fourthly, usage upkeep cycles: although diverse views were expressed about refit intervals, the general impression that emerged was that it was right to stretch these to the maximum. It was, however, suggested that, although new ships managed satisfactorily, when ships got older then probably the sensible refit interval should be shorter. It was also pointed out that, if the refit intervals were stretched too far, the opportunity to update the weapon systems (which quite often caused the ship to be brought in unnecessarily early) might have to be overdelayed. Discussion showed that some officers favoured the garage principle, and they had been told that this was to be formally examined shortly. Some objective answers would come out of this study; there were, however, problems as well as advantages in the garage system.

On the second subject, that of upkeep-by-exchange (U-by-E), the general feeling was of some dissatisfaction, not with the philosophy but with the way it was being applied. There was also some unease about what would happen to the necessary U-by-E supplies in wartime bearing in mind that we do not do very well with them in peacetime. The reasons for adopting the philosophy were well understood. It was felt, however, that U-by-E was not working as well as it might for the following reasons: firstly, because it was not being developed from the outset at the design stage and consequently logistic, training, and personnel back-up were not following suit; secondly, proper account was not being taken of the available skills and support levels; and thirdly, because the philosophy was often overtaken by events, such as Defence cuts, equipment modifications, and changes in the industrial base on which the philosophy is based. There was also concern that the U-by-E policy could lead to loss of expertise and ability of the ships' staff to exercise professional judgement. The Canadian representative said that his country had adopted U-by-E because of their severe manpower restraints but admitted that they had logistic problems.

The third subject, maintenance skills and manning levels, did not produce the expected amount of comment, possibly because there were separate seminars on personnel. The matter of U-by-E tending to lower the available skill levels came up again under this heading; it was suggested that it was necessary to keep up the level of skills in FMGs (whenever manpower constraints permit) so as to be able to cope with a failure of the U-by-E policy in any particular area. On manning levels, the MEO of H.M.S. *Antelope* believed that these were sufficient in his ship, provided that the base support was properly manned (which was not always so) particularly in the area of ship husbandry. There was general agreement that the manning levels in modern ships would probably work with this proviso on shore support.

On the fourth subject, maintenance facilities, there had been a cry from the heart of one submariner who complained bitterly about dockyard support during AMPs and BMPs, particularly at Devonport. Since this is a topic which brings out the demarcation statement for base and dockyard staff, COMMANDER FOX of the staff of CFM Devonport would be asked to say a few words about how he sees the problems affecting Devonport and how they affect the application of our upkeep philosophies. The Conference was reminded that the demarcation agreement was that ships in operational time were maintained by uniformed support and only received dockyard support if the uniformed personnel cannot cover the requirement, and that, for ships in non-operational time (mainly refits and DEDs), work was normally carried out by the civilian labour force. There were problems in implementing this but that was the aim.

COMMANDER BUSSELL (*Staff of DNAP*)
said that we were well practised in running our ships in peacetime but that it will be a different matter in war. Firstly, if we were to present a maintenance strategy for war, we would have to define the war. It would seem prudent to be prepared for an indefinite period of tension and intense maritime activity during which we will not be able to throw maintenance, whether preventive or corrective, out of the window.

How therefore do we cope with it? Do we provide fleet maintenance ships near the scene of operations? Do we make use of commercial facilities that exist near the scene of operations (which it was generally agreed will be somewhere in the North Atlantic) or do we try and continue to make use of our naval bases? It is probable that the latter will not be possible and it was thought (certainly within DNAP) that we should make use of the existing commercial facilities. For ships needing maintenance the most likely pattern could be that they would go into the nearest port, tie up alongside, perhaps with a mobile FSU, and

there, hopefully, get a guaranteed source of spare gear support. These are the options that are being considered.

COMMANDER FOX (*Staff of CFM Devonport*)
said that the demarcation policy comes out of the integrated support policy that is operated at the present moment. All the frigates supported at Devonport were his customers, and his personal feeling (reflected in the feelings of the majority of the MEOs and WEOs in those ships) was that this integrated support which demands a demarcation policy leads us into an unhappy situation with uniformed and non-uniformed support. CFM's organization certainly endeavoured to make this interface as little obvious to the customers as possible; however, dockyard officers and FMG officers do spend a lot of time negotiating and this does lead into some problems, and the question of what assistance is given to whom by whom is frequently in dispute. In answer to the main question, he was not sure that we had got our upkeep philosophies right. Having the organization integrated had done away with the mobility and flexibility that the uniformed support should have and which the ships should be able to demand. The necessary flexibility was reduced by the strength of trade unions despite dockyard management negotiations with the naval support side. The FMGs were continually pressurized by the unions and dockyard management to change their minds and this led (as far as he was concerned) to a continual walk back by the uniformed side into accepting a situation which was not entirely satisfactory. Giving as an example the lagging situation, he believed that all present would agree with him that this demonstrated every point he was trying to make.

CAPTAIN BADCOCK (*H.M. Dockyard, Devonport*)
said that he would like to reinforce what COMMANDER FOX had said in that trying to run an integrated system as we do at present leads to a great deal of difficulty. His management had many problems in attempting to negotiate a way through with trade unions on sensible lines.

REAR-ADMIRAL BRYSON (*Chief Naval Engineer Officer*)
asked if we had a real alternative; was there any other way?

CAPTAIN BADCOCK
replied that he thought a physical fence, if erected around the naval base, would be effective with the operational ships on one side of it and the refitting ships on the other. This he believed was the original concept and it would solve a lot of the problems.

CAPTAIN WILLCOCK (*CFM, Devonport*)
said that he would like to associate himself with both of the previous speakers. We had a demarcation policy and were making it work with very considerable assistance from CAPTAIN BADCOCK and his management team, but at great cost. These costs were aggravated by the heavy load of negotiations; the diversion of other productive work; the irritations and delays; the reduction of flexibility in the use of resources; and the present difficulties in getting top overhauls organized.

VICE-ADMIRAL PILLAR (*Chief of Fleet Support*)
said that the words 'demarcation agreement' and 'negotiation' had been used. In fact, this was a statement of Admiralty Board policy of what was to happen. He accepted that this does give rise to problems, but as a broad statement the intention is that ships in operational time should be looked after by uniformed personnel, that is ships' staff helped by FMGs. If dockyard assistance were required then, of course, it would be called upon. At the same time, the further guidance was that if effort was available from dockyards it would be sensible to use it. The alternative was just to turn it all over to civilian staff and unions, which was happening. There was a time when ships were looked after entirely

by uniformed staff except when they went in for refits or required a particularly large repair. Over the years, a lot more has come to be done by dockyards and the time had come to say that this had gone far enough and that was the reason for this statement. It was a statement, not an agreement; and it was not really for negotiation. Accepting that it has had its problems, he did not see that there was much alternative.

Seminar C—How can we ensure high weapon effectiveness?

CAPTAIN HUGHES (*Fleet Weapons Engineer Officer*)
said, in reporting his Seminar, that as the subject was so far-ranging it had been difficult to single out areas for any discussion in depth. However, all were agreed that weapon effectiveness was a function of two main constituents—the provision of material and the use of that material.

In considering the *procurement* of material, many points were made similar to those reported in the first Seminar. The general opinion was that, at equipment level, matters were improving but, at ship and Fleet level, we were becoming less effective or, at least, failing to realize the full potential of the weapons and warships now in service. It was essential to concentrate on the total capability of the ship as a unit and to have a balanced design with no obvious, exploitable, weaker elements. And all this had to be seen against a continuously changing threat.

In considering the problem presented by a changing threat, the Seminar recognized the dilemma of the diverse options of the quick, possibly off-the-shelf solution to the known current threat and the long development with built-in stretch potential to cover the changing or anticipated threat. As much of this dilemma stems from our basically deterrent, reactive role, some speakers felt that an alternative strategy, with greater emphasis on an attack posture, was the only way significantly to improve weapon effectiveness.

On the organizational side, there was wide agreement within the Seminar discussion that improvements to weapon effectiveness must start with improvements in project organizations. Balanced ship system design necessitates overall ship project teams breaking across the rigidly defined interfaces between DGW(N) and DG Ships, combined with much speedier decision-making process during the development stages. There was a reluctant recognition that such changes in organizations and methods would only come slowly, but come they must.

Within the material development and production area, a number of speakers felt that reliability programmes left much to be desired and that they should yield a more significant contribution to weapon effectiveness. It is believed that reliability programmes are too often very subordinate to the greater pressures to improve or extend performance.

Turning to the *use* of the procured material, the Seminar had seen two major areas affecting weapon performance standards—the lack of 'effectiveness measuring facilities' and 'the man'.

The inability to measure performance and effectiveness in a realistic scenario was seen as a major constraining factor that could, and does, lead to self-deception in the unawareness of the limitations. At present these limitations will only be fully exposed in war! Two particular areas were cited. Target facilities were generally considered inadequate to simulate likely threats or to provide adequate realism during training exercises; and recording facilities, although improving, appeared to lack a co-ordinated approach. Both these areas should be better reflected at the naval staff target and naval staff requirement stages of projects.

On the personnel side, it was recognized that the effectiveness of many of our newer weapon systems was limited by the abilities of the user and by the technical expertise of the maintainer. This was felt to be not only a reflection on our

inability to attract and retain the 'correct' personnel but also on a lack of close co-operation and co-ordination at the man/machine interface.

Some speakers felt that the trade-off between career patterns requiring broad experience and the level of system and unit knowledge required was no longer correct. The case appears strong for more, rather than less, specialization to generate more expertise and professionalism. This, in turn, may give greater job satisfaction and so possibly assist the retention problem. The present approach of providing more specialist shore support teams to compensate both for a reduction of in-service support in the development establishments and for the lower expertise level in ships was seen only as a short term paliative to hold and, hopefully, improve the weapon effectiveness.

REAR-ADMIRAL BRYSON
said that, in our reactive approach to weapon system design, we are not always careful to distinguish between the hard intelligence saying 'this is what the enemy really is doing or, we are certain, will be doing in the near future' and the intelligence saying 'technically, he could do this if he chose to do so'. We often try to make our systems meet the all-embracing intelligence, thereby making the tasks extremely complex both for designers and users. We should not dismiss an approach simply because it might be possible for the enemy to counter it.

He also said that he was very aware of the need for the Ship and Weapons Departments to get closer together. Some steps were already in train, and some co-location was planned for the early 1980s.

He concluded his remarks by saying that he also felt that career patterns often required too frequent 'job changing', and that there was no real substitute for on-job experience over long periods to achieve and maintain the full potential of our weapon systems.

Speakers from the floor generally agreed with the points raised in the Seminar; in particular, the need to introduce overall ship project management with full authority (starting now with the Type 43, one speaker proposed) and the need to improve significantly our measurements of the weapon total (man and machine) performance.

Seminar D—What challenges lie behind the changing face of the Fleet Air Arm?

CAPTAIN SIMPSON (*Superintendent, R.N.A.Y. Fleetlands*)
said that, despite Flag Officer Sea Training's kind remarks about the AE departments he had inspected at Portland, discussion by the AE Seminar had revealed concern over several aspects of the way AE business was done, and about their suitability to carry the FAA into the future. The particular challenges identified were:

(1) How to introduce and control reduced standards of maintenance in wartime;
(2) How to make rapid recovery from battle damage;
(3) The nature of future equipment in terms of complexity and reliability;
(4) The diminishing availability of second-line maintenance facilities at sea;
(5) The maintenance of the material condition of aircraft that now have in-service lives of over twenty years;
(6) The apparent burden of the present aircraft documentation system;
(7) The ever-present gap between spares consumption and spares provision.

In considering reduced standards of maintenance in wartime, the fact was accepted that peacetime maintenance procedures were primarily directed at reduction of the risk to the aircraft, and any reduction in aircraft availability implicit in this was largely accepted. In wartime, in addition to the risk to

aircraft, the danger that lack of availability could bring to the parent ship must also be considered, but the ability to see both in perspective would largely be a Command function. Also, the ability to respond to an operational situation in engineering terms would depend on the knowledge and enterprise of the man in charge on the spot, as reference back to formal authority could not be assumed. This action would place absolute reliance on local engineering judgement and, if this is accepted, it must also be acknowledged in terms of preparation in peacetime by consideration of matters such as selection and training of those in charge of discrete aircraft units, and in the provision and exercising of stripped servicing schedules designed to equate with specified degrees of risk.

In the case of units led by an engineer officer, it was believed that his theoretical training at Manadon should allow him to make the best of any novel situation. The main area of concern lay with the smaller units led by a senior maintenance rating (SMR), where his more practical training might not allow him to see an engineering problem in sufficient depth to allow controlled departure from the rules. Against this, it was recognized that over the past decade SMRs have demonstrated a remarkable degree of resourcefulness and ingenuity which argues the other way. However, it was accepted that the reality of wartime maintenance needs careful study now, so that those who would actually be involved would not be left to work it all out from first principles on the day.

On the second challenge, CAPTAIN SIMPSON said that rapid recovery from battle damage was another wartime situation that needs careful peacetime preparation. The need for an advance in this field had been convincingly demonstrated by the Israeli and Vietnam Wars, where aircraft where required to continue in operation without formal repair. Battle damage repair (BDR) was a less arbitrary problem than reduced wartime maintenance standards, and it could be subjected to more specific treatment. It was related very much to basic skill-of-hand training, together with the availability of techniques and materials for first-aid repair of aircraft structures and systems. The Seminar had noted with some dismay that over the past six years craft training for aircraft artificers had fallen from 2000 to 600 hours, thus nibbling away at the FAA's potential to recover rapidly in a crisis with a consistency that could well be regretted in future years. BDR was now being taken seriously by the MOD, particularly MOD(Air), and so in due course further guidance could be expected on what training and material resources would have to be devoted to it. However, at the moment, there was no means of exploiting the concept of BDR beyond the normal ingenuity of the man on the spot.

COMMANDER JOHNSON (*Staff AEO to FOF3*)
stressed that the aim of battle damage repair to aircraft was ultimately to achieve at least one further mission; this necessarily implied a reduction in the engineering standard of that aircraft, albeit for a limited period, which also implied an increase in the level of risk to the pilot flying it. He was concerned that the senior rating responsible for the maintenance of the aircraft would not be equipped and trained to make the necessary decision or take the necessary judgements on the level of risk, i.e. a risk to human life.

CAPTAIN SIMPSON
said that, on the third challenge (that on the nature of future equipment), COMMANDER SOUTHGATE from MOD(PE) had given a presentation on the Sea King replacement (SKR) that painted a picture of enormous complexity and sophistication making the point that the increased reliability AEs had come to expect as being 'just round the corner' (and which had never actually been achieved) was not necessarily going to be in the SKR either—for two reasons. Firstly, real reliability cost real money, and to buy the degree of reliability that the operator would ideally like might cost more than the SKR budget could afford. Secondly, a simple factor sometimes overlooked was that, in a complex

system, overall reliability was a function of the individual reliabilities of each component. To get the reliability of a complex system up to a percentage figure in the high nineties might call for individual component reliabilities that were either technically or economically unachievable. System reliability was not just something that could be insisted upon as part of technological progress if progress also insisted upon more complex systems—one would tend to cancel out the other. The AE Seminar therefore took note that the SKR was likely to be another traditional engineering challenge in which it would be unwise to assume any short cuts in the way AE business was normally carried out; this led on to questioning the trend towards reduction of second-line maintenance facilities at sea.

COMMANDER SOUTHGATE (*Directorate of Helicopter Projects*)
said that the WD34 (SKR) was going to be a very complex machine crammed with navigation, communication, and defensive and offensive weapon systems, all of which it would be possible to put into the aircraft because of the improvement in the data-handling techniques. To keep this aircraft functioning in the small unit environment originally envisaged for it, good reliability and maintainability would be essential. Although in the specifications for this aircraft the Navy was pressing for good reliability, he expressed doubt whether the massive investment required to achieve that reliability would be forthcoming. In developing the system for the WD34, however, new techniques enabled a look at the critical systems of the aircraft so that certain reversionary capabilities could be built into, say, the flight control system or the basic weapon systems so as to maintain their overall capability.

To enable the aircraft to be effectively maintained at sea in small units, the MOD(PE) was investigating the use of built-in test equipment for easy onboard diagnosis of faults and the easy replacement of boxes or modules. This raised the questions of the level of skill required at sea, the stockholding of spare units onboard, and a fundamental requirement for a relatively close second-line recovery facility whether in a mother ship or ashore. These complex units would require extensive test equipment at second line with an appropriate management system if they were to be turned round in an acceptable time. He was concerned whether the extent and scale of spares holding and the second-line support requirement had really been grasped.

CAPTAIN SIMPSON
said that this led directly into the fourth challenge: the Seminar's feeling for increased second-line servicing at sea. Apprehension had been expressed that perhaps some staff assumptions had been made in the belief that future equipment would be so reliable that plans could be made to reduce or wind up second-line maintenance facilities as at present known. It had been suggested that an earlier study into a mother-ship complex had been abandoned prematurely on grounds of cost without the full logistic equation being taken into account. CAPTAIN SIMPSON said that the Canadians had studied this problem in some depth and they appeared to be much further ahead.

CAPTAIN HARDY C.A.F. (*Exchange AEO, R.N.A.S. Culdrose*)
said that, on the problem of second-line support at sea, experience in the operation of Canadian Sea Kings from destroyers and RFAs had led to the examination of three options:

(*a*) the mother ship with a 'protector' and 'preserver' concept;
(*b*) dispersed operations relying on spares 'pack-ups';
(*c*) line-and-a-half maintenance with 280 Class avionics in the destroyers themselves.

The former worked very well when in close company, but for dispersed operations sending the destroyers away with good pack-up support was the best

option. The experiment with line-and-a-half maintenance had not been quite so successful and a lot of expensive space was required. Decisions needed to be made very early in the concept of operations for success in supporting aircraft at sea. With a proper degree of co-ordination, all three options used together gave the best result, although the cost of equipment was high.

CAPTAIN SIMPSON
outlined the fifth challenge as seen by the Seminar: the maintenance of material condition of aircraft throughout their increased lives. Helicopters had an expected life of about twenty years in the front line, and required frequent rework and updating in modifications to keep their potential in line with operational trends. The current system of maintenance was introduced about twelve years ago for a largely fixed-wing Fleet Air Arm with an operational deployment of one year East of Suez. The lives of fixed-wing aircraft had only been about ten years because technological advances had generated new basic aircraft designs. From a maintenance standpoint, this background had changed quite radically. In summary:

(*a*) With little performance penalty, it was often more economic to install a new generation weapon system in an old generation helicopter than to buy a new aircraft.

(*b*) Ships were now deployed for much shorter periods.

(*c*) New-built ships had very positive limits on the number of men who could be embarked for aircraft maintenance.

Under the present system, aircraft are withdrawn for deep maintenance on condition assessment and not on any predetermined cycle. Concern was expressed that, as in-service assessment could only be superficial, this maintenance system tended to cure rather than prevent. and to repair rather than protect. Evidence of unsuspected damage and deterioration on dismantling in the Yard supported this. Furthermore, with an arbitrary selection of withdrawal to third line, it was impossible to decree which items should be left to go another service cycle if no such cycle existed. The entire maintenance philosophy was therefore felt to be in question.

It was also felt that these extended periods in service in peacetime without withdrawal to third line worked against keeping some reserve in the aircraft: fat that would be available for use in the event of war.

COMMANDER HODGKINSON (*Staff of FONAC*)
said that under the present system there were Wasp helicopters that had been at sea, unwithdrawn, for ten years. Recently, a helicopter withdrawn only because it required a specific modification was found on close examination to have a great deal of unsuspected faults. He said that the question must be asked whether units should be able to look more deeply into aircraft in the Fleet, or would that be looking at them to 'find out why they were working'? Should the particular helicopter withdrawn for specific modifications have anything more done to it? After all, it was capable of flying; it was holding together! Would it have held together for the necessary period of conflict? The whole matter should be considered in the light of the anticipated length of a conflict, the length of time the FAA would have, and how much fat must be left in the aircraft.

CAPTAIN SIMPSON
said that the inclusion of the sixth challenge—that of aircraft documentation—was predictable. Nearly ten years ago, the FAA adopted a maintenance data system requiring almost 100 per cent. data capture of work carried out on naval aircraft; this provided the input to a central computer shared with the Royal Air Force at Swanton Morley. The front line complained that support management did not appear to be using the information that had entailed so much effort

to produce, and this indeed was confirmed by support managers at the Seminar. It seemed that this system was not earning its keep.

LIEUTENANT-COMMANDER WOODWARD (*Officer-in-Charge, R.N. Data Squadron*) said that the computer was dealing with about half a million naval inputs per year. To produce figures on systems and equipment reliability, it had to depend on the information fed into it. The conflict arose because the man who was putting in the information seemed to be getting very little benefit. The whole concept depended on information from systems now so that lessons could be learned from past and present mistakes. The setting up of the Naval MDC should be looked on as an 'act of faith'.

CAPTAIN SIMPSON
introducing the seventh challenge—spares consumption and spares provision—said that the most important factor facing the maintainer was whether he had got the spare part at the time he needed it. It was accepted that 100 per cent. spares satisfaction was impossible; however, AE management must not relax or stop pressurizing for the best solution to this fundamental problem of maintenance.

COMMANDER HOWARD (*Staff of NAVSEC*)
was horrified to hear that Wintex 79 had rediscovered a problem first experienced in 1971, namely that, when activating the reserve aircraft, there was insufficient role equipment to make them effective. Identifying a problem was one thing, but surely fixing it must be more important.

COMMANDER ASKINS (*Supt. R.N. Aircraft Workshops, Perth*)
said that, for spares, the Fleet Air Arm was now tied in closely with the R.A.F. central supplies computer. This had created a new system with great potential provided everyone continued to work at making it responsive to the FAA's needs. It was fundamental to get the provisioning right not only initially but also with continuous adjustment following operational and defect trends. In-house provisioning organized at places like Perth had allowed production of major aircraft components to continue more or less uninterrupted, and he thought that the front line had noticed no diminution in the supply of repaired spares from the third-line source.

REAR-ADMIRAL HOOD (*Director General Aircraft (Naval)*)
said that it was surprising that most of these problems had not been solved already, although the items that had arisen at this Seminar were being highlighted by an awareness of the expensive aircraft (like the Sea King replacement coming along) together with small ship operation on a more extensive scale. He thought that a most important issue was the third-line servicing policy for aircraft, but recreating the old way of reconditioning them to virtually new condition at fixed intervals must be avoided; this was the system that effectively locked up may front-line aircraft in the air yards in the sixties. It was, however, worrying to learn that when samples were inspected in the Fleet, it could be concluded that they were all right just because they looked good and were cleaned and polished. There were advantages in more regular withdrawal to third line, not only in keeping reserve stocks up to scratch but also in the more efficient utilization of civilian manpower. It would be necessary to look at this carefully.

Another important feature, battle damage repair, was a thing for which air engineers were trained. They received a general training in structural and systems theory (which ratings did not) and so should be able to respond to and deal with such situations as they arose. Allied to this point was the AEO's ability to make a decision and know that it would be backed by those in authority in genuine cases of operational urgency. The problem of introducing a rational BDR policy would be in those areas where engineering authority lay exclusively with a senior maintenance rating.

LIEUTENANT-COMMANDER WALWYN (*Staff of Director General Aircraft (Naval)*) said that, for the Sea Harrier weapon system (particularly in the area of avionics) predictions of individual reliability were beginning to appear from the early flight trials of the Hunter, which was developing and testing avionics equipment for the Sea Harrier itself. These were showing a very substantial improvement on any figures achieved in the past from such equipment. There had been many faults but these were mainly software/operator problems rather than hardware failures.

On the matter of surviving battle damage, the most important development had been the use in the United States of airborne data buses. This employed a system where black boxes in the aeroplane were connected by a thin co-axial cable. In the event of damage, this could be repaired much more easily than the harness/loom, the repair of which was most difficult to achieve in the old type aeroplane. In the air world, electronics at least looked as though it had a better chance of survival or would be easier to repair than the mechanics.

REAR-ADMIRAL BRYSON
commented that it was pleasing to note that someone in the AE world saw a bright future ahead for reliability, but there could be no such complacency on the surface weapons side which had a long way to go.

Seminar E—Is our officer manpower well founded for the future?

CAPTAIN HAMMERSLEY (*Captain, H.M.S. Thunderer*)
summarized, in anticipation of further comment from the floor, the findings of this seminar and restricted his report to three main areas covering:

(*a*) the employment of engineer officers;

(*b*) career prospects;

(*c*) educational and training requirements.

Under the heading of employment he said there was a need to satisfy various requirements. Engineer officers clearly needed sea experience early in their careers, but later on the means by which they could accede to the higher jobs had to be provided. (He noted that other seminars had also raised the question of the employment of engineers within the Naval Staff.) In addition there was a requirement to employ officers in the PE and the dockyards. Although a feeling was voiced that perhaps we could opt out of these areas the vast majority affirmed the need to infuse these organizations with sea-going experience.

He said that the concept of a common list embracing GL, SL, and SD officers for the first five years of their officer career had found general support. The lists would then be divided into a general engineering stream for the more practical mass leaving the specialist field open to the academically gifted. Thus all GL engineer officers need not qualify for C.Eng. which would follow anyway if the Institutions demanded a minimum 2:2 degree and it would enhance the opportunities given to SD officers.

Turning to career prospects he stated that it was generally felt that the General List concept did not work in favour of the engineer officer and that a statement showing the way ahead, and confirming a route to the top jobs, would be welcomed.

In discussing education and training he said that the best balance between practical training, general training, character, and leadership development, and academic education, had been widely argued. The majority view was that at present the academic side was over emphasized at the expense of the other aspects. However, the academic education could not be reduced without the consequential loss of the degree awarding capability at R.N.E.C., Manadon. He felt that the newly introduced naval engineering degree and the recent developments in application training were moves in the right direction. He

echoed the strong feeling within the seminar that leadership and management training had been somewhat neglected, but said that this had been recognized at R.N.E.C. and that action had been taken to develop the officer-like qualities of those under training with significant success. The demise of the Engineering Management Course was, however, regretted.

Finally he said that the X/WE interface question had been raised repeatedly and there was a firm body of opinion in favour of much closer co-operation between the branches, and in fact moves towards a WE 'take-over' of the X branch were mooted.

CAPTAIN HAMMERSLEY then opened the discussion from the floor by asking LIEUTENANT-COMMANDER THOMPSON to expand on his ideas for a Common Engineering List.

LIEUTENANT-COMMANDER THOMPSON (*10th Submarine Squadron*)
said that his proposals should improve the fighting efficiency of the Fleet and would provide the right sort of officers at all levels. He suggested that the present SD, SL, GL 'strait jacket' should make way for a common pool of engineer officers in open competition, regardless of academic qualifications, up to and including their time as lieutenants. After that, officers would opt for a specialist stream destined for MOD(PE)/dockyard work or remain as dedicated fleet engineers. He foresaw the specialist officer starting with an M.Sc. course and the fleet engineer officer with some form of staff course. He would expect this type of officer to fill Naval Staff jobs having gained full parity with the executive branch at all levels. In fact, he saw the need to unify the X/WE branch in order to find room at the top for engineer officers. As a final punch line he said that, 'We must kick out the "cowboys" and let the professionals in.'

COMMANDER FURZE (*Ship Department*)
objected to the proposal and said that he liked going to sea, and liked putting sea experience back into the PE. It was also pointed out that the proposal had forgotten the manpower and training field, which could be a third career pattern. There was general support, however, for equating the SD officer with those on the General List.

CAPTAIN LOCKYER (*DNOA(E)*)
said that a study on the SD Branch had recently been carried by ADMIRAL TOWNSEND and that work was going on to develop his report. He said that many of the points which had been raised in one of the seminars were covered, and that the disenchantment felt by many SD officers was well known and had provoked this study in the first place. He added that the Common List concept was being discussed and he welcomed the support it had received from the floor because some GL opposition to it had been anticipated.

VICE-ADMIRAL EBERLE (*Commander-in-Chief Fleet (desig.)*)
asked if he could comment 'as one of the Chief Cowboys'. He said that he wanted to make it clear that no room would be made at the top for engineers but that they would get there by merit. He said that he believed that this was what engineer officers would want, and that they were not doing badly in this respect having one Board Member, two other three-star engineer officers, and his relief was to be an engineer.

Seminar F—Is our rating manpower well founded for the future?

CAPTAIN GROVE (*Captain, H.M.S. Fisgard*)
introduced his summary by saying that the Engineering Branch Development (EBD) project was Admiralty Board approved policy; that the planning and definition of tasks and responsibilities, and the definition of new rating categories, etc. for the project were virtually complete. Indeed, implementation had

already begun in some fleet submarines, and various training establishments were well advanced with course design and were preparing to start the new style courses. In Seminar, this scene was set by the EBD project manager, CAPTAIN PURVIS, who said that the answer to the question posed by the Seminar title must be 'yes' or, indeed, the Navy would be in great trouble; but—and there was a large 'but'—the engineering branch of the Service was some 750 short of skilled rating technicians *now* and this posed a very serious problem to the maintenance and fighting efficiency of the Fleet whether EBD was implemented or not.

Notwithstanding the EBD project being approved policy, the Seminar nevertheless spent some time discussing its principles and, indeed, not surprisingly confirmed that its basic philosophy was the right one and the path down which the engineering branch should proceed. Whilst there were no major dissenters, some reservations were expressed, particularly with regard to the increased responsibilities of the MEO. However, submarine experience to date had been encouraging and it was generally felt that the skilled man rose to the challenge and, indeed, derived greater satisfaction from the systems engineering approach. Air engineers present confirmed this view, this approach having been part and parcel of the air world for many years. Introducing a word of caution, submarine representatives admitted that an underestimate had been made of the resources required by the ME sub-branch to support electrical aspects of ship system maintenance. However, this was a minor problem and was being overcome, but it did emphasize the need for detailed planning.

The discussion of EBD principles concluded with the general feeling that the concern felt regarding increased MEO responsibility was probably engendered by apprehension in anticipation of taking over the new responsibilities before the fact of actually doing so. As already stated, practical experience in the submarine and air branches confirmed this view.

The Seminar devoted virtually the remainder of the available time to discussing the probable causes and possible remedies for the very major problem of skilled manpower shortage that was with the Fleet here and now. Against the background that it takes five years to train an artificer and roughly twelve years to produce a chief artificer, the problem was predicted to get worse before it got better. Even an upturn in recruiting now would not show benefits before the mid 1980's. Short term measures were required *now*. Discussion centred round:

(*a*) improvement in skilled manpower retention;

(*b*) reduction of commitments;

(*c*) making more effective use of existing skilled manpower.

The Seminar was in no doubt that retention was the key to the solution of the problem. Why did skilled manpower leave the Navy? Pay was not considered to be a major issue, particularly if the Government honours its pledge to restore full comparability. Conditions of service did, however, loom large in many different aspects. Examples of this were the anomalous treatment of the MOD(N) civilians and service personnel when engaged in similar activities with particular regard to expenses, separation warrants, etc. Another was the conflicting situation of senior ratings being encouraged to buy their own houses, and then finding their time ashore being spent out of their own area either wholly or on long courses; the situation being further exacerbated by present legislation being much more in favour of the tenant than the home owner, so that moving families to place of duty could be a difficult, unprofitable, and, indeed, risky business.

'Stretch' both at sea and ashore was considered to be a significant factor, particularly the latter. Amongst other speakers, LIEUTENANT-COMMANDER CLIFTON (H.M.S. *Fife*) said that the majority of personnel were prefectly content to work hard and long hours at sea but nowadays port visits during group deployments and at other times tended to be so short that engineering personnel

spent much of their in-port time on repairs and maintenance and got minimum time ashore. It was concluded that the fun had gone out of foreign visits largely because of this situation. As regards 'stretch' ashore, LIEUTENANT-COMMANDER BEATTY (H.M.S. *Defiance*) highlighted instances where certain highly-skilled and specialized nuclear submarine ratings, having spent some ten years at sea as nuclear operators and maintainers, found themselves in the submarine bases working shifts seven days a week, such that normal family life was very disrupted. Nearly all men left the Navy with a sense of regret and sadness but felt that they owed it to their families to seek employment that gave less turbulence to the family as a unit.

CFM Devonport expressed the view that the additional stretch both in the naval bases and FMU staffs resulted from the greater than expected support required by the new classes of ships, particularly the Type 21: originally it was thought that they would need 20 per cent. more support than the LEANDER Class because of smaller ships companies but, in fact, something like 50 per cent. more support was required. The new ships were supported by the U-by-E policy, which worked well for all the main propulsion systems but poorly for other equipments. These still required the deep craft skills for effective maintenance.

COMMANDER KEENAN (H.M.S. *Centurion*)
expressed great concern at the effects of the 'constrain' policy. Centralization of training in the Portsmouth area meant that non-Portsmouth ratings spent a considerable amount of their shore time out of their area, away from their families doing qualifying courses, Adquals, etc. A strong plea was made for the reintroduction of base-porting with trading facilities made available in the port areas for the abovementioned types of courses. Shortages were now so acute in some categories that ratings in these categories could not be drafted to sea as under the present regulations minimum time ashore requirements had not been met.

The Seminar concluded that in order to improve retention in the short term, urgent consideration must be given to the following factors:

(*a*) Improve conditions of service.

(*b*) Reduce 'stretch' both at sea and ashore (restore some fun to service life).

(*c*) Reintroduction of base-porting.

The situation was a stark one and drastic measures were necessary. Commitments would have to be cut and possibly ships laid up. If a theme was required for the next conference, it could well address itself to this major problem.