TRAINING A NAVY

THE EXTENSIVE USE OF SIMULATORS

BY

VICE-ADMIRAL SIR ROBERT HILL, KBE, BSc(ENG), CENG, FIMECHE, FIMARE
(Chief Naval Engineer Officer)

This article is a shortened version of the 55th Parsons Memorial Lecture presented at the Institute of Marine Engineers on 27 November 1990. Abbreviation has been achieved mainly by omission of the extra information required for a non-naval audience and also by reducing detail on non-engineering simulators. The full text of the lecture is being published in the Transactions of the Institute of Marine Engineers.

ABSTRACT

The Royal Navy makes extensive use of simulators to train its ever-changing population, so that warships are safely and efficiently operated by their young crews. The word 'simulator' is not restricted to computer-driven training equipments, although these are widely used, but extends to include environments and devices used to train people in fields as wide-ranging as ship administration, damage control, firefighting and maintenance, as well as operation.

Introduction

The mediaeval tournament, described by Roger of Hoveden[1] (1174 – 1201) as 'military exercises carried out, not in the spirit of hostility, but solely for practice and display of prowess' is perhaps the earliest example of military simulation. During periods of peace, tournaments provided the opportunity for knights to keep their weapons skills honed against real opposition, albeit in an artificial and constrained environment. It requires no great stretch of the imagination to relate those events of simulated warfare with the computer-based weapon simulators used by armed forces today to train operators in the skills needed in war. The rationale is the same in each case; war fighting skills must be maintained in the absence of war itself.

As Karl von Clausewitz wrote:

> It is of immense importance that the soldier, whatever rank, should not have to encounter in war those things which seen for the first time, set him in astonishment and perplexity. If he has only met with them one single time before, even by that he is half acquainted with them.

The concept of deterrence depends crucially upon the possession of a credible war fighting capability; and credibility depends not only upon possession of suitable weapons, but also on personnel able to use them effectively. In the Royal Navy, as in the Army and the Royal Air Force, extensive use is made of simulators to train personnel, at all levels and in all branches, in the skills and techniques they need to be effective at sea and ashore.

This article shows the extent to which simulators have become fundamental to the training of all types of person in all fields of naval employment. Simulators having been brought into use piecemeal, according to the needs of the times, in the constant search for ever greater training efficiency and value for money, it has only recently come to be realized how widespread is their use, and how diverse is the number of types.

A teaching revolution has been in progress for many years, and it has made a marked contribution to the ability of the Royal Navy to sustain high quality forces able to counter the full range of potential maritime threats underwater, on the surface, and in the air. Increasing pressure for economy in the use of resources, without reduction of quality, will ensure that the trend of ever-increasing use of simulators will continue, but in a climate of scarce funds naval customers will be increasingly discerning and selective. The principal factors affecting the overall training load year by year are, of course, the number of people to be trained and the amount of knowledge and range of skills they require. These factors must therefore be the starting point.

How Many People?

The Royal Navy and Royal Marines today have some 63 000 men and women in uniform. In July 1990 the Secretary of State for Defence, announcing the outcome of the Government's Options for Change studies, said that this figure would reduce to 60 000 by 1995. Young men can join from the age of 16, and women from 17. After a period of training, personnel join the 'trained strength' of about 57 000, and are sent to a first complement job at sea. Training continues on the job.

The age profiles of the Royal Navy are shown in FIG. 1 for the trained, 'sea', and total strengths. It can be seen that the age of greatest population in the Fleet is just 21 years, an age which needs to be judged against the wide range of equipments and technologies contained in a modern warship, and the range of skills needed to operate it effectively.

Each year, through reaching the normal end of their careers or through premature voluntary retirement (PVR) some 6000 men and women leave the Royal Navy, and this figure thus determines the number to be recruited and trained if the total strength is to be kept constant.

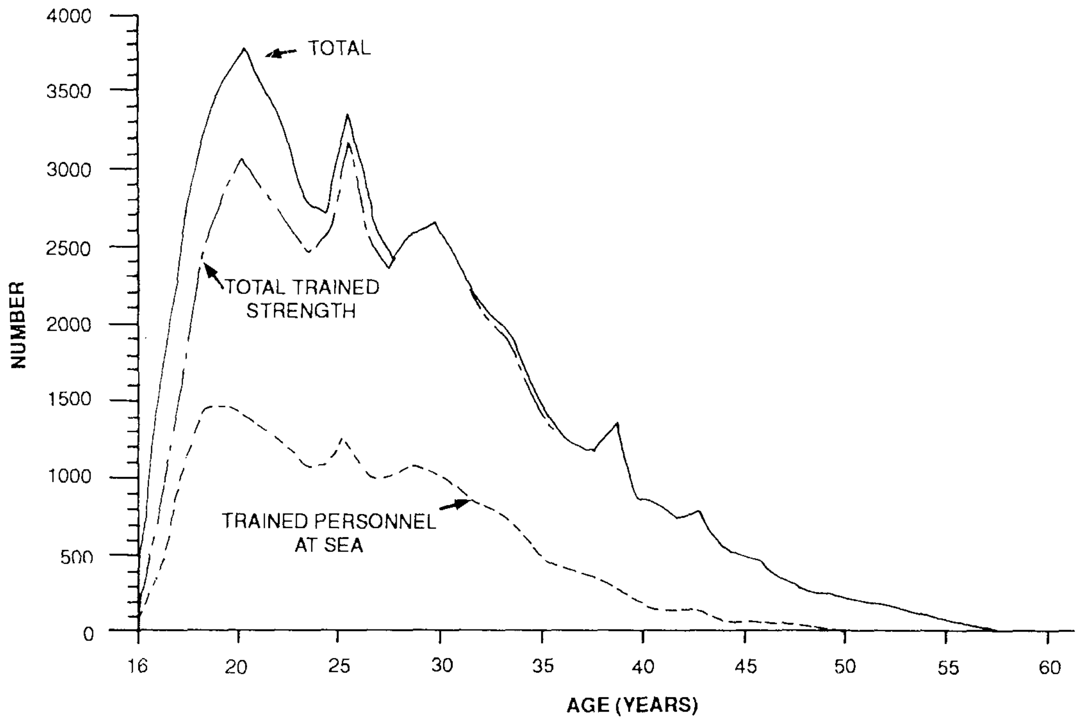

FIG. 1—AGE PROFILES—RN, RM, QARNNS, WRNS

How Many Skills

The three-dimensional employment matrix of FIG. 2 illustrates the range and diversity of the types and levels of training that are required. Even this matrix, with 27 zones, is a grossly simplified picture because each category on each axis contains several subdivisions. The 'field of work' axis subdivides

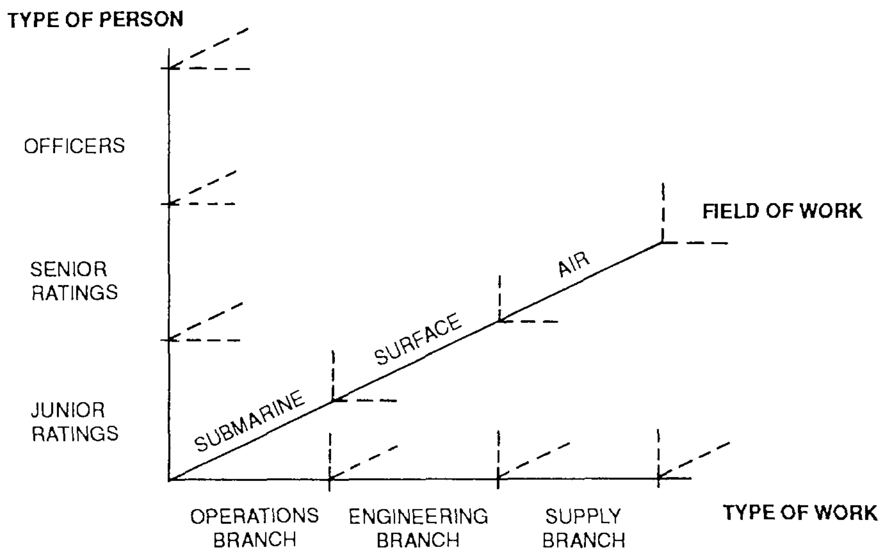

FIG. 2—THE 3-DIMENSIONAL EMPLOYMENT MATRIX

into each class of submarine, surface ship, aircraft, weapon system, command system and propulsion system in service, with further more detailed subdivisions. Each subdivision on the 'field of work' axis gives rise to a range of training requirements for all who will be involved. Careers courses are influenced by this axis, which also determines the list of courses that require to be taken by individuals immediately before starting a new job. This is known as the pre-joining training (PJT). This axis also contains a range of activities in which only a very small proportion of the population of a ship require to be skilled. Such skills are acquired by courses yielding additional qualifications (ADQUALS).

Thus a fourth axis shows the 'types of training' courses in FIG. 3. Included on this axis is sea safety training which is required by all seagoers. This includes firefighting training which is repeated before each sea appointment.

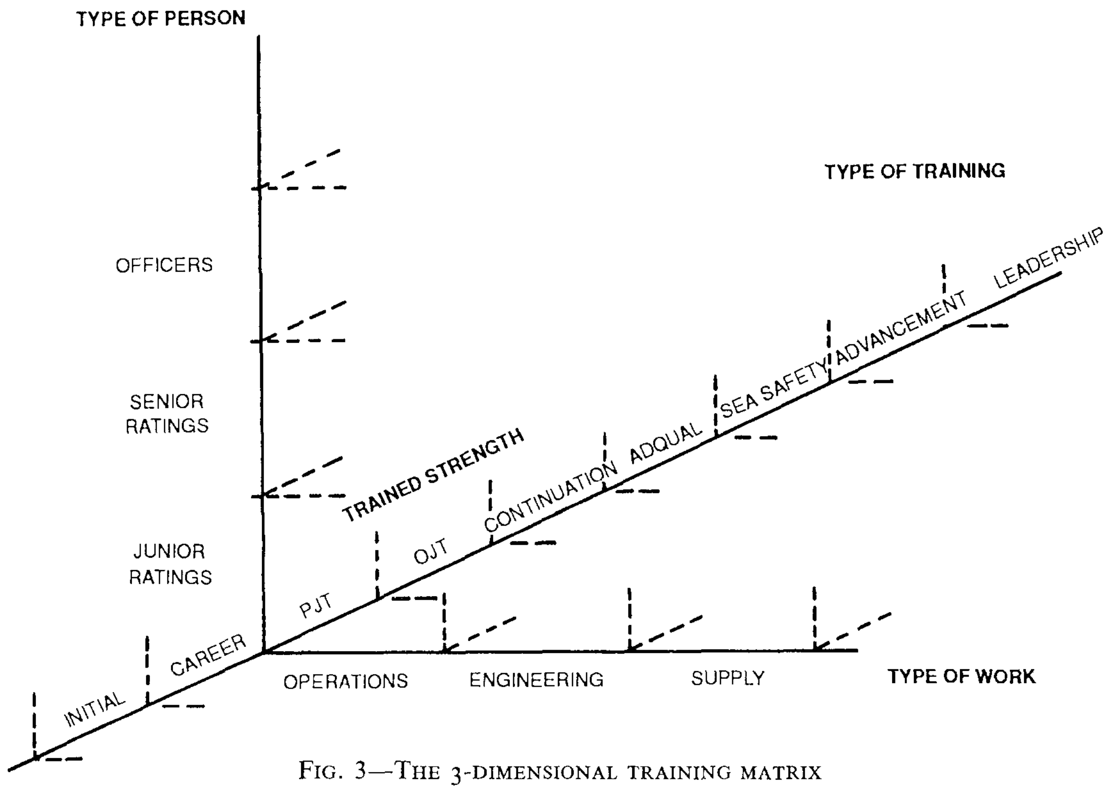

FIG. 3—THE 3-DIMENSIONAL TRAINING MATRIX
OJT: on the job training
PJT: pre-joining training

By visualizing the three-dimensional matrices of FIGS. 2 and 3 with all subdivisions included, some concept can be gained of the complexity of the recruiting, training, drafting and advancement management task. Even in a navy of 60 000 personnel there are few individuals in each group of similarly trained people, and the number of discrete skills needed to operate and maintain a modern navy amounts to many thousands.

It is appropriate at this point to draw a distinction between educational courses, which form a large proportion of the career courses in engineering and lead to national qualifications, and training courses which are concerned with the acquisition of specific knowledge and skills required in the operation and support of warships, and which also in many cases attract national civilian recognition. This article is primarily concerned with training courses. Educational courses and staff courses are not covered to the same extent, although they are important components of the Navy's overall learning programme. Having thus described the complexity of the training requirements, it is appropriate to describe how they are structured.

The Training Structure

It has long been the practice in the Royal Navy for each branch to look to its own standards and training within an overall framework co-ordinated by policy groups in the Ministry of Defence (Navy). Associated with each of the main branches is a training school which takes the lead in the development and evolution of training courses to meet the changing needs of the Navy and the branch. The implementation of training policy and the standard of administration of the training establishments are the responsibility of the Commander-in-Chief Naval Home Command.

An important stage in the development of training policy was the decision in the early 1970s to adopt a formalized objective training system developed by the Canadian Armed Forces. This had two important effects. It brought a greater degree of order to the development of training courses, gradually ending the rather haphazard process which depended rather too much on historical factors, branch influence, and individual imagination—or lack of it.

The second effect of the introduction of objective training was to give a considerable impetus to the more widespread use of simulators.

Objective Training

The principles of objective training are easily described, but practical application of the principles, like all work involving the detailed documentation of processes, step-by-step and task, is a laborious and time-consuming business.

To determine, objectively, the training that a person needs in order to be able to carry out a particular job, requires the following work to be done:

(*a*) analyse the job in detail to determine the knowledge and skills that are required to perform successfully;

(*b*) from this wok, prepare the operational objectives which describe what a trainee shall be expected to do at the end of all training, including on the job training (OJT);

(*c*) determine the elements which can be met by formal training and prepare the training objectives which represent the highest level of trainable activity that can be achieved in the training establishment.

It is very well understood that attributes such as wisdom, judgement and speed of execution of a job are acquired from experience on the job, and that it is simply not worth attempting to achieve the full operational objectives in a training environment. Given a foundation of training properly designed to include the training objectives, the best training for the job is then the job itself. Getting the right value from the first few months in the real job at sea depends here, too, on ensuring that people follow a structured approach to learning. This is known as OJT, for which task books are prepared by branch lead schools.

The Stimulus to Simulate

The acquisition of knowledge can be tested by traditional examination methods, and training on a large scale involving teaching a standard course repeatedly, makes it worth developing large question banks and using multi-choice answers in order that training assessment and quality control can be computerized. But the main impact of objective training was that it forced course designers to ask the question: 'How can I most economically promote the acquisition of necessary skills and how can I test that they have been acquired to the desire standard?' Task analysis, the prodution of Operational and Training Performance Standards, led directly to the search for skill trainers, and hence to the more intensive use of simulators.

What is a Simulator?

The common assumption is that a simulator is a true-to-life operating position through which the trainee operator interfaces with a computer containing a model of reality, which can be varied either by predefined computer programs or by the instructor. Many simulators are of just such a type, but as long ago as 1962 Gagne,[2] identified the three key features of any form of simulation:

(*a*) it attempts to represent a real operational situation;
(*b*) it provides means of control over that situation;
(*c*) it is deliberately designed to omit certain parts of the real operational system.

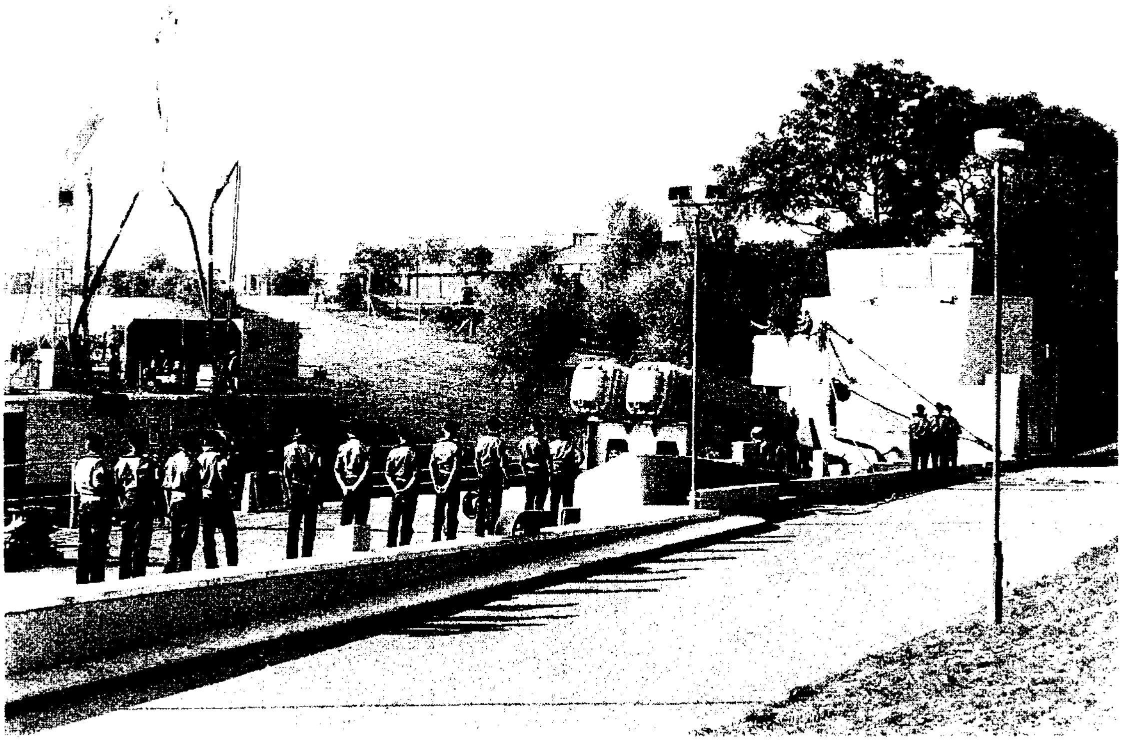

FIG. 4—REPLENISHMENT AT SEA RIG USED DURING INITIAL TRAINING, HMS 'RALEIGH'

In 1989 the Defence Training Committee decided that its Training Technology Subcommittee should carry out a study into the use of simulators for individual training in the three armed services. The first work of the subcommittee was to carry out a census of simulators in use and on order. The NATO definition of simulator was used, and it can be seen to be based closely on that by Gagne:

> Simulation may be of either equipment or situations. (For the purposes of this questionnaire) a simulator is defined as any system used as a representation of real working conditions to enable trainees to acquire and practise skills, knowledge and attitudes. A simulator is thus characterised by the following features:
>
> 1. imitation of real situation and/or equipment which may permit, for training purposes, the deliberate omission of some aspect of the equipment or operation being simulated;
> 2. user capability to control aspects of the operation being simulated.

In the naval area the result of the census was the list of simulators given in Appendix I, many of which are not computer based. It is interesting that none of the responses to the questionnaire included the traditional rifle range, although clearly it qualifies as a simulator under the terms of the definition.

The range and diversity of naval training simulators is illustrated in FIGS. 4 to 6.

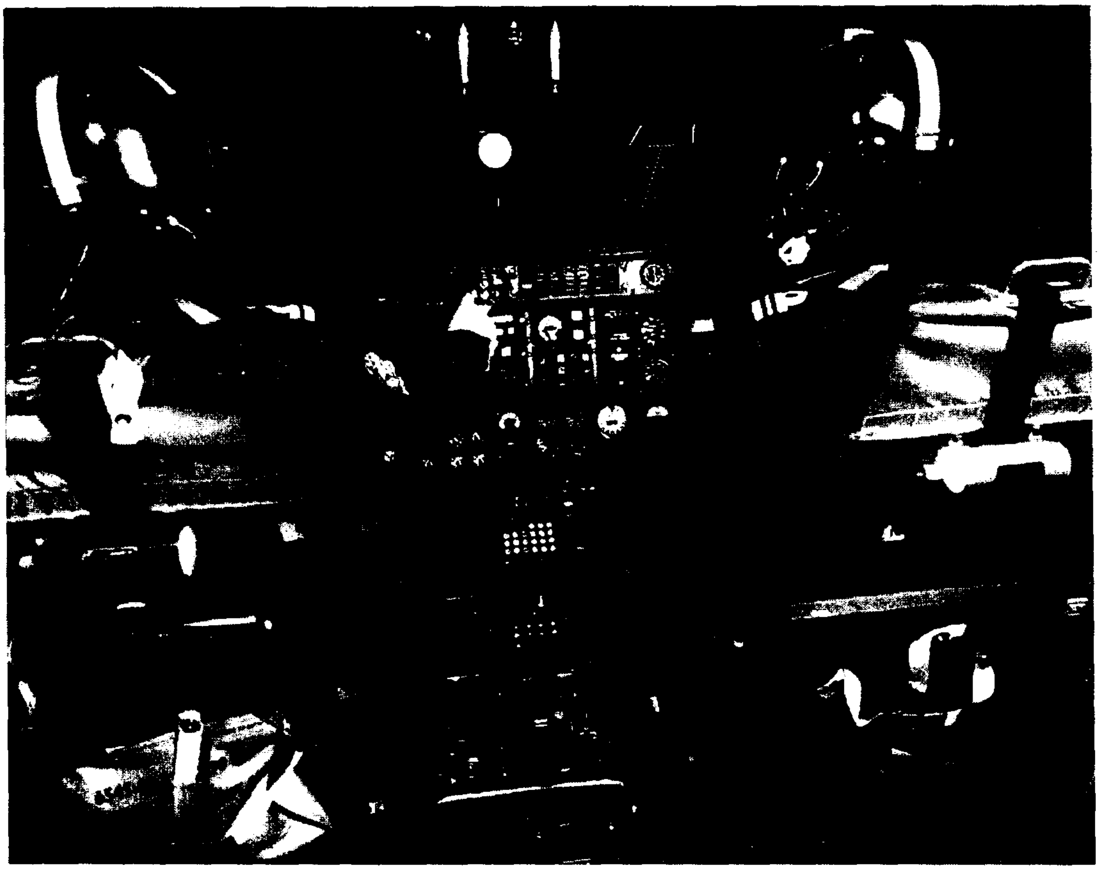

FIG. 5—LYNX MISSION SIMULATOR, HMS 'OSPREY'

Why Simulate?

It has been said that objective training gave impetus to the use of simulators for skill training; but they had been in use for many years before its introduction, and it is relevant to review the reasons for using simulation rather than doing all training on full-scale standard operational ships, aircraft and equipment, as might at first thought seem preferable and more

FIG. 6—TYPE 22 FRIGATE OPERATIONS ROOM SIMULATOR AT HMS 'DRYAD'

economical. After all, if the nation possesses expensive ships, tanks and aircraft as a war deterrent, should it not suffice for these to be used for training purposes in peacetime without the additional expense and overhead of shore-based simulators?

In many areas the reasons for simulation are intuitively obvious, although the nature and type of simulator that is needed may require considerable study and good judgement. If an unskilled person at the controls would risk his own life, and others' lives, as well as being likely to cause expensive material damage, there are clearly grounds for considering a graded approach to learning through simulation. Airline pilots and nuclear reactor operators are typical cases. Even so, if only very few people each year need to acquire the skills in question, it may well be cheaper and more effective to provide training 'on the job', with an experienced operator or training instructor able to take over if disaster threatens. Thus the number of trainees is a factor in the decision of whether to adopt a simulator approach to training or to develop operator skills exclusively in the real environment. Also relevant is the degree to which it is necessary to train operators in the skills of controlling the process under fault or battle damage conditions, when to degrade the real machine or process in order to create the desired condition would be expensive, damaging or excessively risky.

A further factor may simply be the cost involved in creating the real environment needed for useful training to take place; it is extremely expensive to take a task force to sea and then subject it to simultaneous attack from surface, submarine and air forces. Such full scale events are clearly necessary, from time to time, to subject the whole material and training regime to scrutiny, but it is obviously sensible to develop individual and group skills through structured progressive training before the expense of a full-scale exercise is incurred. Even the full scale exercise itself will not replicate the nature and scale of attack of a potential adversary since, by definition, friendly forces are employed on both sides.

Structured training commonly involves the use of simulators for both individual and team training, because it is universally recognized that, for a wide variety of skills, simulator training is the most effective of all. It has the significant advantage that the rate of skill acquisition can be monitored and measured. Pace and intensity can be suited to trainee capability, and misconceptions and difficulties are quickly revealed and can be quickly corrected. In a word, simulators bring quality control to training in a way no other method achieves.

To summarize, simulators are used for training:

(*a*) if training on the real equipment would involve high risk or danger;

(*b*) because simulator training is often the most effective of all (training can be extended into failure and emergency regimes without causing damage, and trainee performance can be readily monitored, analysed and assessed);

(*c*) if using real equipment would incur higher capital cost, operating cost, or both;

(*d*) if the real situation for training purposes cannot be fully recreated by one's own forces or equipment.

It is normal for a combination of these reasons to apply, and hence in this situation, as in all others concerning defence forces in peacetime, the criterion that must be satisfied is value for money.

Value and Effectiveness

Belief in the value and effectiveness of simulator training is very widespread indeed, and is still growing. The pressure to maintain and improve training standards in the face of reducing numbers of ever more capable warships, in a climate of tight budgetary constraints, appear to have had a forcing effect on their use even though there have been few specially designed trials to determine effectiveness.

In 1982 and 1983, however, trials were undertaken to evaluate the effect of simulator-based training relative to traditional training at sea in visual navigation for junior Royal Navy officers, the report of the study[3] concluding, *inter alia*, that:

(*a*) the crucial aspect of effective simulation for training is that it represents task demand rather than reproducing precisely the operational situation;

(*b*) simulator-based training in visual navigation and blind pilotage produces effective learning and skills development, and that these transfer effectively to sea in about 80% of trainees;

(*c*) this form of simulator-based training can provide a positive and valuable contribution to RN navigational training;

(*d*) there were significant differences in personality between the most and least successful students, and between the latter and the pattern of characteristics of expert navigators.

Even when, as in this case, confidence can be acquired that simulator training will be effective it is still necessary to show the relative cost, and perhaps difficulty, of providing equivalent training in a real vessel or aircraft. This introduces the problem of defining the cost, or the value of an operational day of a vessel or an aircraft for use in the comparative costing exercise. These problems are now beginning to be resolved under the MOD's New Management Strategy, which will undoubtedly yield better information for these purposes than hitherto has been available.

Notwithstanding the paucity of hard, reliable, objective data on both effectiveness and value, the weight of considered subjective evidence and opinion is very great, and is growing. Naval policy makers are now clear that best value for money is achieved by:

(*a*) a progressive approach, interleaving simulator training and real experience;

(*b*) the use, wherever possible and appropriate, of part task trainers devoted to the acquisition of specific skills, conserving large and comprehensive trainers for situations such as team training that merit this level of simulation.

Simulators Ashore

The complete list of simulators used in RN training ashore is given in Appendix I, while Appendix II provides an outline description of a few engineering examples, each selected as illustrative of its type.

Simulators range from relatively simple single-task units, used for individual skill training, to large units used for team training and needing many staff for their operation.

For its surface forces the Navy has evolved a centralized training system, with the main operating skills simulators sited at three schools in the the Portsmouth area:

HMS *Dryad* — Command and Control

HMS *Sultan* — Machinery Control, and Marine Equipments

HMS *Collingwood* — Weapons and Sensor Systems

Conversely much submarine and aircraft training is decentralized with simulators both at schools and at operating bases. Having the relevant training simulators in the operating bases of the submarine and air squadron is efficient in the use of people's time, and avoids travelling and accommodation costs. A decentralized policy is particularly relevant where:

(*a*) operators must make frequent periodic use of simulators to requalify, or to maintain qualifications in date;

(*b*) an aircraft or vessel type is associated with a particular operating base, e.g. Polaris submarine—Clyde Submarine Base; Sea King Helicopter—RNAS Culdrose;

(*c*) the vehicle operates independently and teaching operating skills does not depend on linking a number of different simulators.

By contrast, the surface fleet in action operates in groups of ships of different types, so training requires simulated operations rooms of different classes of ship to be linked to a central computer so that all can fight the same battle. This is done in the simulator complex at HMS *Dryad*, the School of Maritime Operations. While the quality of the training that this simulation provides has justifiably earned a wide respect, it represents a significant capital investment and each new class of ship entering service brings the need for a new simulator operations room to be added.

On-Board Simulators

Most simulators ashore are not suitable for deployment in ships or submarines because of their size and their interference with the real enviroment. However, the use of simulation afloat has particular benefits. Firstly, and self-evidently, the actual ship equipment can be used, training data being injected into the relevant consoles. The method is extremely convenient and involves less of a credibility gap and translation process during and after training sessions. Its immediacy and convenience enable the skill levels achieved during formal training and assessment, either ashore or during specific work up periods, to be maintained throughout normal sea service.

On-board simulators thus act principally in support of the lead school training and not as the prime teaching aid. However, in new classes of warships digital control systems and data highways increase their potential and may simplify aspects of trainer federation.

Trainer federation is a term which has been coined by the RN to describe the process whereby the training function is totally integrated into a ship's computerized combat system, utilizing the combat system highway. Federation enables the actual ship equipment to be used in a training scenario with training data being superimposed on top of actual tactical data (if required) in order to achieve a training objective for an individual or the whole ship's combat team.

There are, however, disadvantages to this approach. It is difficult to use such packages on ship consoles that are being used concurrently for real ship operation, and training value may be reduced if qualified instructors are not available. Using on-board simulation when the ship or submarine is alongside is an option which limits these disadvantages. However, in the submarine service a training package is in use at sea which interacts with the main control room computer and all sensor displays (with the exception of the periscope): it is used for training in areas such as exercise weapon firings, oceanographic effects, target motion analysis, and general control room training, and is highly effective.

An alternative to full integration of training functions into the ship's system, which also avoids the need to transport an entire command and combat system team to a training establishment, has been adopted by the United States Navy and the Royal Australian Navy.

They take the training facility to the ship, rather than the ship's personnel to the training facility. A trailer-borne trainer is driven to the pier and connected to the ship's combat system via cables. It provides artificial stimulations for the ship's own sensors and command and control systems, so that training takes place at the normal ship's operator positions[4]. If such devices were adopted by the Royal Navy they could be linked by radio or by land line to the central computer at HMS *Dryad*, enabling all connected ships, safely alongside in port, to fight together in a simulated battle. Alternatively, with on-board trainer federation widely applied, radio links or land lines would enable a number of ships to be linked into a central maritime battle training model. Such concepts are being studied, and the relative costs of alternative future strategies will have a large influence on the choice that is made.

The Need for Fidelity

Considerable attention needs to be paid to the question of how far to go in simulating the full real environment when providing a training simulator. Each case must be considered on its merits and few general rules can be made.

'What's being trained? Who's being trained? What has to be faithful—sight, sound, motion, touch?' asks Herb Bell, a research psychologist with the Air Force Human Resource Laboratory at Williams Air Force Base[5].

An acquaint trainer for new recruits who have yet to go to sea provides the first experience the trainees get of the equipment, and the first impressions matter. It is therefore beneficial and important that as far as possible the actual service equipment is used in the simulation. This policy is generally followed in the Royal Navy, notable examples being the replenishment at sea rig (FIG. 4) and the simulated warship environment in the Supply School. An exception, however, is a new helmsman trainer (FIG. 7) where standard ship fitted controls and instruments are replicated, more cheaply, using commercial items. Here the aim of the simulator is to train skills of course keeping, and manual and verbal responses to helm and engine orders. The parts of the operation that require to be authentic are the movement of the compass repeater in response to helm orders, under a range of speed and sea conditions, and the verbal orders and pattern of dialogue between officer of the watch and helmsman; extensive replication of the environment, which in any case varies between classes of ship, would hardly be warranted for such a limited training objective.

Once people have been to sea they view simulators in a new light. Rather than using them, as will new entry trainees, to help answer the dominating question 'what is it like at sea?', the sea experienced rating and officer will instantly recognize the extent to which the simulator attempts to replicate the real environment, and this will largely determine the bounds within which that simulator can be used for training. Attempts to extend training beyond the limitations of the simulator's physical environment or its model will, with sea experienced trainees, risk discrediting the training and the simulator.

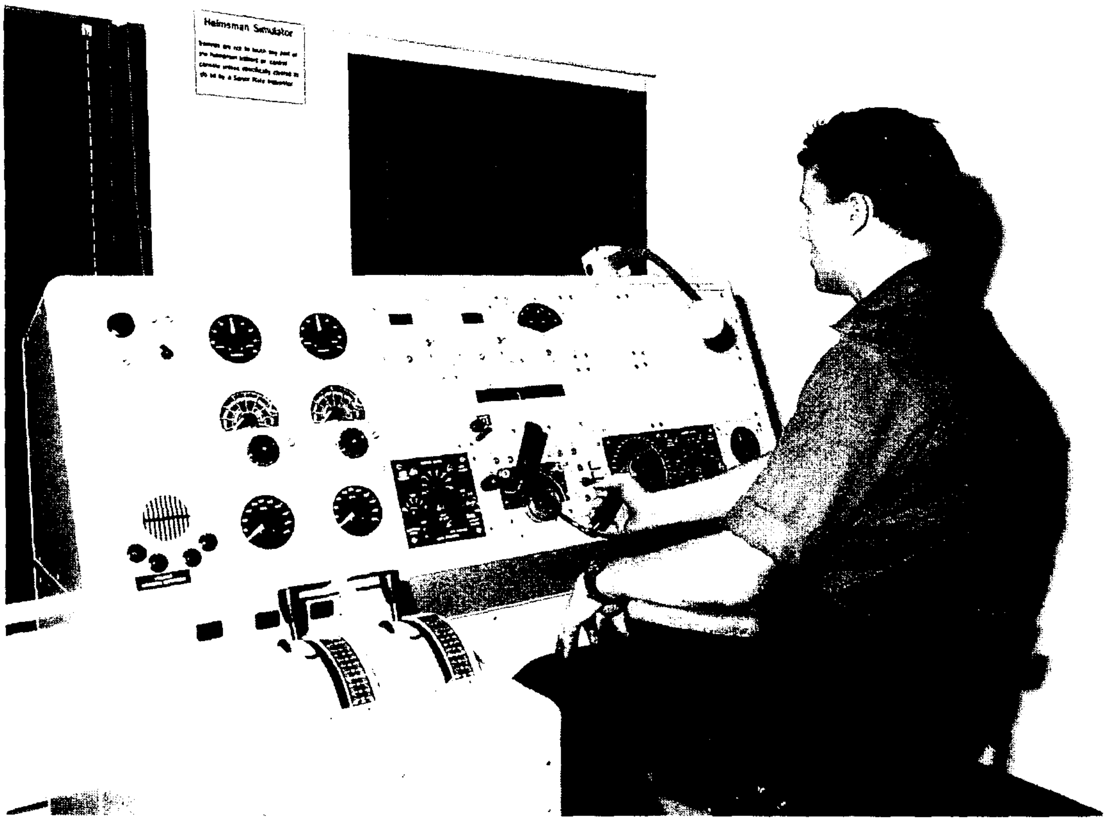

FIG. 7—A NEW HELMSMAN TRAINER

However, personnel of the armed forces of UK are all volunteers, and the normal well-motivated teams and individuals undertaking continuation training quickly overlook minor simulator shortfalls of panel detail and missing physical clues, and accept shortened timescales and accelerated occurrences. They take pride in their performance, and recognize that simulator training affords an opportunity to test and tune wits and responses before doing the job in real time and circumstances at sea. They think themselves into the mood and the situation, thereby raising the level of self-imposed pressure and stress to that which they know to be normal on the job.

Visual Systems

Simulation articles and companies' promotional literature demonstrate the high quality visual effects that are currently available. In a warship, however, few people see the outside world, let alone use its visual information in their jobs. The potential requirement for simulation of sea, land, coastline, sky and other ships and aircraft sharing the visible space out to the horizon is limited to simulations of:

(*a*) a warship bridge;

(*b*) a submarine periscope;

(*c*) a naval aviation cockpit.

Nevertheless, in these applications visual systems play an important role.

Validation

Validation of simulator response can be a problem. Normal operations and simple failure drills are verified by routine use, but the more complex, abnormal and emergency conditions present difficulties. Valuable confirmatory information can be learned from post-incident analysis and shore test equipment can be modified and instrumented to acquire data from specific trials, but some effects can remain speculative. It must therefore be well understood that whilst simulators are excellent facilities for providing training in normal operations and the immediate actions to be taken in response to abnormal/emergency events, they are only complementary to extensive live operating experience, and personnel must have a profound understanding of all aspects of the equipment for which they are responsible for operating. Every opportunity should be taken to validate and to enhance the fidelity of response of these trainers, but in some circumstances they will only represent a best estimate of how the real systems will most probably behave.

Ship Motion

Nowadays the majority of people in the Operations and Engineering branches at sea spend all or part of their watch-keeping time operating at panels, keyboards and screens under artificial lighting, bright or dark according to circumstances. This environment is relatively easy to specify and to simulate. A crucial question is whether or not to provide ship motion simulation. To do so increases the cost of a simulator several fold. The governing criterion is that effective training in key activities must not be seriously compromised for want of a feature, and platform motion has been found to be fundamental to the simulation in the following cases:

(*a*) flight simulators;

(*b*) submarine control simulators (but not submarine reactor and machinery control simulators);

(*c*) damage repair instructional units.

It is important to realize that the body cannot sense a constant velocity but is very sensitive to force and to acceleration. Vibration may therefore be the most relevant motion to simulate.

For flight simulators the case for attitude response is self-evident. In submarine control the situation is analogous, but the justification relates more to the emergency situations than the normal, dived mode. Flooding and a jammed hydroplane are two potential emergency situations which require quick, correct action if a serious depth excursion is to be avoided; officers of the watch need to be trained to cope with the situation, with the simulator assuming realistic attitudes.

Damage repair has seen two stages of evolution, each incorporating more realistic attitude response. Basic trainers have no movement; the more advanced trainer adopts a single tilt angle representing list under damage conditions; while the latest unit, 'HAVOC' (see Appendix II E), can roll realistically about a longitudinal axis[6]. This stage of evolution of trainer design was prompted by experiences in the Falklands conflict, the significant effect of roll being to cause internal flood water to wash from side to side, making it considerably more difficult to take the necessary damage repair actions. This example prompts consideration of the subject of stress during training.

Stress

Stress and its symptoms and effects are well researched and well known, as is the knowledge that stress resistance can be improved by training and by familiarity with potentially alarming events and situations. It is therefore a topic closely allied to the use and justification of simulators.

An important part of leadership courses and leadership training is to create stress and help students to recognize and cope with it. As far as possible this is done in ways which are independent of the skills, knowledge and environment of any particular branch of the Navy, and hence (surprisingly to some people) the training takes place ashore, and on hills rather than the high seas. The aim is not to teach orienteering skills but to demonstrate the effects of stress, and the benefits of teamwork and straightforward leadership skills in coping with it.

Simulator training complements this training by allowing stress to be applied, should it be desired, within the field of professional competence of the trainees. Stress is applied by stretching the trainee, either in terms of difficulty of the task or exercise, or by the frequency of incidents with which he has to deal. The general and rather obvious rule is that stress has no part during initial familiarization training because to introduce it at this stage could well inhibit the assimilation of information and obstruct the learning process. During more advanced training, however, and during performance assessment phases, stress has a real part to play both in hardening the trainee to its effects and in assisting the process of learning through heightened awareness. At the heart of the problem is the fact, however, that the more complicated the process an operator has to perform the more likely and the more potentially serious is degradation of performance under stress. Repetition, to the point of overtraining, has been the traditional military solution. It is better for this to be done using simulators than buying up the time of operational units.

The right amount of stress is a good sharpener for producing the most effective training, and provides a self-knowledge which is of benefit to the individual when having to deal with real situations.

Operating a Simulator

Once it has been determined that the procurement of a simulator is the most cost-effective means of meeting the training objective, the actual role of the device must be clearly defined. Even so, the success and optimal use of a facility depends largely upon the imagination of the trainers. It is a great benefit if they have had similar training themselves and are thus aware of the danger of overloading trainees, and recent operational experience is also highly desirable if not essential. For these reasons the majority of simulator instructors are uniformed staff. The Royal Naval School of Educational and Training Technology (RNSETT) provides courses specifically for simulator instructors in which the emphasis is placed upon 'brief—monitor—debrief' techniques.

Highly capable facilities are required by the training instructors. Their control consoles should be able to inject the full range of possible faults and changes in operating conditions. Typically this requires a hybrid system of discrete devices and software-based functions. Instructors' operating positions should be sited such that the instructors have an unobstructed view of all trainee actions, using remote viewing facilities where necessary. Sufficient duplicate instrumentation must be available to ensure that the instructors have a clear indication of the state of all systems and equipment at all times. Maximum use should be made of any facilities which will reduce the instructors' routine workload and will permit them to concentrate on monitoring and assessing the trainees' performance (e.g. computer assistance for the instructors' various roles when staging complex evolutions, with voice synthesis for standard communications from outstations, and drill fault analysis on completion). FIG. 8 shows a simulator operator at work.

FIG. 8—THE SIMULATOR OPERATOR AT WORK

Recording and replay facilities on the more complex simulators are invaluable in assisting the instructor to analyse events and provide convincing debriefing. Permanent records may not normally be required but events which occur during a training session can be used to further the instruction of future trainees. The instructors must be able to judge the pace of a session so that the trainees are not left behind and lose their understanding of a particular evolution. Conversely, as the trainees become more experienced, the session must remain a challenge. It is important however that the instructor does not feel that he must always win, come what may, as this clearly defeats the training aim and leads to a loss of motivation of the trainees.

An experienced officer formerly responsible for a simulator facility, in this case a nuclear submarine reactor and machinery control room (known confusingly as the Manoeuvring Room), described the process thus:

Simulator conciousness

It is important to remember that simulator training takes place in an alerted atmosphere: the watchkeepers are constantly expecting to be challenged and care needs to be taken that the experienced candidate has not detected a predictable pattern of drills; despite the use of ruses to distract the watchkeepers' attention away from the major problem, their initial reactions to failures may be faster than during live plant watchkeeping. Thus there is, most assuredly, the requirement for the operator not to react, through over-familiarity or a variety of other reasons, as an automaton, but to develop the skills of broad observation, rapid analysis, accurate assessment, confident prediction and positive action. However, well-conducted simulator training can valuably assist in all of this.

The pattern of instruction

The instructional staff, therefore have an important role to play. A carefully structured training programme, ideally over a sequence of at least three periods, each of three hours duration, is essential. During the first two sessions, a wide spectrum of simple drils and more complex evolutions, at a pace which takes account of each team's capabilities, should be exercised. The latest amendments to Operating Procedures are practised and the lessons learned from recent at sea experience are highlighted. Mid-way through each session, and again on its completion, the team under training are debriefed in detail on their performance: any basic drill errors, or failure to implement standing instructions or unnecessary imposition of operating restrictions, or apparent lack of understanding of operating principles, are all discussed and a Drill Replay facility is used to assist in this. The training that follows concentrates on identified 'weak areas'.

Assessment

The final session, in conclusion of the training sequence which has usually been spread over two or three days, is a formal Operator Performance Assessment. This is a prepared programme of undisclosed drills specifically chosen to rigorously test the particular trainees, some of whom may have considerable experience whilst others will have recently qualified. Each operator is monitored not only for his comprehensive knowledge of individual Standard and Emergency Operating Procedures, but also for his ability to recognize problems early and to take the correct actions, for his general operating technique, and for his detailed equipment and system knowledge. Teamwork is important. The Watch Supervisors (Engineer Officer of the Watch and Chief of the Watch) are particularly observed for their appreciation of the longer term implications of any equipment failure, for their judgement in allocation of priorities for ensuring that essential Reactor and Ship Safety are maintained, for their ability for concise and informed briefing of the Command, and for their overall Plant management. Correct and timely action in dealing with an incident and then swiftly restoring the Plant to full capability may be essential for surviving some operational scenarios, and an appreciation of the delicate balance between preservation of safety, but maintaining the submarine fully available for its warship role needs to be demonstrated.

Application of stress

The Assessments provide some opportunity to observe operators under stress. The stress is induced by the purposely created formality of the occasion, the natural pride of individuals who would wish not to be found inadequate when under observation, and by the manner in which the drills and evolutions are applied. As an Assessment session progresses, the trainees are pressed harder: new plant failures are imposed during operational conditions which are already abnormal as a result of earlier unrectified defects, double failure evolutions are used, any ambiguous instructions to the 'Machinery Spaces' are purposely misunderstood, expected expert assistance is not always available, unimportant events are used as distractions during crucial moments. Training of course must sustain realism and contain a balance of both pressure and encouragement, preventing any complacency by the competent operator but also creating some confidence in the inexperienced watchkeeper. Thus, it is intended not that 'the training system' will win come what may, but that:

(*a*) if an individual or team is good, let them demonstrate how good; their achievements can encourage others to raise standards overall;

(*b*) if an individual or team is nervous, allow them first to gain some confidence in their own abilities; however,

(*c*) if an individual or team is suspect under pressure, then their weaknesses must be exposed and remedial training given to correct them.

Future Needs

Each branch of the Royal Navy has a list of future simulator requirements which are progressing through the procurement process. Three areas of current deficiency stand out in particular.

With bridge simulators now in quite common use in the commercial shipping field it is perhaps surprising that the Royal Navy does not possess one. This deficiency is being rectified and a bridge simulator is now seen as an essential facility for maintaining and improving bridge watchkeeping facilities.

The second case is firefighting training. Present training units are uneconomic and pollute the atmosphere. Procurement of a new design is described in Appendix III.

The third area is ship and department administration. The Supply Branch has shown the way with its unique and imaginative simulators for teaching office and administration skills. The engineering branch schools, HMS *Daedalus* (see Appendix II D), *Collingwood* and *Sultan*, similarly help officers and senior ratings cope with departmental adminstration. It is an important and inescapable facet of engineering management and simulation could play a much bigger role.

Conclusions

This article illustrates the widespread use of simulators of many forms and types for training Royal Navy personnel of all rates and ranks and in all branches. There is no doubt that simulators are here to stay and that their use is set to increase. They capture the imagination and attention of instructional staff, and they are readily seen by trainees as directly relevant and useful. Their progressive adoption has revolutionized training, releasing instructors and students alike from much of the tedium of the classroom, with its 'chalk and talk' and innumerable 'vugraphs', allowing these traditional methods, which still have a real place, themselves to be viewed with more enthusiasm.

With great imagination and initiative, training staff in all branches of the Royal Navy have brought into being a splendid variety of simulators and trainers which ensure that high standards of operation, maintenance, management, and safety, are sustained by a young and constantly changing population of ratings and officers, operating modern, complex, and highly effective warships and aircraft.

Acknowledgments

I am very grateful to many people in the Ministry of Defence and in Royal Navy training establishments for their contributions to the paper and its production.

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APPENDIX I—SIMULATORS IN USE FOR ROYAL NAVY TRAINING

A: officers	I: individual training
B: senior ratings	T: team training
C: junior ratings	*: not computer-based

Simulator	*Trainees*	*Scope*	*Remarks*
OPERATING SKILLS TRAINERS			
Command and control surface ships			
Operations room simulators	A B C	I T	See FIG. 6. Total of five able to be linked
Action speed tactical trainers	A B	I T	Provides concurrent training for up to 20 teams
Maritime tactical school	A	T	
Anti-submarine universal attack trainers	A B C	I T	
Blind pilotage trainer	A	I T	
Mine countermeasure vessels trainer	A B C	T	
Tactical communications trainer	A B	I T	
Command and control submarine			
Upholder control room trainer	A B C	I	Includes motion
'O' class control room trainer	A B C	I	Includes motion
SSN/SSBN control room trainer	A B C	I	Includes motion
'O' class command team trainer	A B C	T	
SSN command team trainer	A B C	T	
SSN/SSBN command team trainer	A B C	T	
'O' class attack team trainer	A B C	I T	
SSN attack team trainer	A B C	I T	
Command and control air			
Sea King airborne early warning trainer	A B	I T	
Air traffic control trainer	A	I	
Jetstream observer radar console	A	I	
Sea King rear crew trainer	A B	I	
Fighter controller tactical trainer	A	I	
Sea King flight simulator	A B	I T	Includes motion
Lynx flight simulator	A B	I T	See FIG. 5. Includes motion
Hunter flight simulator	A	I	
Sea Harrier flight simulator	A	I	Includes motion
Sea Harrier radar tactical trainer	A	I	
Machinery control surface ships			
Machinery control room trainers:			
INVINCIBLE class	A B C	I T	
HUNT class	A B C	I T	
Type 22	A B C	I T	
Type 21/42	A B C	I T	
Type 23	A B C	I T	See Appendix IIA
Type 42 switchboard trainer	A B C	I T	
Machinery control submarine			
Machinery control room trainers:			
UPHOLDER class	A B C	I T	
CHURCHILL/RESOLUTION class	A B C	I T	Two in use
SWIFTSURE class	A B C	I T	Two in use
TRAFALGAR class	A B C	I T	See Appendix IIB. Two in use
VANGUARD class	A B C	I T	
Equipment operation surface ships			
Basic gunfire control trainer	A B	I*	
2016 sonar operator trainer	B C	I	

Simulator	*Trainees*	*Scope*	*Remarks*
OPERATING SKILLS TRAINERS			
2050 sonar operator trainer	B C	I	
Acoustic analysis operator trainer	A B	I	
Operations room equipment	A B C	I	
Operations room MMI	A B C	I	
Basic EW trainer	B C	I	
Mandarin sonar operator trainer	C	I	
Mentor weapons operator trainer	C	I	
Seawolf operator trainer	B C	I	
Basic radar plotter trainers	C	I	
Tactical signals operator trainer	A B C	I	
Weapons aimer generic trainer	B C	I	
Auxiliary machinery operator trainers (BT)	C	I	
Electrical equipment operator trainers (CBT)	B C	I	
Navigational radar trainer	A B	I	
Voice procedures trainer	C	I T*	
EW/Jammer operator trainer	B C	I	
Equipment operation submarine			
Mandarin CBT (various facilities)	A B C	I	
Acoustic analysis operator trainer	B C	I	
EW operator trainer	B C	I	
Sonar operator trainer	B C	I	
Polaris weapons system trainer	A B C	I*	
Pressurized water reactor trainer	A	I*	
Reactor dynamics simulation—Telewall	A	I	
Equipment operation air			
Sea King tactical navigation trainer	A B	I	
Basic radar trainer	A B	I	
Lynx weapons loading trainer	A B C	I T*	
Equipment operation weapons			
Torpedo pre-setting trainer	B	I	
OTHER PROFESSIONAL SKILLS TRAINERS			
Fleet command and control			
Fleet dispositions and operations trainer	A B	T*	
Operations room fleet command trainer	A B C	T	
Seamanship skills			
Replenishment at sea trainer	A B C	I T*	See FIG. 4
Seaboat/davit trainer	A B C	I T*	
Seamanship barge	A B C	I T*	
Seamanship school	A B C	I T*	
Helmsman ship steering trainer	B C	I	See FIG. 7
Supply skills			
Junior officers administration trainer	A	I*	
Computerized administration system trainer	A B C	I	
Stores procedural trainer	B C	I T*	
Wardroom trainer	C	I T*	
WP/typing trainer	C	I	
Writers office trainer	C	I*	
Field kitchen trainer	C	I T*	
Air engineering management skills			
Air engineer management simulator	A B C	I T*	See Appendix IID

Simulator	*Trainees*	*Scope*	*Remarks*
OTHER PROFESSIONAL SKILLS TRAINERS			
System/equipment maintenance surface ship			
Machinery controls maintenance trainers:			
INVINCIBLE class	B	I*	
Type 22	B	I*	
Type 21/42	B	I*	
Type 23	B	I	
Type 22 Batch III	B	I	
D86 processor generic trainer	A B	I	
Teddingtons maintainer trainer	B	I	
Type 22 steering controls maintainer trainer	B	I	
Controllable pitch propeller maintenance trainer	A B C	I*	
Gas turbine maintenance trainers	A B C	I*	
System/equipment maintenance submarine			
Reactor instrumentation maintainer trainers:			
VALIANT class	B	I*	
SWIFTSURE class	B	I*	
TRAFALGAR class	B	I*	
UPHOLDER class	B C	I*	
System/equipment maintenance air			
Helo acoustic analysis unit	A B	I*	
Lynx maintenance training rig	A B C	I*	
System/equipment maintenance weapons			
4.5 Mk8 gun maintainer trainer	B C	*	
Weapons case studies trainer	B C	*	
Phalanx (cubic) maintainer trainer	A B C		See Appendix IIC
Seawolf magazine maintainer trainer	B C	*	
HUNT class equipment trainer	B C	*	
ACTION CONDITIONS TRAINERS			
Firefighting			
Ship firefighting training schools	A B C	I T*	Three schools, one in each base port area. Total of 11 trainers.
Aircraft firefighting training school	B C	I T*	
NBCD			
Basic damage repair instructional unit	A B C	I T	Limited motion.
Advanced damage repair instructional unit	A B C	I T*	See Appendix IIE. 'HAVOC' includes motion
NBCD command team trainer	A B C	I T*	
NBCD protection training unit	B C	I T*	
Electrical damage repair trainer	A B C	I T*	
First aid			
First aid training units	B C	I*	Total of three with one in each base port area
SURVIVAL TRAINERS			
Submarine escape			
Submarine escape training tank	A B C	I*	
Helicopter escape			
Helicopter immersion trainer	A B C	I*	Includes motion

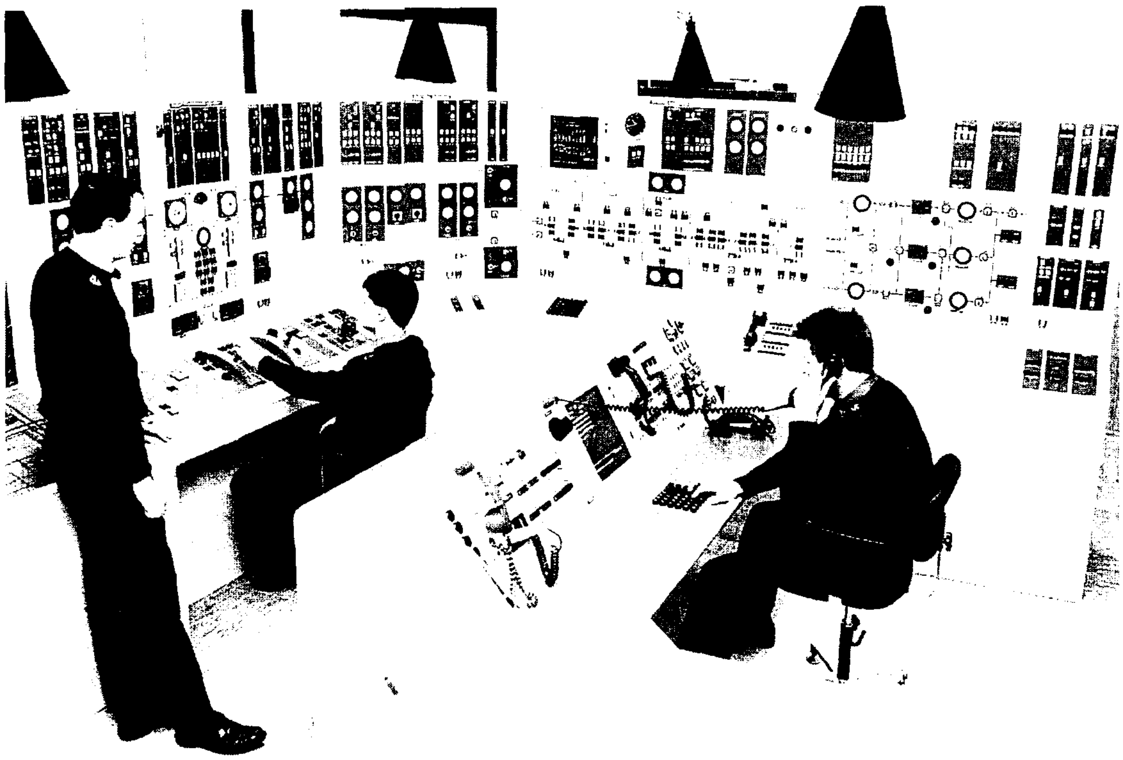

FIG. 9—TYPE 23 FRIGATE MACHINERY CONTROL TRAINER

APPENDIX II A—TYPE 23 FRIGATE MACHINERY CONTROL PROCEDURAL TRAINER

The Type 23 frigate machinery control trainer (FIG. 9) is a good example of the standard of procedural training facilities provided to instruct personnel about to join a new ship or for personnel requiring consolidation training as watchkeeping teams. It also demonstrates new procurement policy designed to anticipate training requirements as part of the package associated with a new ship class. This has resulted in the training facilities becoming fully available well in advance of ship acceptance for the first of class.

The simulator provides exact replication of a Type 23 frigate's Ship Control Centre (SCC) with full real-time simulation of propulsion and auxiliary systems as well as realistic responses. Full simulation also ensures that the correct knock-on effects of any operator input, correct or incorrect, or fault, are experienced by the trainee. An important aspect of realism is the inclusion of outstation or local control facilities which allow trainees to take over local control in simulated machinery spaces and to operate manually some systems using mimics presented on touch-sensitive monitors. Comprehensive communications systems and officer of the watch facilities are incorporated to exercise all aspects of a watchkeeper's duties and drills.

Type 23 procedural trainer control is exercised by the instructor using a touch-sensitive monitor and menu-driven software. Many automated functions are included for procedure training as well as exercising breakdown drill routines and emergency procedures. Freeze, slow time, snapshot, and replay are also available to the instructor.

APPENDIX II B—SULMAT III-TRAFALGAR CLASS MANOEUVRING ROOM SIMULATOR

The safe operation of the submarine pressurized water reactors (PWR) is based upon three principles:

(*a*) the 'load following' characteristics of the reactor;

(*b*) the automatic protection system and operating rules derived from in-depth failure analysis;

(*c*) the high standard of training and level of knowledge of the nuclear operator.

It is in this third area where the use of manoeuvring room simulators proves to be so valuable in both initial and continuation training.

The initial training simulators are at HMS *Sultan* and the continuation training simulators at the base port appropriate to the submarine class. All the simulators consist of a full scale replica of the Reactor and Machinery Control Room. All controls, instrumentation and equipment normally operated by the watchkeeping team are included, for it is essential that the simulator presentation should be indistinguishable from the real-time using a mathematical model of the plant dynamics.

All potential and qualified nuclear power plant operators spend time in the simulator either as a prerequisite to initial qualification or as part of mandatory continuation training assessments. The specific advantages of these highly complex training aids are:

(*a*) Watchkeepers can gain experience ashore and thus reduce training time on board.

(*b*) Accident and emergency drills can be covered which it would be imprudent, and in some cases impossible, to conduct at sea.

(*c*) Errors can be made by the trainees, but without serious consequences, and they can learn from their mistakes.

(*d*) The performance of operators can be objectively assessed at regular intervals.

(*e*) Senior supervisors' practical qualification boards can be conducted covering a wide range of drills.

(*f*) Proposed amendments to emergency and standard operating procedures can be evaluated.

Simulator training is only part of the overall training package. Personnel must have a profound understanding of equipments and systems before reaching the simulator stage, and need to consolidate their training with extensive live plant operating experience.

APPENDIX II C—WEAPON MAINTAINER TRAINER-PHALANX 'CUBIC' TRAINER

An example of a maintainer trainer is the Phalanx 'cubic' trainer sited at HMS *Collingwood* (FIG. 10). This training aid is used principally by senior rates drafted as the prospective maintainers on board in the weapons data and ordnance control sub-branches. It is also used on an acquaint basis for officers.

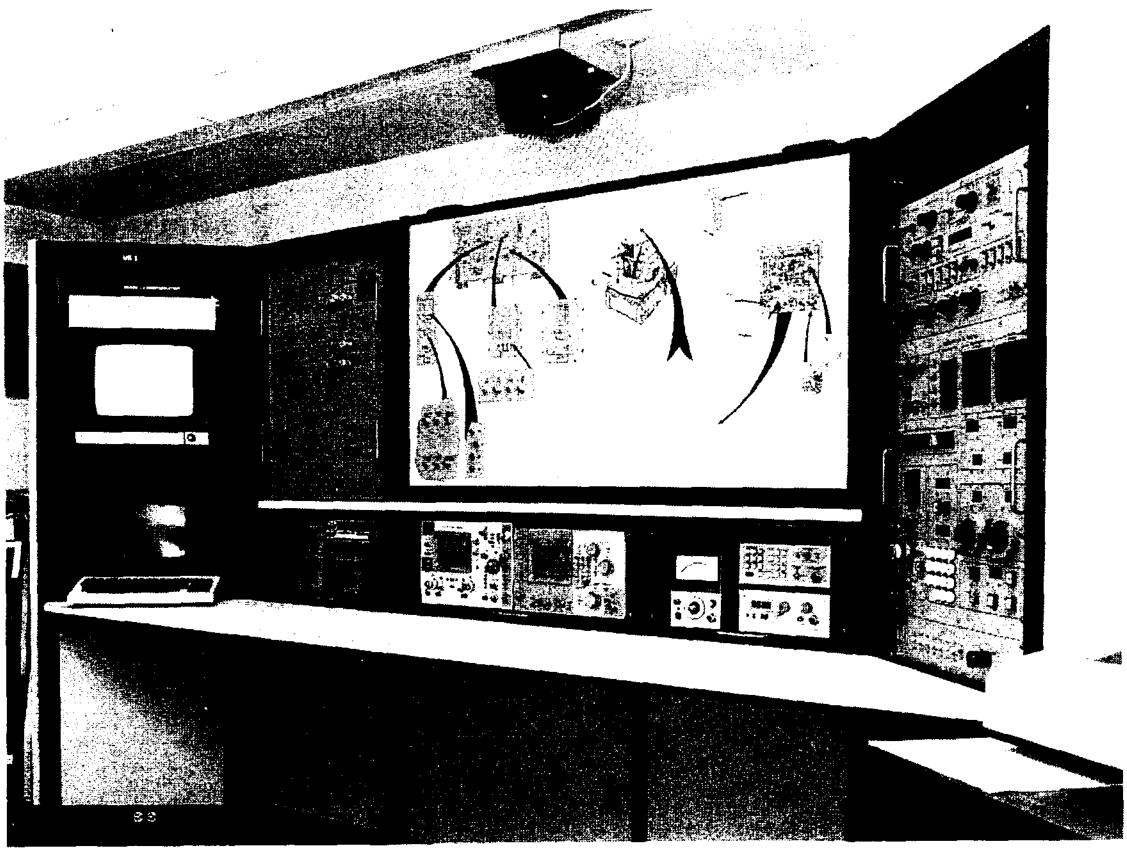

FIG. 10—PHALANX 'CUBIC' TRAINER

The unit simulates the functions of the Phalanx Close-In Weapon System automatic gun fire control system by splitting it into eight sub-units, each of which can be loaded into the front panel of the trainer. The instructor can then choose from about 480 typical malfunctions and can subsequently monitor the students as they detect, isolate and correct the system defects down to component level.

Important features of the trainer are:

(*a*) An optical laser video disc system and colour monitor which allows a pictorial representation of the actual equipment that needs to be rectified, and shows its location within the overall system.

(*b*) Incorporation of the actual test equipment which will be used on board for fault finding.

(*c*) Use of the fault finding and analysis equipment held on board.

(*d*) A printed debrief of the training session.

The advantages of the simulation are that the training can take place in complete safety, without interaction with the gun mounting, and in much less time than if the actual equipment were used. The facility at *Collingwood* also benefits from the subsequent provision of an actual gun mount and working control system supplementing the video disc displays for further maintenance training.

An alternative approach to this type of maintainer training is to provide the actual equipment but with additional faulted circuit boards. This gives better 'hands-on' training, but the training takes longer and it is difficult to procure 'one-off' faulted circuit boards at realistic prices.

FIG. 11—THE 'DAEDALUS' AIR ENGINEER'S MANAGEMENT TRAINING SQUADRON

APPENDIX II D—THE 'DAEDALUS' AIR ENGINEER'S MANAGEMENT TRAINING SQUADRON

A good example of a professional management simulator which has evolved over a number of years is the air engineer's training squadron at Lee-on-Solent (FIG. 11). This facility has been developed from an informal serial of practical tasks on time-expired aircraft to assist the training of air engineer officers into a dedicated dummy squadron used by officers and future air engineering technicians.

In the engineering sub-branch of the Fleet Air Arm in particular, the management load created by the requirement for detailed certification of all work is further compounded by operational demands and the maritime environment. Hence the value of practical management training.

The facility itself consists of a near replica of a Royal Naval Air Squadron including hangarage for up to eight aircraft (currently one Lynx, four Wessex and three Wasp helicopters), typical engineering office space, a tool centre, ground equipment facilites and crew rest and locker rooms. The simulator also has an office for instructional staff and a dedicated classroom. As a facility its initial and running costs are very low indeed, yet the initiative of the trainers has created a management training environment which is proving invaluable in giving students an insight into the working practices of an operational air squadron.

In the officers' course in particular the students play out the roles of the key members of a squadron, dealing with the scenarios imposed by the training staff just as if they were in their first complement job. This constitutes the final phase of the officers' application training and it brings together air engineering theory, administration and man management training in a practical environment. The move from the classroom to this practical environment is more than welcomed by the students; their motivation to do well is high, and information retention is far better for actually having done the job and gained hands-on experience.

The facility saves on-the-job training time in a front line squadron. Perhaps more importantly, it very successfully consolidates previous classroom training and increases motivation to do well once the student is in his first job.

APPENDIX II E—THE DAMAGE REPAIR INSTRUCTIONAL UNIT

The ability of a warship to survive once damaged depends to a large extent on the efficiency, expertise and confidence of the ship's company and in particular of the damage repair teams.

FIG. 12—'HAVOC'

The Falklands conflict clearly demonstrated the need for more realistic and stressful damage repair training to replace the very limited capability of on-board training and existing shore facilities. This requirement resulted in the provision of a new generation of damage repair instructional units, or DRIU, the first of which is sited at HMS *Raleigh* and is named 'HAVOC' (FIG. 12).

This facility provides damage control and repair training for both ship and submarine teams by simulating action damage under realistic conditions. The whole unit, consisting of typical ship compartments over three decks, can be rolled 15° each way on its longitudinal axis to simulate ship roll or loll conditions. The compartments have typical damage incidents built into them, water being supplied from a 90 tonne header tank. The compartments are fully fitted out to RN standards with all the electrical, salt water systems, and emergency facilities found in a warship. The capabilities of this simulator allow trainees to be placed under considerable stress, experiencing at first hand the benefits of success as well as some of the penalties of failure in damage control.

The design of the unit allows potentially hazardous evolutions to be carried out in a controlled and expertly supervised manner, producing high levels of stress in trainees without placing them at significant risk. To achieve this, control of the unit is exercised within the unit from a control room located on 2 Deck. Emergency stop buttons around the unit allow instructors to halt an exercise at any point, causing motion to cease, the unit to drain down, and lighting and ventilation to be restored. Commercial safety devices are also included in several areas, including all electrical supplies in the unit.

APPENDIX III—DEVELOPING A NEW FIREFIGHTING TRAINER

At present the Royal Navy provides firefighting training in Portsmouth at the Royal Naval Firefighting School Horsea Island, Rosyth (HMS *Cochrane*), and at Plymouth (HMS *Raleigh*), using a total of 11 fire training units. These units are three deck multi-compartment steel boxes which basically replicate a typical warship configuration. They are devoid of internal fittings, and lack perceptual realism in all but the most basic aspects. In these units the fires are in open hearths burning wood and oil, and are not realistic reproductions of on-board fires. Moreover, the fires cannot be controlled to vary the stress conditions and there are practical limitations on the training time provided to the trainees, caused mainly by the need to re-light fires doused by copious quantities of foam and water.

Notwithstanding the basically primitive nature of the existing training units, the numbers of training staff required to control the exercises and provide safety cover is too high in relation to the trainee throughput. In addition to the limitations imposed by the training units on the quality and cost-effectiveness of the training, the units impose a heavy maintenance load and, on environmental grounds, the thick black acrid smoke emitted is not acceptable.

Post-Falklands conflict studies led the Navy Board to require a significant improvement in damage control, firefighting and sea survival training. This new approach requires trainee man-days to be increased from 8777 to 17166, with a total throughput of 14115 trainees per year. Clearly a new approach to firefighting training was necessary.

Amongst the options considered were the possibility of retaining and expanding the present facilities with upgrades where appropriate, assessing the civilian fire brigade training methods, and looking at new techniques. Preliminary studies, which were supported by small-scale trials, showed that a computer-controlled propane burning trainer which used artificial smoke promised the best overall solution. To provide obscuration using artificial smoke in the presence of heat is particularly difficult as the heat tends to vapourize the smoke. The combination of flame, smoke and heat at representative levels, and all generated independently in large volume compartments, introduces what is termed the three zone concept. Studies have been undertaken to provide guidance, and a UK firefighting training unit (FFTU) development programme has now been initiated. Each FFTU will consist of a number of similar modules, with each module consisting of 12 compartments sited on two deck levels. Each compartment will be realistically fitted out to represent typical warship compartments. Within each module there will be 15 gas-fired fireplaces each designed to replicate a typical ship fire scenario for solid, liquid or electrical fires. The compartment fireplace combinations range from machinery space major bilge fires to accommodation space gash bin fires. Artificial smoke will be used to provide visual obscuration, and hot air at around 200°C will be ducted to the compartment to simulate the heat effect. The three zone concept is applicable to 40% of the fire scenarios being developed.

A computer control system will link the flame, smoke and hot air systems so that they respond to the trainees' use of extinguishant. Extinguishant sensors are being developed that will allow the system to differentiate between water and foam.

The advantages of the new FFTU are:

(*a*) A significant increase in the 'hands-on' training time within the overall time spent training.

(*b*) Objective assessment of individual and team performance.

(*c*) Stress levels graded to match skill levels.

(*d*) Repeatability of the training standards.

(*e*) Scope for a more flexible training approach.

(*f*) Ability to exercise procedural drills that effective firefighting needs, i.e. crash stop ventilation, electrical isolation, system isolation, activate gas drench systems if fitted, etc.

(*g*) Exercise of command, control, and communication skills.

The project is now in the project definition phase and MOD, assisted by design consultants, are conducting trials in a prototype compartment at Portsmouth (FIG. 13). The prototype has 11 burner systems and is designed to confirm that the predictions for the three zone concept are achievable, and that the computer control system can provide the required response characteristics.

The first FFTU is scheduled to enter service in Portsmouth in mid 1995, with the second unit, at Plymouth, following in 1996.

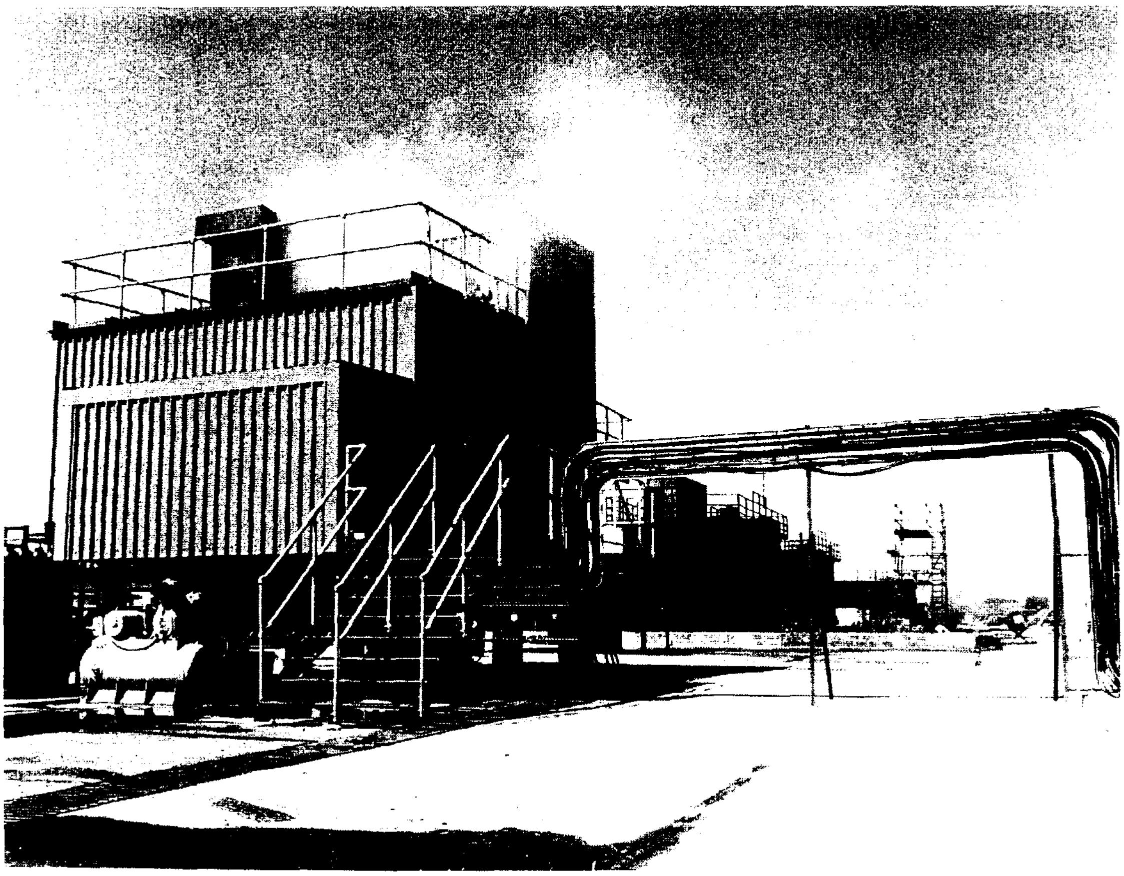

FIG. 13—PROTOTYPE FIREFIGHTING TRAINING UNIT (FFTU)