THE WEAPON SYSTEM MANAGER

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ABSTRACT

This article aims to explain the concept of the Weapon System Manager (WSM) within a Warship Project. Historical background is followed by a review of how the WSM fits into the current organization. The weapons specialist himself and his professional standing are briefly discussed before expanding on the role, the work and the resources available to the WSM. Contractual and other support facilities lead to the concluding remarks. Throughout, emphasis is placed on the idea of Ship Weapon System Engineering (SWSE) and the range of professional disciplines that it relies on.

Introduction

The Weapon System Manager (WSM) is now an established member of the individual Warship and Submarine Projects within DGSS and DGSM. However, there remain many misconceptions as to what the WSM is and what he does. This article aims to explain the role of the WSM; in some cases it may open doors to some who have been looking for a means of dealing with an otherwise intractable problem which cuts across traditional professional boundaries. In others it will regrettably show that the WSM is not a sink of expertise that can absorb the rejects of individual Equipment Projects. At the end, all who have dealings with WSMs should have a clearer perception of what the WSM does, what he is expected to do, and what the constraints imposed on him are.

Scope

There is no such thing as a typical WSM. In describing the general nature of his work it is essential to illustrate general points with specific examples. Since the author resides within DGSS, submariners may find that their case is less well aired; since he is, further, the WSM for Mine Warfare Vessels the examples will draw largely on that sphere of work. But specific cases are intended to illustrate what would otherwise be rather abstract generalizations in order to show how principles are being put into practice.

Neither is this article intended to put across any particular party line. The WSM is sufficiently an innovation to be still in a state of flux, as will be descibed later. Personal views are therefore inevitable, albeit tenable. It is as important for the outsider to understand the constraints imposed on the WSM as it is to understand what, in an ideal world, he is supposed to achieve. It is also important to appreciate the common ground on which he stands with others in the SSC, and where he has unique problems.

One general point; at times the reader may find the descent into alphabet soup a little disconcerting. Acronyms are expanded in Appendix I (p. 527) rather than disrupt the discussion, but most should find them more or less familiar.

History

When the research behind this article was undertaken, it was surprising how poorly documented was the emergence of the WSM. No doubt those with a lifetime of experience in the weapons field, particularly in the former DGW(N) and DG Ships, will protest that what is set down here is not at all how it all began. All that can be said is that what is quoted here is written

down in various studies, and that those who have been consulted and who have claim on knowledge of the background nevertheless admit to differing recollections of those early debates. What is not at issue is the conduct of business today.

New Look

The starting point is taken as the Final Report of the New Look Review Team, published in 1982. The Team was directed to look at the organization and structure of the Sea Systems Controllerate with an eye to the future. This was seen by many at the time and subsequently as rationalizing the growing dichotomy between the former DGW(N) and DG Ships. From this emerged DGSS and DGSM dealing with platforms, and DGSW(N) and DGUW(N) dealing with weapon equipments. The continuing split between platforms and weapons nevertheless remained and was further perpetuated in the form of DCW and DCWE, with CNWSE uncomfortably bridging the gap between them. Since then further evolution has replaced DCW and DCWE with CASE and CUSE, and CNWSE has split, his functions being subsumed by DCS/SS and DCS/SM respectively.

SWSE and the WSM

Before New Look the growing recognition of the penalties of separating weapons from platforms, not least in their management, had resulted in the establishment of DSWS under DGW(N). This Directorate was responsible for the acceptance of new weapon equipments and systems into service, overseeing weapons work in ships under construction, programming weapon equipment deliveries and the provision of some ranging facilities. These latter tasks are now undertaken by CSSA and CSMA, and DTS(W). But the task most relevant to this article resulted from the introduction of the concept of Ship Weapon System Engineering (SWSE). This aimed at the overall weapon system design for a given class of ship and the integration of weapon equipments and systems into the ship design. The SWSE concept continues and is at the core of the work of the WSM.

The Warship Project

As already noted, the emergence of the WSM himself is not well documented. Although the term is not used in the New Look Review Team's Final Report, the concept of WSM is clearly identifiable through the recommendation that SWSE work should pass to overall Warship Project management. The Report also recommended that SWSE work should be separated from other work with which it was indirectly related, quoting Trials and Acceptance as prime examples.

The Future

New Look has continued to evolve; the replacement of DCW and DCWE by CASE and CUSE has already been noted. Further development is in the wind as a result of another recent study of the Controllerate's working, the results of which are not yet known. At a lower level, the attempt of New Look to pull together weapons and platforms has not been entirely successful. Although the WSM is now firmly established within Warship and Submarine Projects, his role (within DGSS at least) is being reviewed with the aim of recommending measures to improve his effectiveness further. This article cannot speculate on the outcome of these further studies, but subjective views on what might be advisable are in order. Finally, in this brief review of history, the decision to collocate major elements of the Controllerate in the Bath area is likely to ease the WSM's task in dealing with Equipment Projects.

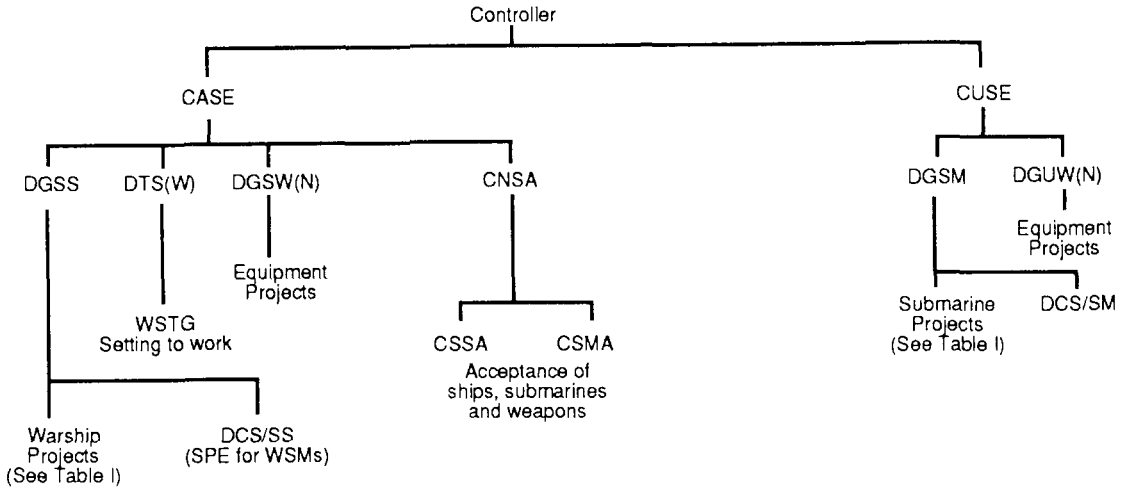

FIG. 1—SEA SYSTEMS CONTROLLERATE—PRINCIPAL COMPONENTS OF ORGANIZATION AFFECTING WEAPON SYSTEM MANAGERS (SEE APPENDIX I FOR ABBREVIATIONS)

Organization

In order to illustrate the diversity of the components of the SSC with which the WSM regularly does business, an extract of the relevant elements of the organization is shown in FIG. 1.

DGSS

Within DGSS each Warship Project has its WSM, as shown in TABLE I. The WSM invariably has a weapons background, and may be a civilian Grade 7 or naval commander WE. In some cases he may also have responsibilities for electrical as well as weapon systems. Typically he will be working alongside Constructive, Mechanical, Electrical (if the WSM does not already have this task), and Production and Support Managers at the Grade 7 or SPTO level.

TABLE I—*Weapon System Managers*

DGSS
Surface Ships A
Type 23 frigate—commander
The future frigate (formerly NFR 90)—constructor
Mine warfare vessels—commander
Surface Ships B
Auxiliaries, AOR, SOV—constructor
Surface Ships C
Amphibious ships—constructor
Carriers, destroyers and Type 21 frigates—commander
Type 22 frigates and LEANDERS—constructor
DGSM
Trident
Tactical weapon systems—captain
Type 2400
Tactical weapon systems—captain
In-Service Submarines
Tactical weapon systems—grade 6
SSN 20
Weapon system—grade 6

The Warship Project itself is headed by an AD at Grade 6 or captain level. The Mine Warfare Project under AD/MCM, a chief constructor, is shown in FIG. 2 to illustrate a typical Project organization. Under the WSM the structure varies widely, reflecting the peculiarities of individual ship classes and the status of the Project. The WSM's staff will consist for the most part of PTO grades with a leavening of WE officers.

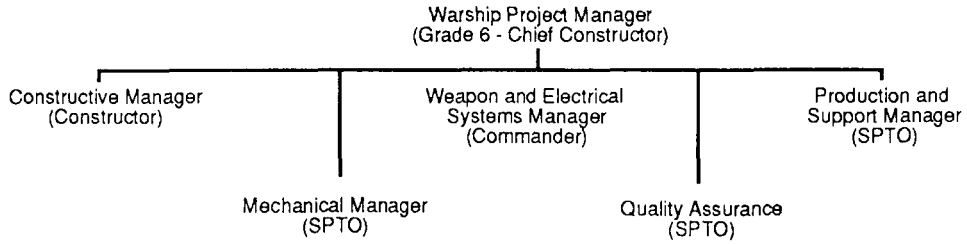

FIG. 2—TYPICAL WARSHIP PROJECT STRUCTURE (FOR MINE WARFARE VESSELS)

DGSM

Arrangements within DGSM are rather different, since individual submarine projects are headed by Directors at Grade 5, with WSMs usually at Captain or Grade 6 level as shown in TABLE I. The nominally higher level (justified, and possibly reflected, by numbers overall) of staff relative to their DGSS counterparts has attracted some attention recently, but there is no indication whether or not any alignment between DGSS and DGSM will result.

DGSW(N) and DGUW(N)

What is immediately evident from FIG.1 and the organization that has been described is that the WSM has no line or functional authority over individual Equipment Projects. Equipments Projects are nevertheless functionally accountable to Warship Project Managers for ensuring that their equipment is available to cost, programme and performance. Authority therefore derives from the WSM acting as the Warship Project Manager's agent. In many cases common interest stems from particular Weapon Systems being specific to classes of ship, but there are also many systems which have a wider fit throughout the Fleet, and the Equipment Project Manager has no simple allegiance. The onus is therefore placed on the WSM and Equipment Project Managers developing a close working relationship and personal rapport; with the best will in the world this will become most strained when it is most needed. There are also some procedural methods by which the two can conduct business, and these are fully exploited by both sides in their common interest; these include a number of committees as described below.

The Weapons Specialist

Whatever his background, and whether he is a naval officer or a civilian, the weapons specialist is often viewed with a little suspicion tinged with awe by his colleagues. Work in the weapons field is regarded by others as difficult, complex, and even arcane; the weapons specialist may occasionally be his own worst enemy in encouraging this attitude for his own ulterior motives. Others, with some justification, see him as inclined to hide behind jargon and to have a cavalier attitude to costs and time scales. These charges are, for the most part, based on limited understanding of the peculiar problems of the weapons field. While they cannot be debated in detail in this article, discussing them in the context of the WSM's work should give some insight into why these characteristics should impress themselves on outsiders to a misleading degree.

The WSM cannot allow misconceptions about what he does to persist. His entire business revolves around his ability to communicate with his professional colleagues on his Warship Project, and above all to convince his superiors that he has particular skills which are an indispensible contribution to their common goals. In addition to stripping a complex subject down to its comprehensible essentials, the WSM will often have to cultivate more ready acceptance of his line of business amongst both engineers of other specializations and administrative staff with little or no technical literacy.

This need to sell his professional interests is currently evident within DGSS and to a similar degree within DGSM, where senior management is predominantly drawn from constructive and mechanical backgrounds. This is probably an historical accident following the evolution of DGSS from DGW(N) and DG (Ships), and there are obvious exceptions; DGSS himself is an ex-DGSW(N). It does mean that the WSM may feel a little isolated, with professional sympathy limited largely to fellow WSMs. He does have access, however, to his own Senior Professional Engineer (SPE) in the form of DCS/SS; similar lines of access to their own SPEs exist for other engineering disciplines. Since the SPE has access to the Controller on professional matters this can be a powerful tool, but for that reason needs to be invoked sparingly. In practice the WSM is routinely better served by engaging his own personal powers of expression and persuasion in maintaining the attention, comprehension and active support of colleagues and superiors. In the meantime, the imbalance is recognized by senior management, and there is evidence that senior management is receiving an increased leavening of weapons specialists.

The other side of the coin, however, is that weapon systems are indeed increasingly complex, expensive, and above all incur significant risk during development. No amount of management or financial sleight of hand can conceal that fact, and this is probably the root of the unease felt by the WSM's colleagues. If the WSM has to work on establishing his professional credentials, then those same colleagues should recognize that the infrastructure and uncertainty that they find unsettling are necessary—but imperfect—components of the weapons business. Mutual appreciation of each others' particular problems is needed in order to meet halfway along the road of co-operation which leads to the success of their common projects.

What it boils down to is that the WSM is, like the majority of weapons specialists, invariably an enthusiast. He is operating near the cutting edge of high technology, and he finds the range of engineering professionalism that his work demands to be stimulating. If he occasionally indulges in a tendency to revel in deep technical detail, and if he sometimes shows irritation with the delay inherent in MOD procedure, bear with him. You are likely to find that he understands rather more about the facts of life in the MOD at large than he cares to let on about.

The Task

The Warship Project Manager builds the ship, and the Equipment Projects produce the weapon systems that go into it. The former, however, needs to ensure that the weapon systems individually and collectively meet the ship or submarine Staff Requirement in addition to their own Staff Requirements, and that they are properly installed, set to work, integrated and subjected to successful trials. It is the task of the WSM to bridge the gap between ship and weapon systems. He is the design authority on behalf of the Warship Project Manager for the overall weapon system design and is responsible for its implementation.

Before going into some detail it is appropriate to point out that the tasks of WSMs fall into one of two categories, although some WSMs cover both. The first category is new construction, with the further subdivision into those who are concerned with whole ship procurement and those who are concerned with conventional procurement. The arrangements for whole ship procurement or some similar form of prime contractorship are somewhat different from conventional procurement, but space precludes their being addressed in any depth. The second main category is that of running ships. Whereas one starts with a nominally clean sheet of paper, the second has to oversee the evolution of an existing design from a fixed baseline.

Combat System Design

The need for a systems outlook has long been recognized and indeed cultivated in the weapons field. Practice has however lagged behind the theory. It is receiving new impetus, particularly in the case of new ship designs. Formal specification and design methods are now establishing themselves and are acquiring a fair measure of respectability. The submarine world has achieved rather more than surface ships. There are good reasons for this, and DGSS is now catching up. Whether or not he has the benefit of these more modern techniques, the WSM has to keep firmly in mind the overall weapon system performance that has been called for. This will include its specified and achieved performance, its integrity (including vulnerability to failure or action damage), safety matters and ARM performance.

Integration

The WSM needs to cut through a plethora of detail in order to keep sight of the aim, in which he ensures that the ship design can accommodate the weapon systems that it is intended to carry. Individual equipments have to be made to work together as well as in isolation. Achieving this is the process of weapon system integration, which has to be as carefully planned and documented as the build of the ship itself. His influence over the design and development of new systems is primarily concerned with their ability to conform to overall weapon system characteristics and to meet the requirements for weapon system integration. In addition he needs to exercise control over the way in which they affect the design, cost and programme for his ship. The formal methods referred to above in the context of Combat System Design appear to have great potential in replacing the laborious heuristic methods that currently abound.

Platform

When a new equipment is to be installed into either an existing ship or into a new design, the first question to be settled by the Warship Project Manager is that of weight, size and services required. It is surprising how often these fundamental parameters either change during the procurement process or are specified late in the day. Design changes of the ship itself may be injected from a wide range of authorities who have an interest in specific aspects of the design. Nominal savings in unit procurement cost may be eroded by costs of ship design change or consequent increased costs of installation.

Supply and Procurement

Supply of equipment will inevitably be uncertain in the early stage of its service life, and also towards the end when the cost of supporting obsolescent equipment will tempt DGST(N) or an Equipment Project to economize in its repair and replacement. Although these two authorities between them are responsible for ensuring timely equipment supply, whenever the supply chain

threatens ships' build or refitting programmes the WSM may need to step in to help restore good order, perhaps with the help of DGSR for ships in refit or DED. The WSM is responsible for producing the Weapon Fit Acquaint, stating what equipment is to be fitted in each ship, and for the Weapon Equipment Delivery Programme, which represents the agreement between the WSM, Equipment Projects and Shipbuilder on what equipment is to be supplied and when. These two documents are subject to continuing review to reflect minor changes in equipment fit and supply; it cannot be assumed that the issue of these documents is a guarantee that their provisions will be met. The WSM's staff spend much time at this level of supply detail.

Installation

As each equipment is installed into the ship the Shipbuilder works to the relevant Installation Specifications. Typically these fall into two parts. The first is the set of instructions produced by the Equipment Project, which describe how the equipment should be installed in any ship. This is more than a mechanical procedure of bolting electronic cabinets onto their mounts. They also have to be connected to the various services needed to make them work; electrical supplies (and that includes converted supplies as well as main supplies), chilled water, air conditioning and so forth. One system will invariably consist of a number of units fitted in different parts of the ship, and these have to be interconnected, probably with thousands of separate cable terminations having to be accurately identified and made. In order to identify where these services and interconnections are to be found in a particular class of ship the WSM produces a set of instructions which are the ship counterpart of those produced by the Equipment Project. This, the second part of the Installation Specification, must be consistent with the first and exhaustive attention to detail is needed to ensure that this is so.

Setting to Work

Having got the equipment into the ship it has to be set to work. This is normally done by the Weapon Systems Tuning Group (WSTG) within DTS(W), but may under certain conditions be undertaken by the Equipment Project or a contractor. Normally the WSM need do no more than monitor progress, as WSTG make their plans and carry out their work in consultation with the Shipbuilder and the Naval Overseer. The WSM does, however, need to know when to take a closer interest because things are going wrong; this may be due to lack of test equipment, spares, poor documentation and so forth. It remains his responsibility to ensure that this stage of work is satisfactorily completed and on time.

Trials, Inspections and Acceptance

Installation and setting to work are conducted against a background of trials and inspections carried out by CWTA. Again, the WSM has little to worry about if all goes well. If CWTA pronounce adverse judgements at any stage, the WSM has to establish what has gone wrong, what is needed to put it right, who is taking the necessary action, and above all to ensure that the impact of the failure on the ship's programme is reduced to the minimum. Once setting to work is completed a sequence of Harbour Acceptance Trials and Sea Acceptance Trials (HATs and SATs) begins, in which CWTA representatives rigorously examine the performance of each equipment and system. They also examine a number of other features, particularly in the support field, to ensure that the equipment can be supported throughout its life. The WSM will take a close interest in these trials as their success or failure will have a direct bearing on the Ship's Part IV Programme, and he does not have the buffer of either WSTG or Naval Overseer to act as

intermediary. He also ensures that adequate and timely responses are made to CWTA Trial and Inspection Reports. At the end of the day he has to ensure that CSSA is able to recommend acceptance of the ship and its weapon systems.

Committees

For all equipments, and particularly new ones, the WSM needs to take an interest in the Project Review Boards and Weapon Acceptance Committees that regularly audit the health of Projects and oversee their progress towards Fleet Weapon Acceptance. His staff will attend Upkeep and Support Committees. These meetings enable him to keep abreast of developments on a broad front and to hear the views of other authorities that may well colour his own perceptions: support arrangements, funding difficulties, LTC provision, changes in requirement and so on. They also give him the opportunity to inject his own views in public and if necessary to apply pressure.

The Real World

Once a ship enters service operating authorities will want to ensure that her operational effectiveness as well as the nominal technical performance of her weapons is being achieved and maintained. Some means of measuring in-service performance needs to be provided. This will cover purely technical parameters and also assessment of operational data. The WSM will need to ensure that the widely differing requirements of operational and weapon data recording are properly provided for, and that the necessary means are available for its analysis and interpretation. Here he is closely involved with operational authorities. His contribution to Systems Effectiveness Groups (SEGs) and Platform Effectiveness Groups (PEGs) is important as they make their input to the annual Fleet Effectiveness Assessment Review (FEAR).

Upkeep

Much of the above applies with some modification to refits and DEDs. In order to explain the foundation on which these tasks are based, it is now necessary to explain the concept of SWSE in more detail.

Ship Weapon System Engineering

It will be clear from the way in which the concept of the WSM emerged from its origins within the former DSWS that SWSE work lies at the core of the WSM's work. There is another fundamental change, additional to that of reorganization under New Look, which has to be taken into account. Formerly the SWSE role was undertaken intramurally by civilian and naval staff. Value for money and Government policy that work should be placed with industry on a competitive basis, unless there are overriding reasons for doing otherwise, has led to the bulk of SWSE work being placed with contractors. If one can achieve the same results at less cost without penalty of any kind the arguments for doing so are irresistible.

First it must be explained what SWSE work is and to examine the task of the WSM. The range of work covered can be very wide indeed, ranging from routine technical administration through deep engineering study of system performance and design to assessment of the impact of system performance on operational effectiveness. The level of expertise and depth of specialist knowledge can vary widely. Whereas specific tasks can be specified at the design stage of a new ship, aimed at meeting system performance parameters and subsequently at successful design integration, SWSE work can be much more variable and unpredictable later in the life of the Class. New requirements have to be studied and evaluated, unforeseen problems must be

addressed as they arise from operational experience with the ships, and plans to upgrade ships to maintain or extend their useful lives and operational effectiveness have to be studied. The content of SWSE work is now described in more detail, but the outline of a typical SWSE Contract Specification at Appendix II illustrates the diversity of its content.

Records and Change Control

There is a substantial element of technical administration that has to maintain accurate records of weapons equipment and the ships into which it is fitted. This is closely allied to Change Control and Configuration Management. Despite the extensive infrastructure that has been established within the Sea Systems Controllerate for this purpose, the weapons field is something of a patchwork, often reflecting the constraints imposed on individual Equipment Projects. Although a fair degree of consistency has been achieved at the higher and intermediate levels for weapons, at lower levels of detail the variability of quality and content leave much to be desired from the WSM's point of view. He needs his SWSE contractor to put in a substantial effort on his behalf, capitalizing on, for example, the Master Records Centre and thereby preventing the contractor from implementing his own ideas unchecked. Typical of the information to be processed are Alterations and Additions, modifications to equipment and their implementation in individual ships, maintaining an accurate database of equipment handbooks, installation specifications, setting to work instructions, trials schedules, interface specifications, upkeep and support documentation (all of which must have issue states accurately recorded) and supply documentation. All this is needed simply so that the WSM, his staff, equipment projects, support staffs and ships' staffs know what their engineering baseline is.

Weapon Engineering

Having defined the baseline the real work can begin. All of the above documentation has to be kept under constant review in order to accommodate the fact that the ships themselves and their equipment are always in a state of flux. Deficiencies and improvements in design, changes of requirement, equipment upgrade all have to be identified and critically examined before they proceed to their eventual implementation. The WSM has to ensure that he has taken full account of their impact on the weapon equipment itself, its integration within the weapon system and the impact on the ship. He needs to provide for the means for recording and analysing the results of trials, routine operation and exercises. The increasing emphasis on ARM must now be given much more than the passing attention it has previously attracted. Rarely can the WSM take on this work in full himself. He has to engage the support of other authorities, in particular with Equipment Projects, in order to ensure that the right expertise is tapped and that full account is taken of their opinions and activities.

Platform Engineering

In addition to the weapon systems themselves their mutual effects on the ship must be taken into account. This will include signature control; acoustic, magnetic, radar cross-section and infra-red signatures are all of increasing importance and are also considered by the Warship Project as a whole; the WSM has to contribute as a member of a team and not react in isolation. Electromagnetic compatibility and mutual interference have implications beyond their impact on weapons equipment and indeed within individual ships. As an example, consider the scope for counterproductive unilateral action in reducing the vulnerability of GRP mine warfare vessels, which are electromagnetically transparent, to having their machinery control systems

shut down by high power radar transmissions from ships in company. The radars are needed for air defence of the force and so cannot be switched off, while the mine warfare ships must clear their routes to high degrees of probability in order that an amphibious force can approach the shore safely. TEMPEST and RADHAZ affect the whole ship and its operation, but their detailed effects result from the way in which the ship is built and how equipment is installed.

Resources

Staff

WSMs would probably put at the top of their problem priorities the lack of qualified staff. A numbert of factors—the demographic trough, the poor record of the U.K. in producing high quality engineers, conditions of service in the Civil Service, and Government insistence on passing more work to industry—all contribute to staff levels being considerably below what WSMs consider adequate. The balance between intramural effort and contractor support is discussed later. Like his colleagues, the WSM has to establish and exercise priorities.

Finance

Although the WSM is not responsible for bidding for finance in support of Equipment Projects, he has to make LTC provision to cover his SWSE work. This is likely to centre on a single SWSE Contract, but will incorporate others relating to weapon system integration, data managment, electromagnetic compatibility, and perhaps a Shore Development Facility. As the LTC advances refinement of the costings will evolve as supporting studies are conducted under the WSM's supervision. This is because the specialized nature of many of these tasks is beyond MOD costing resources and must themselves be put out to contract if they are to be realistic and capable of being defended during the annual round of Scrutiny. Overall financial provision may be modest by comparison with individual Equipment Project budgets, but as an investment the WSM's bids are good value for money—without them weapon system integration would never take place.

Contracts

It is Government policy to place work with industry wherever possible, and to obtain value for money when it does so. The implications for the WSM are such that the subject is discussed in greater detail below.

MOD Agencies

Quite apart from the various Equipment Projects that he deals with, the WSM needs to call on the expertise of many other authorities within the Controllerate to cover such subjects as electromagnetic compatibility, mutual interference, trials, acceptance, upkeep and support, magazine safety, ARM to name a few prominent subjects. He will often be in competition with others for limited resources in these specialized fields. As Defence Support Agencies are established, there will be a greater need to justify and account fully for the resources bid for and expended. Alternatively the work may be placed with a SWSE Contractor.

Contract Support

It is now worth examining the use that the WSM makes of contract support; the topic has been touched on at several points already in this article. This, of course, is as much a common feature of his work as of that of his professional colleagues.

Making the Contract Work

In common with other areas of work, a balance has to be struck between engaging contractual support and consequential erosion of intramural expertise. Contracts need to have accurate and comprehensive specifications written, and these need to be drafted by engineers who understand the problems that are to be solved. Bids have to be called for, evaluated, and the contract placed; Contracts Branches play an important role here in drafting the legal and financial element, but they are heavily dependent on technical advice for the specification and evaluation process. Once in place the WSM's staff have to monitor the progress of the work carried out under the contract and ensure that the product meets the WSM's requirement. Managerial expertise in addition to purely technical skills is called for to ensure that programmes and costs are effectively controlled. This combination of technical and managerial expertise is a substantial overhead that relies heavily on a wide professional competence. Care needs to be taken in assessing the trade-off between nominal staff saving and the overhead incurred in administering the Contract from specification to implementation.

Competition

There is also the requirement for competition. Although expenditure on SWSE is modest by comparison with many other areas of defence procurement, the contracts are keenly sought by those contractors working in the field, many of whom see spin-offs into more lucrative contracts in related fields. Many WSMs have strong personal preferences, based on past experience of individual contractors and their own subjective but nevertheless professional assessments of their competence. But each WSM neverthless must invariably set up a competition which will withstand the scrutiny of audit. Arguably the result will be what the WSM would have expected (or indeed have wished for), although now objectively set out and agreed by Finance and Contracts Branches. This is a significant component of the overhead previously referred to which is often overlooked.

SWSE Contracts

SWSE contracts are inevitably the major contenders for contractual support, although additional specialist contracts will be required from time to time. A SWSE contract, however, has a distinctive feature that is not often reflected elsewhere. What is being sought is a service, and particularly the ability to react quickly and effectively to system design problems arising in most case from operationai experience. The workload is therefore unpredictable beyond the short or medium term, and the range of engineering expertise called on may be wide and variable, depending on the work in hand. The contract has somehow to accommodate this range and variability without giving a licence to the contractor to run away out of control. Each WSM has his own solution to this problem to suit his particular circumstances. Some of the factors to be taken into account are worth reviewing.

Work Content

No one contractor is likely to have credible expertise across the full range of the SWSE requirement. Provision must therefore be made either for him to subcontract under control of the WSM, or for separate contracts to be placed by the WSM himself as and when required. The former has the attraction that the effort of placing the work is shifted onto the SWSE contractor himself, although it will attract a premium (overheads and profit) for his doing so. It is also likely that the work will be placed more expeditiously, since it will avoid the procedural delays enforced intramurally.

Such a procedure is fortunately in accordance with the principles of placing work with industry whenever possible.

Workload

A second factor is control of the workload, regardless of the content; it is part of the intramural contract overhead. One solution, adopted in different guises by individual WSMs, is firstly identification of a base load, largely covering the routine business of technical administration that would otherwise be accommodated intramurally. This is a candidate for fixed or firm prices, the work actually undertaken being subjected to regular monitoring. The second component is then a series of work packages, the content, cost and programme for which are agreed between the WSM and SWSE contractor on an individual basis. Costs of these work packages will, wherever possible, be based on fixed or firm rates agreed at the time of placing the contract. This enables the WSM to keep the programme of work and cost under control.

Continuity

A third factor that is characteristic of SWSE work is continuity. The effectiveness of the contractor benefits enormously from corporate expertise gained over months and years. SWSE contracts are likely to be placed for three years, the maximum being five years through contract extensions before a fresh competition and contract becomes mandatory. The WSM can therefore expect a break in continuity of service unless his original contractor has managed to win the competition for a replacement. This can be an uncomfortable period.

Costing

Finally, a few words on the financial aspects. The overriding principle for pricing a contract is that it should be at fixed or firm prices unless there are compelling reasons for doing otherwise. As described above it is often possible to establish a base workload that can comply with this requirement. The variable element is likely to be based on fixed or firm rates; this calls for the WSM to exercise judgement on whether the contractor is overstating the hours or expertise he is proposing for the package. This points up an intramural deficiency in the estimating of costs. Whereas many other areas can call on the services of cost estimators in order to establish or validate costs quoted by a contractor, no such service exists for SWSE work. This does not accord well with obtaining value for money. That aside, the inherently variable nature of SWSE work makes it difficult for the WSM to do more than make an educated guess at the level of financial provision needed for LTCs. He is on safer ground if he is dealing with SWSE support of running ships since he has precedent to fall back on. The problem is more difficult if he is dealing with a new class of ship.

Support Services

It has already been noted that the WSM is reliant on a large number of authorities in order to discharge his responsibilities. The role of Equipments Projects, other MOD Agencies and the SWSE Contractor in the technical and project management fields has been described.

There are, however, intramural support services which are not directly concerned with technical issues and which have no convenient contractual substitute and which are vital to the WSM's work. Firstly, Finance Branches, who scrutinize bids for funding and approve release of funds, need cultivation.

They are not qualified to appreciate technical nuance, and the WSM will take care to explain in layman's terms what he wants and why. This exercise in itself can be a valuable discipline. Secondly, Contract Branches, who will ensure that the necessary contractual rigour is applied, need equal consideration on the part of the WSM. Thirdly, unless the WSM and his staff understand the mechanisms of supply, embarrassing and costly mistakes in providing equipment for installation or spares for maintenance and repair can occur. Good liaison with these essential but non-technical supporting services pays dividends and rewards effort expended out of proportion to the time taken.

In common with many other parts of the Controllerate, WSMs are endeavouring to offset cuts in staff and other resources by acquiring modern IT. The continuing pace of development in hardware and software makes it difficult for even the most well-heeled and informed to ensure that he is getting what he needs, but applied intelligently even modest IT support is enormously beneficial. The subject warrants an article in its own right, but suffice it to say that there are significant areas of routine technical adminstration that respond readily to currently available technology. Unfortunately the Controllerate fails to meet the demand for IT and to match the pace of the defence industry in embracing its benefits.

Conclusions

Lest the reader feels that the WSM does protest too much, let me reassure him that neither I nor my weapons colleagues are trying to set ourselves up as in any way exceptional. If the impression is gained that the general nature of the problems described are no different to those that everyone else faces, then it is correct; the WSM is probably no worse and no better off than his peers. But his work is different in character; if it were not so then there would be no need for the WSM, still less for this article to explain what it is all about.

The professional challenges faced by the WSM are wide, as exemplified by the core concept of SWSE. System engineering, electronic and electrical engineering, computer hardware and software, applied physics (acoustics, hydrodynamics, geodesy, electromagnetics), and mechanical engineering at all levels of technical detail feature in his work. In addition to managing his own section within his Warship Project he has to tread a delicate path in advising, consulting, persuading and otherwise influencing autonomous Equipment Projects on whom he is entirely dependent. He has to make the most of limited resources and in doing so establish and exercise sometimes unpalatable priorities; he is constrained by staff, finance and the terms of contracts that he himself has set up. His preoccupations with present crises must not divert him from looking to the future in planning his work. Life is never dull. But at the end of the day he is the member of the Warship Project team who transforms a hull into a warship. Others may debate whether ships are built to carry the weapons or weapons developed to match the ship; the WSM recognizes that one depends on the other.

One final observation; this article has attempted to cover a wide field. There are subjects that have been touched on lightly or not at all, or that have been somewhat distorted by the need to generalize. To those who feel that their interests have been neglected or misrepresented I apologize and ask for their understanding that broad brush strokes necessarily obscure important detail.

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APPENDIX I—ABBREVIATIONS AND ACRONYMS

AOR	Auxiliary Oiler Replenishment
ARM	Availability, Reliability and Maintainability
CASE	Chief Above Water Systems Executive
CNSA	Commodore Naval Ship Acceptance
CNWSE	Chief Naval Weapon Systems Engineer
CSMA	Captain Submarine Acceptance
CSSA	Captain Surface Ship Acceptance
CUSE	Chief Underwater Systems Executive
CWTA	Captain Weapons Trials and Acceptance
DCS/SM	Director Combat Systems (Submarines)
DCS/SS	Director Combat Systems (Surface Ships)
DCW	Deputy Controller Warships
DCWE	Deputy Controller Warship Equipment
DED	Docking and Essential Defects
DGSM	Director General Submarines
DGSR	Director General Ship Refitting
DGSS	Director General Surface Ships
DGST(N)	Director General Stores and Transport (Naval)
DGSW(N)	Director General Surface Weapons (Naval)
DGUW(N)	Director General Underwater Weapons(Naval)
DGW(N)	Director General Weapon (Navy)
DG Ships	Director General Ships
DSWS	Director Ship Weapon Systems
DTS(W)	Director Technical Services (Weapons)
EMC	Electromagnetic Compatibility
FEAR	Fleet Effectiveness Assessment Review
HAT	Harbour Acceptance Trial
LTC	Long Term Costings
PEG	Platform Effectiveness Group
SAT	Sea Acceptance Trial
SEG	Systems Effectiveness Group
SOV	Seabed Operations Vessel
SPE	Senior Professional Engineer
SPTO	Senior Professional and Technology Officer
SSC	Sea Systems Controllerate
SWSE	Ship Weapon System Engineering
WSM	Weapon System Manager
WSTG	Weapon Systems Tuning Group

APPENDIX II—SUMMARY OF A TYPICAL SWSE SPECIFICATION

Management and Control

Conduct of Contract. Control of work programme and costs, including any sub-contracts.

Monitoring. Supervision of the work programme, progress, manpower and other resources deployed on SWSE work.

Change Control

Change Control. Configuration management and maintenance of records.

Modifications, and Alterations and Additions. Effective planning and liaison with equipment projects, production of supporting documentation.

Weapon Engineering

Services. Compartment layouts, ship fittings, related structural work, production of drawings and installation specifications, integration with ship services.

Integration. Maintenance of the Ship Weapon System Handbook, Interface Specifications. Weapon data management, provision of weapon data recording and analysis, support of assessment of weapon system effectiveness.

ARM. Prediction and modelling of ARM performance, specification, recording and analysis of trials.

Platform Engineering

Signature Control. Specification, recording, analysis and control of acoustic, noise, magnetic, infra-red, radar and other signature components.

Electromagnetic Compatibility and Mutual Inerference. Recording, investigating, analysing problems related to EMC, EMP, TREE, TEMPEST, RADHAZ and all forms of mutual interference. Internally and externally generated contributions are included. Evaluation of solution options.

Ship Upkeep and Support

New Construction and Ships in Maintenance. Recording, analysis and evaluation of defect reports, trials and inspection reports.

Supply. Production and maintenance of documentation in support of maintenance and supply activities.

Shipbuilder and Ship Refitting Liaison. Briefing and information release.

Support Activities

Services. Drawing Office, Reprographic and ADP facilities. Secretarial support.

Representation. Attendance at meetings, trials, inspections. Direct staff support.
