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EVALUATING NAVY MANPOWER, PERSONNEL AND TRAINING POLICIES IN TERMS OF PERFORMANCE

Stanley A. Horowitz

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INSTITUTE FOR DEFENSE ANALYSES
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<p>Policies regarding manpower, personnel and training (MPT) should be chosen according to the level of military performance associated with them. This is generally not done because it is not believed to be feasible. Development of performance-oriented MPT policies requires four things: a framework showing how policies conceptually relate to performance, actual measures of performance, a research methodology for relating policies to performance, and a commitment to carry out a program of research in the area. This paper develops a conceptual framework, enumerates relevant measures of performance, identifies and reviews the existing literature relating aspects of MPT policy to performance, and, having demonstrated that it is feasible, recommends that a major research program be undertaken. The main focus of the paper is on the Navy, but data and research from all the services are discussed.</p>				
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INSTITUTE FOR DEFENSE ANALYSES

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PREFACE

Under the Personnel and Readiness Task (T-5-353) sponsored by the Office of the Secretary of Defense (Program Analysis and Evaluation), the Institute for Defense Analyses (IDA) studied the possibility of improving the way in which policies relating to manpower, personnel and training (MPT) are developed and evaluated--with principal attention given to the Navy. A concise review and digest of existing literature relating personnel characteristics and MPT policies to unit readiness and performance was provided. It was concluded that MPT policies should be more explicitly designed to improve the performance of individuals and units in the military, that there is adequate data to quantitatively relate MPT factors to performance, and that a research program to develop such quantitative relationships should be undertaken.

The author is grateful for the many helpful suggestions received from Dr. Richard S. Elster, Deputy Assistant Secretary of the Navy (Manpower), Mr. Douglas May, his staff director, and Mr. Mark Mohler of OSD (Program Analysis and Evaluation). The assistance of Dr. Robert M. Carroll and Lt. Cdr. Robert C. Carter of the Office of the Deputy Chief of Naval Operations (MPT) is also gratefully acknowledged.

EVALUATING NAVY MANPOWER, PERSONNEL AND TRAINING POLICIES IN TERMS OF PERFORMANCE

A. INTRODUCTION

In this paper a new approach is developed to evaluate policy options in the area of manpower, personnel and training (MPT). The approach is based on a belief that wiser MPT policy will result if policy decisions are assessed in terms of their implications for the achievement of broad national defense goals. After additional background is presented, the paper develops a causal chain, or framework, that links MPT decisions to broad measures of defense capability. Then the feasibility of transforming the conceptual chain into a set of quantitative planning tools is considered, and a program for developing such tools is recommended.

Decisions about MPT policies or the allocation of MPT resources are rarely made with explicit reference to their quantitative contribution to national defense capability. This is not surprising. There is far too much uncertainty both in international politics and in warfare for predictions to be made with any degree of confidence regarding the impact of MPT decisions within the Defense Department on national security. The real question to be considered by MPT policy-makers is whether they can be evaluated using indicators having a stronger apparent relationship to that ultimate measure than the ones being used today. Linking MPT policy-making with measures of performance would put DOD in a position to receive better performance for its money. Four areas of policy that could benefit substantially from such linkages are requirements determination, compensation, retirement and training.

The statements of the military services describing their personnel requirements shape the context in which MPT decisions are made. The mixes of experience and mental ability that the services say are needed are derived without reference to how well other mixes would perform or to how much they would cost. The compensation system then strives to keep the requirements filled. For example, consideration is not given to the possibility that senior people contribute so much to military performance in some settings that money could be saved, military capability improved and training costs reduced by paying these people more to keep greater numbers of them in uniform, while bringing in fewer new recruits. Under the current system, the thinking is that this action would just

lead to overfilling requirements for senior personnel and that some would have to be forced to leave.

Similarly, today's retirement system is reasonably efficient for achieving the level of post-20-year personnel implied by the services' statements of requirements. However, an examination of units with more men of "post-retirement" age might show this level to be based on misguided assumptions. A performance-oriented approach to requirements could suggest modifications to the retirement system that would allow it to serve better the real needs of the services.

Considerable effort and expense go into the design and execution of programs of training in the military. Individual training programs are usually evaluated on the basis of individual test results after training, with some feedback from the field. Further follow-up that examined the performance of units manned by individuals trained in different ways could give vital clues to people interested in designing effective training. Unit training programs could also benefit from such examination.

Tying MPT policies to performance would not only facilitate the adoption of better MPT policies, but might also strengthen the position of MPT advocates when they compete against advocates of additional forces and modernization for increasingly scarce funds. When manpower, personnel and training resources can be linked to warfighting capability, their need can be more easily justified. This should lead to greater success in negotiations for budget dollars.

While much of the discussion in this paper focuses on the Navy, examples from all the services are used. The principles addressed here are equally relevant throughout the DOD.

B. FRAMEWORK DEVELOPMENT

In order to assure that this paper is focused on the real output of the defense decision-making process--war-fighting capability--framework development begins by considering the prerequisite factors for combat success. The approach taken is to move from the abstract to the more concrete one step at a time. At every step the question is asked, "What do we need to get that?" By the end of the process the categories of resources that MPT policies are concerned with are reached. Then, retracing these steps,

the links that must be forged to connect MPT policies with combat effectiveness are seen. Incremental steps that can be taken to make MPT decision making more output oriented, even if the most difficult links remain unforged, are also evident.

1. The Determinants of Combat Capability

Figure 1 illustrates the most commonly used taxonomy for describing the components of military capability, the four pillars. This structure illustrates the fact that successful pursuit of military goals requires four inputs: force size, modernization (reflecting the inherent level of capability of individual units), readiness, and sustainability. While this taxonomy is correct as far as it goes, it masks the distinction between factors that affect the capability of units and those that permit a unit with a particular level of capability to fight effectively. A modification may more clearly reflect the way in which factors interact to produce overall defense capability.

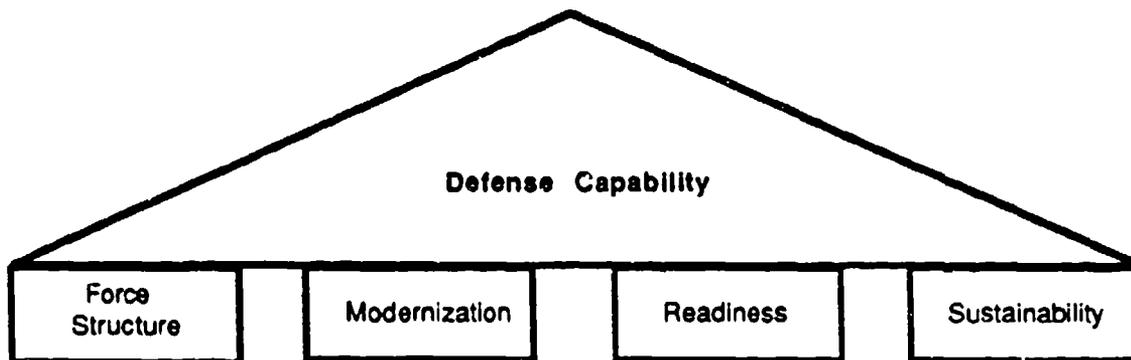


Figure 1. THE OFFICIAL TAXONOMY--THE FOUR PILLARS

What components are needed for a force with the requisite military capability? They are the right combination of force size and unit capability to perform the operation and the ability to sustain it as long as is necessary. Of course, the ability to do the job depends on what the job is. That is, it depends on the threat being faced and on the scenario--what both sides are trying to accomplish.

As Figure 2 shows, the capability of a unit is determined by a combination of its design capability and its readiness. This is consistent with the standard definition of

readiness as the ability of a force, unit, weapon system or equipment to perform the mission for which it was organized or designed. Since MPT policy affects defense capability largely through its influence on readiness, the discussion will be confined to the underpinnings of readiness, although links between various categories of expenditures and the other components of defense capability could also be developed.

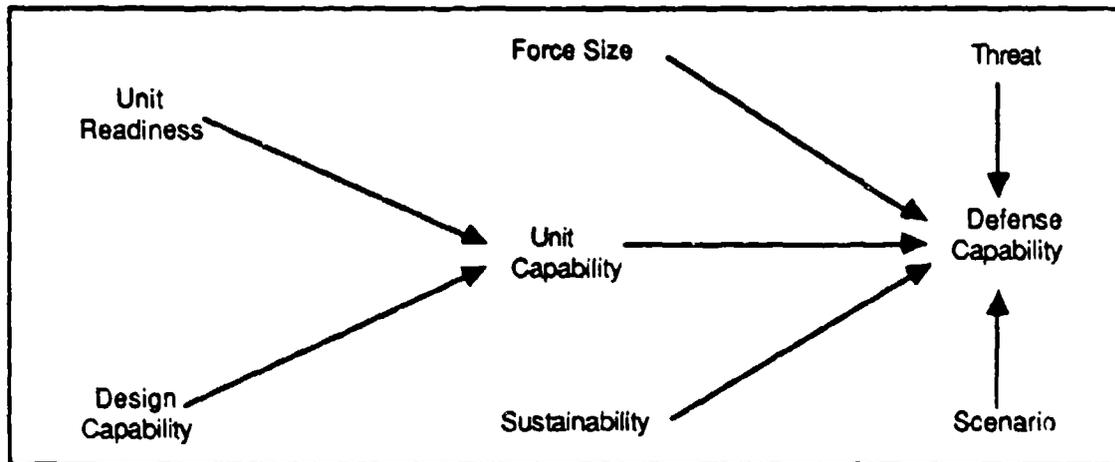


Figure 2. AN ALTERNATIVE VIEW OF DEFENSE CAPABILITY

2. Categorizations of Readiness

The standard treatment of readiness, as set out in JCS Pub. 1 and institutionalized in the Unit Status and Identity Reporting (UNITREP) system, breaks down overall readiness into four components: material readiness, personnel readiness, training readiness, and supply readiness (principally ordnance for the Navy). This is illustrated in Figure 3. Even more than was the case for the four pillars of defense capability, this taxonomy masks complex interactions among the components of readiness.

It perpetuates the incorrect notion that there are four dimensions of readiness that do not affect each other. The concept that having better people can cause greater material readiness is not formally admitted to the structure, for example. Neither is the possibility that unit training can enhance the performance of individual tasks. Absence of such links severely hampers the value of the UNITREP structure as a framework to guide analysis.

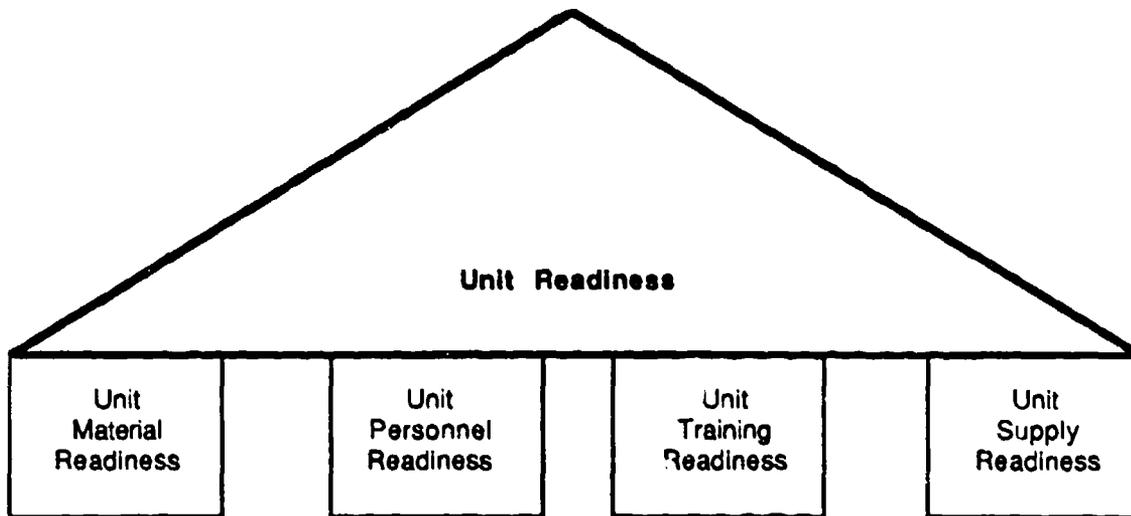


Figure 3. THE OFFICIAL VIEW OF READINESS--FOUR MORE PILLARS

What does a unit need to be ready? It needs equipment that works; it needs a crew capable of using the equipment effectively; and, it needs something to shoot, if its mission involves shooting. That is to say, as Figure 4 shows, that the three components of overall unit readiness are training readiness, material readiness and supply readiness. Does that mean that personnel readiness plays no role? Not at all. It plays a key role, but the role is multifaceted and indirect.

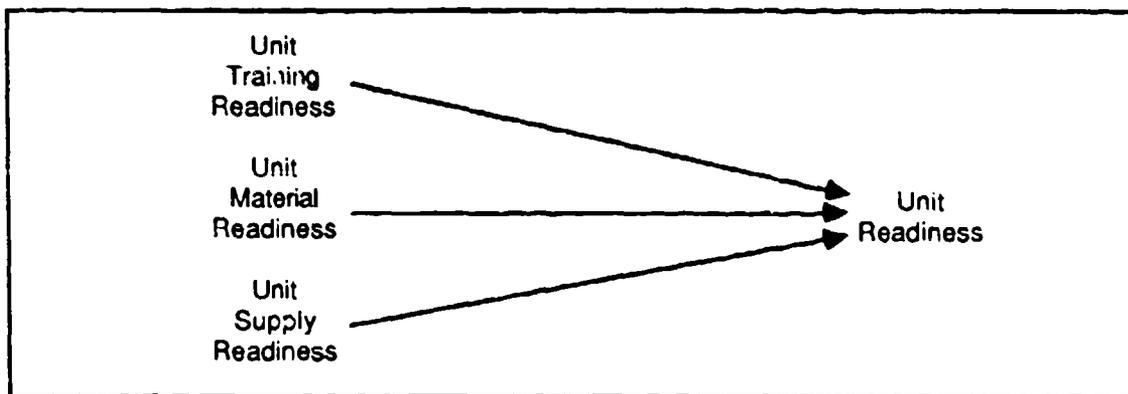


Figure 4. A MODIFIED VIEW OF READINESS

3. Perspectives on Personnel Readiness

Personnel readiness is determined by the quality and quantity of people attached to a unit. Personnel quality is best thought of as being largely synonymous with the level of individual performance. Its relationship to the sorts of measures that are usually used to gauge personnel quality will be discussed below. It is not determined solely by the skills individuals had before arriving at a unit. The accomplishment of unit training can hone the performance of individual tasks at the same time it improves the performance of team tasks. The level of unit training, in turn, depends not only on how much unit training is done, but also on how much is needed--a function of the amount of personnel turnover and the ability of individuals to absorb their team tasks (as well as the degree to which skills are perishable). This ability presumably depends on personnel quality.

As Figure 5 shows, personnel readiness is part of a complex web of interrelationships that underlies material and training readiness. Material readiness, essentially the availability of equipment to perform when called on, is determined by how often the equipment breaks (its reliability) and how long it takes to repair when it is down. Reliability is usually taken to depend only on equipment design and the environment in which it is used. In fact, there are undoubtedly user-induced failures, but they will not be incorporated explicitly into the framework being developed here. The speed of repair, while dependent on the availability of parts, is also highly dependent on the ability and availability of maintenance personnel--that is, on their personnel readiness. It should also be remembered that maintenance is not strictly an individual job. Trouble shooting is to a considerable extent a team effort. One would expect the speed of repair to depend not only on the quality and quantity of repair personnel, but also on their level of unit training.

Unit training is, of course, also expected to be a key factor underlying training readiness--that is, the ability of units to use their equipment effectively when it is working. It is reasonable to believe, however, that there is a trade-off between personnel readiness and the unit training level in the production of training readiness. Thus, it should be possible to achieve a given level of operating proficiency with fewer team skills if personnel readiness--the quality and quantity of personnel--is higher.

Thus far, the discussion in this paper has been quite abstract. It has not incorporated the kinds of measures of personnel quality that are usually used in judging the success of MPT policies. It is now time to turn to that incorporation.

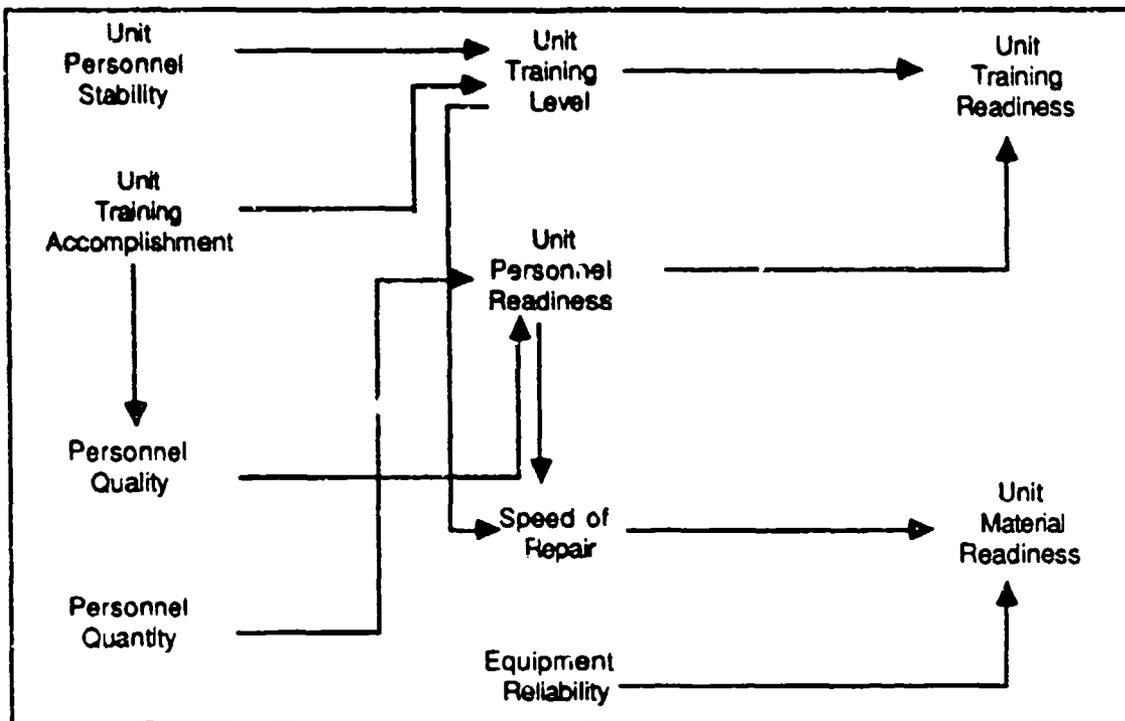


Figure 5. THE ROLE OF PERSONNEL AND UNIT TRAINING IN PRODUCING UNIT READINESS

4. Determinants of Personnel Quality

Discussions of the quality of the Navy's enlisted force often revolve around three factors: the distribution of personnel by mental group, as measured by entry test score; their education level (the fraction who graduated from high school); and the length of time they have been in the Navy (or their pay grade distribution). It is reasonable to assume that these factors, along with the amount and type of Navy schoolhouse training they have received are key determinants of individual performance. Motivation also plays a central role, as Figure 6 reflects. Unfortunately both the level of motivation, and the influence of policies on motivation, are very hard to quantify.

Similarly, unit training accomplishment is often considered to be directly related to the quantity of steaming (or flying) time available to units. Actually the situation is more complex. The training syllabi that units strive to complete do require operating time, but

not all steaming time (or flying time) is the same for the purposes of producing training. As an example, steaming time can be broken down into transit time, operations time, project support time, explicit training time, and other steaming. Not all steaming time is labeled as training time, and not all underway training gets done during "training" time. Further disaggregation of steaming categories is possible, and probably would be fruitful for consideration of the determinants of personnel performance. But steaming (or flying) isn't the only way to get unit training. Non-underway training can be accumulated in trainers or simulators. Also, some parts of the training syllabi can be completed aboard ship while in port.

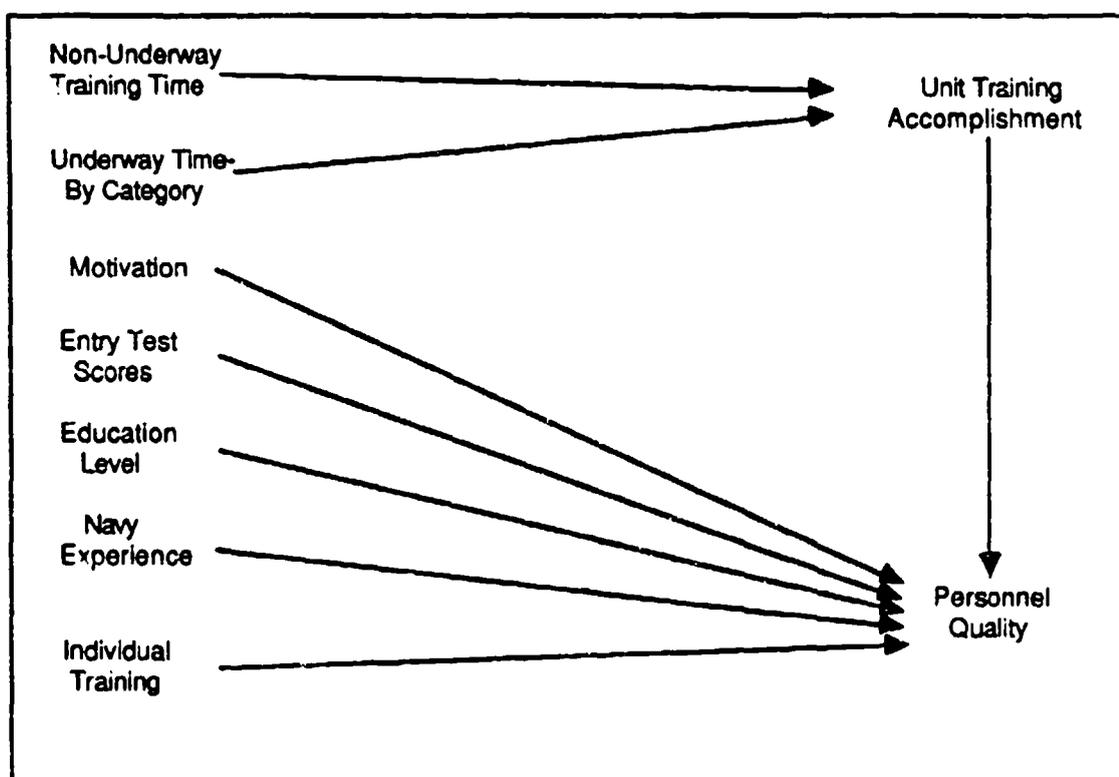


Figure 6. DETERMINANTS OF PERSONNEL QUALITY

The development of our framework has now reached some familiar ground. The factors on the left side of Figure 6 are things the Navy is used to thinking about buying or influencing with MPT resource decisions. The next section addresses the link to resources.

5. Manpower, Personnel and Training Resources for Readiness

Figure 7 depicts the plethora of relationships between various categories of resources and the factors underlying personnel performance discussed above. Some of the relationships are straightforward: trainers make non-underway training time available, fuel is necessary for increased underway time, Navy schools must have funding if individual training is to be increased. The resources associated with accession and compensation, however, can be expected to (and often have been shown to) have multidimensional outputs.

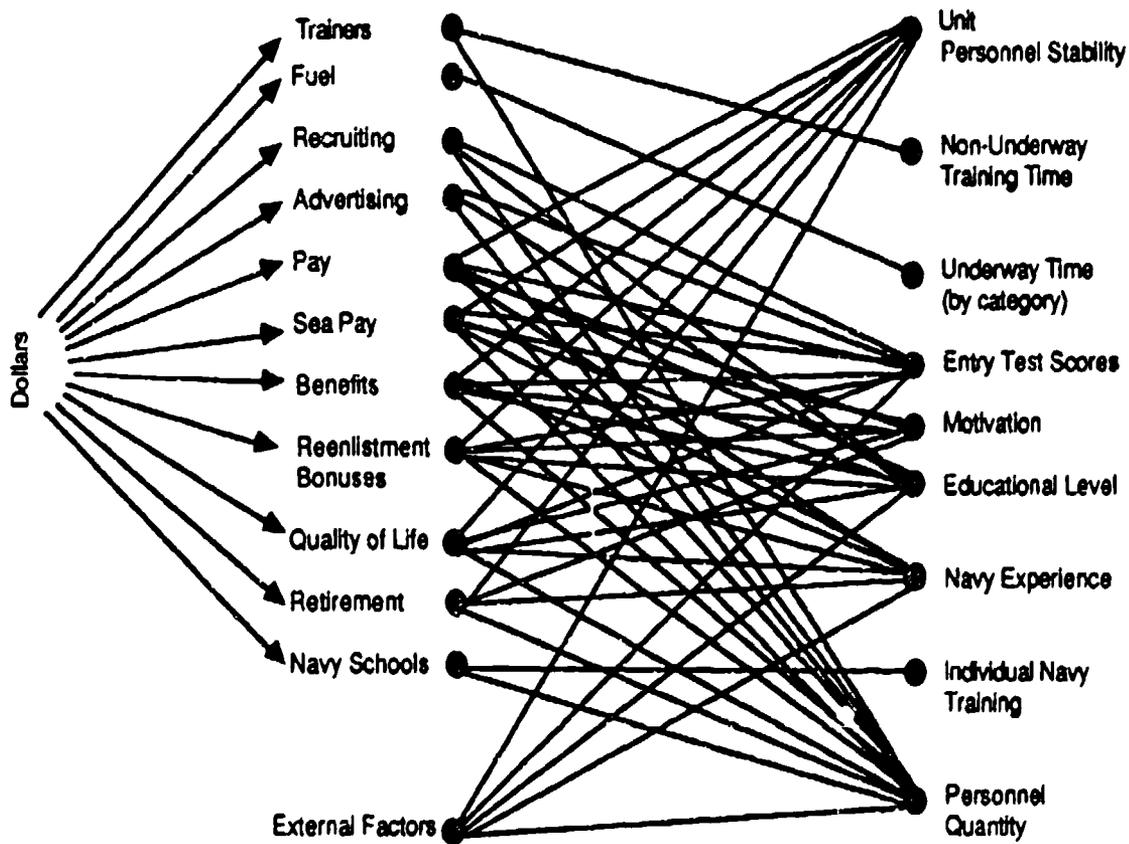


Figure 7. LINKS TO RESOURCES

Thus, for example, more recruiters and advertising will raise the mental group distribution of new recruits and attract more high school graduates. So will pay, benefits

and sea pay. By encouraging extensions at sea, sea pay should also improve the level of unit training by increasing crew stability. These compensation tools also affect retention (though some benefits, like the G.I. Bill, can be expected to decrease the level of experience in the Navy by decreasing retention). Reenlistment bonuses and quality-of-life expenditures are, of course, expected to improve experience levels by improving retention.

They may also be particularly important in retaining individuals with high entry test scores and education levels. The retirement system obviously plays a central role in shaping the experience profile of the Navy personnel structure. In addition, both the monetary and quality-of-life aspects of Navy life can affect the motivation of personnel. Also, by influencing service-wide turnover, they help determine the personnel stability of individual units.

Decisions to increase the number of personnel in the Navy, holding constant levels of personnel quality, require additional expenditures in most of the MPT resource categories.

Of course, neither the quantity nor the quality of personnel is determined solely by DOD and service policy. It depends critically on the national environment. Fewer recruits will be attracted when entry-age cohorts are small, and more will be when civilian job opportunities are poor. Such external factors should have (and have had) an explicit place in MPT policy analysis.

While not all of the links hypothesized in Figure 7 have been quantified, many of them have been. The challenge facing MPT policy makers and researchers is to quantitatively connect the factors on the right side of Figure 7 with measures of performance, readiness and capability that are further along the chain of causation that runs from the size of the MPT budget to the production of overall defense capability.

6. Applicability of the Framework

Thus far, this paper has presented a series of relationships that fit together into an overall framework connecting MPT resource and policy inputs to a hierarchy of outputs of the defense management process. This framework is presented in Figure 8. While the web

of interrelationships appears somewhat daunting, it suggests a methodology for evaluating MPT policies in broader terms than are typically considered.¹

This kind of evaluation requires three things: an ability to develop quantitative indicators of some of the concepts, such as individual performance or training readiness, that should be measured; an ability to match the characteristics of personnel with their performance (or their unit's readiness); and the resolve and resources to do the research to quantify the hypothesized links. Before a research effort is embarked on, however, it is important to establish that adequate data exists to support the effort. It is the question of feasibility that must be raised as the next step in considering a program to give MPT policies their due as crucial determinants of the strength of the Navy.

C. INDICATORS OF PERFORMANCE

Forming and evaluating personnel policies on the basis of the performance of personnel and units can only be done by using information on such performance. An analysis of what kinds of people tend to perform best under what kinds of circumstances cannot be made without accepted yardsticks with which to measure their performance. This requirement does much to frustrate consideration of performance-oriented policy making. For most of the jobs performed in the Navy, policy-makers do not have routine access to the kind of information that would allow them to base decisions on how well people do, rather than solely on what kinds of characteristics they have. The problem is not that useful information does not exist. The problem is that it is usually not available for policy analysis and development. In this section the purpose is to demonstrate that performance data are generated for a wide range of units, missions and tasks. Further, these data are often used to judge the performance of people and units in an operational setting.

In terms of the framework developed in the previous section, existing performance indicators sometimes approximate measures of unit capability. Other times they provide information more consistent with the notions of unit readiness, training readiness, material

¹The framework focuses on the MPT area. It could be expanded to address the contribution of all kinds of resources to military performance. This would facilitate cost effectiveness analyses that cut across the pillars of defense capability of the kind performed in [1].

readiness, or personnel quality as indicated by individual performance. In no cases are they perfect. It is always possible to develop arguments against their use for policy evaluation and development. Their flaws should be borne in mind, but the decision about whether to use them should depend not only on how they depart from the ideal, but also on the alternative. What will be used to form MPT policies and justify MPT expenditures if existing indicators of performance are not? The same old input measures--entry test scores, pre-service education, pay grade mix, steaming days, and flying hours--that have a more obvious tie to cost than to effectiveness will continue to have the field to themselves. The desire for perfection should not be allowed to overshadow the possibility of substantial improvement.

Enumeration of specific sources of potential performance indicators for the Navy follows. Measures oriented toward operational performance will be addressed first, and then other measures oriented towards material readiness and individual performance. At the end of this section sources of similar and, in some cases better, information for the other services are identified.

1. Measures of Operational Performance

a. Training inspections. These are, perhaps, the best source of information on the performance of units in a combat-like situation. They are scheduled, observed, and scored by authorities outside the units involved, but the results are not usually available centrally. They are kept at the type-command level. Some training inspections, like Operational Propulsion Plant Examinations (OPPEs) and Ship ASW Readiness Effectiveness Measuring Exercises (SHAREMs) reflect proficiency in individual primary missions (in these cases mobility and ASW). Others, Operational Readiness Evaluations (OREs), for example, are broader assessments of a unit's performance.

Of course, training inspections have their drawbacks as performance indicators. They do not have the realism of major exercises, but an attempt is made to score them in a more consistent fashion. They are prepared for, and thus probably do not reflect typical performance. Perhaps they approximate an upper bound on performance. They may only occur at set places in the deployment cycle. OREs, for example, take place shortly before the start of overseas deployments. Nonetheless, if we are willing to accept the assumption that units which do well in training inspections are more likely to perform well in combat,

an assumption on which the inspections rest in the first place, they could provide a very useful benchmark of the success of MPT policies.

b. Selected Exercises. These are evolutions performed by ships as part of their regular training syllabi. They differ from other elements of the syllabi in that they must be graded by outside observers once during each cycle of competition for excellence awards. They include live-firing exercises, like naval gunfire support exercises. Taken together, they cover all of a ship's primary missions. Their weaknesses are that, individually, each only reflects a small part of overall performance for any particular mission, that failing grades may not be numerically recorded, and that considerations other than performance may sometimes play a role in the determination of a grade. Still, they are a principal factor in determining the recipients of awards in which the Navy places considerable stock.

c. Excellence Awards. Scores on selected exercises are aggregated to help determine the winners of the mission-area-excellence awards held by squadron commanders. Multiple awards are usually given. Either the aggregate mission-area scores or the receipt of mission-area awards could be the basis for the kinds of performance indicators being studied. The overall Battle-E competition may not yield as suitable an indicator of performance. Only one ship in a squadron can receive the Battle-E, so receipt of the award may not do much to distinguish good performers from bad ones. More important, the relationships between MPT policies and performance presumably differ by rating. This means that performance measures that can be associated with people in particular ratings (or groups of ratings) will be more helpful to this analysis than broader measures.

d. Bombing Scores. Most of the discussion above deals with information on the performance of ships (though air wings undergo OREs). Sources of information on the operational performance of aircraft and aviation units will be addressed next. Attack squadrons keep track of the accuracy of their practice bombing runs. Different kinds of bombing runs are identified. It is possible to associate bombing runs with particular air crews, opening the possibility of analysis at the individual (as well as the unit) level. Data on bombing accuracy is forwarded to functional wing headquarters and is used to compare the performance of squadrons.

e. Air Combat Maneuvering Ranges. The Tactical Aircrew Combat System (TACTS) is the most advanced and realistic instrumentation system ever developed for training air crews. It provides information, instantaneously and on tape, on the flight dynamics, weapons system status, and weapons firing of each aircraft engaged in a training mission. Systems are installed at Yuma and at Oceana. This information is used to debrief air crews about their missions. It should be possible to develop summary measures of mission performance and relate them to training history (among other things). TACTS data are held extremely closely and is not now used for the sort of analytic purposes being considered here.

f. Simulators. Information on the operational performance of units and personnel can be supplemented by data on their proficiency using advanced training devices. The results of simulator exercise results for P-3 squadrons are particularly promising as a source of information. Crew members on these ASW aircraft, both officer and enlisted, spend a substantial amount of time in simulators. These sessions, which last several hours, are used both as training exercises and as indicators of crew readiness. The exercises are taped, and individual crew members, as well as the crew as a whole, are graded on their performance. The results of actual operational flights are similarly recorded but they may not provide a data base as extensive or as well controlled. Training by ship teams in ASW, AAW and EW training simulators ashore should also provide measures of performance.

2. Measures of Maintenance Performance

While operational performance is what the Navy ultimately cares about, the indicators of operational performance that can be generated in peacetime largely reflect the efforts of operating personnel. They are usually the result of using equipment that has a much higher than typical probability of working properly. A large proportion of Navy personnel, however, devote themselves to making equipment work properly. Performance measures that reflect the success of their efforts are needed. Unlike indicators of operational performance, indicators of maintenance performance typically are available centrally, and, indeed, are used to judge trends in the readiness of the fleet. They are not, however, used very extensively to develop MPT policies calculated to enhance readiness.

This section lists some of the more promising sources of information on material readiness that could be used for that purpose.

a. **Casualty Reports (CASREPs)**. Whenever a ship suffers an equipment failure that adversely affects its ability to carry out its primary missions (and that cannot be repaired within 48 hours), it is supposed to file a casualty report. CASREPs range in severity from C-2, which implies only a partial degradation in mission performance, to C-4 which implies loss of the ability to perform at least one mission. While CASREPs form the basis of one of the most widely used indicators of fleet material condition, they have serious shortcomings as the basis for analysis of the causes of variations in material readiness across ships. They are not objective, and the criteria for filing CASREPs may vary widely. Further, even if they were objective, good performance by a CASREP-based measure would not necessarily reflect high maintenance performance. It might just be that the equipment was not operated often. Nonetheless, CASREPs have been successfully used to derive the measures of proficiency in at least one pilot study of the determinants of personnel performance. A virtue of CASREP data is that they are taken seriously by type commanders and by the supply system for determining the priority of requests for parts. In addition, they are readily available from the Fleet Material Support Office.

b. **The Unit Status and Identity Reporting System**. The UNITREP system is the official JCS-sponsored tool for measuring readiness. It contains information on the status of units in each of four resource categories: personnel, training, supply and material. In the first three categories UNITREP reflects more whether a unit has the resources it is supposed to have than whether it can do its job. In the material readiness category, however, ships use detailed logic diagrams to assess their ability to perform each of their primary missions in view of the operational status of all relevant equipment. Unfortunately, this mission-specific information is not forwarded to Washington, and may be difficult to obtain. Also, UNITREP data suffers from some of the same flaws as CASREP data: it is self-reported and it is only meant to capture the condition of equipment, not the proficiency of the maintainers. Once again, equipment that was never turned on will appear to have been well maintained.

c. **Form 4855 Data**. These data reflect information on equipment logs for selected combat systems. It is possible to tell when the equipment was on, when failure was detected, when parts were on order, and when failures were fixed. They are probably

the cleanest ship maintenance data in the Navy. They are kept at the Fleet Analysis Center under the sponsorship of NAVSEA, but it has not always proved to be accessible.

d. Board of Inspection and Survey (INSURV) Data. The INSURV Board carefully inspects over 100 ships per year. Inspectors are highly trained and are respected for their objectivity and consistency. The principal indicator of material readiness generated by INSURV inspections is the Material Condition Index (MCI). It disaggregates equipment into 25 categories, and assigns a score to each category. For each, a score of zero indicates no deficiency, a one indicates a deficiency, and a two, a mission degradation. Unfortunately, the 25 categories are probably not detailed enough to be of use in the kind of analysis being considered here. For instance, there is only one of the 25 that addresses all combat equipment. The INSURV Board has begun to develop a more detailed data base on selected individual equipments. This may be more suitable for deriving information on the maintenance performance of people in particular ratings.

e. Aircraft 3-M Data. The Maintenance and Material Management (3-M) System is the Navy's regular maintenance reporting system. As a source of information on the material readiness of ships, 3-M data is seriously flawed. Drawbacks include non-reporting, reporting errors, differences in reporting requirements from ship class to ship class, and changes in reporting requirements over time. In the aviation world, however, 3-M information gets much more respect. Perhaps this is because the maintenance action forms used to manage repair work are directly used to feed the aviation 3-M data base. In any case, 3-M data is used to develop the statistics on mission capable (MC) and full-mission-capable (FMC) rates that are routinely used to track the material readiness of aircraft. Under the Sub-system Capability Information Reporting (SCIR) system, aviation 3-M data can also be used to generate more detailed information on the readiness of particular kinds of equipment. This could prove extremely useful for various MPT analyses.

3. Measures of Individual Performance

It will not always be possible to determine what kinds of people and training tend to produce the best performance in units in the field. It will sometimes be impossible to isolate the effect of MPT factors on operational and maintenance performance. Some enlisted personnel, especially those in administrative and medical ratings, perform vital

functions but do not much affect the performance of units in peacetime. Even in such cases, better means can be found than basing MPT policies on the proxy measures--such as entry test scores--used today. Designing and validating policies in terms of how well people perform as individuals can be tried. Two sources of readily available information suggest themselves.

a. Scores on Advancement Examinations. With few exceptions, in order to be promoted to any pay grade above E-3 in any rating an individual must pass a written examination in the skills that must be mastered to perform successfully in that higher pay grade. Supervisor approval--presumably based on actual performance--is necessary to take the exam. Of course, test scores measure verbal mastery of a subject, which is not the same thing as mastery in the work environment. Performance in test taking is biased in favor of those who are good at taking tests. Still, the Navy obviously values these tests. It only promotes people who have passed them.

b. Promotion Decisions. Advancement exams are not the only factor in determining promotion decisions. Explicit consideration is given to the supervisor's appraisal of non-testable military skills. Whether or not someone is promoted is probably the best single summary measure of how highly he is regarded relative to other individuals who are eligible for consideration. Promotion results cannot be compared across ratings or across groups of people who took advancement exams at different times since the ease of advancement depends on the quality of the competition and on the need for people in the higher pay grade. Also, promotion results do not provide a continuous scale--you are either promoted or you are not. How long it takes people who entered the Navy at a given time to reach any particular pay grade does provide such a scale, however. A problem with both advancement exams and promotion decisions as measures of individual performance is that neither allows a comparison of the value of personnel in different pay grades, a key element in designing an efficient personnel structure, since both only address variations in individual performance within a single pay grade.

4. Measures of Performance in the Other Services

The Navy has a broad range of performance measures that could be used to aid in assessing and designing MPT policies. The other services, especially the Army and the

Marine Corps, have developed approaches to generating information about performance that might fruitfully supplement the Navy's. Some of these will be briefly discussed here.

a. The Army Training and Evaluation Program (ARTEP). For various kinds of units, the ARTEP provides a list of mission elements and subelements that the units should be able to perform. It is the basis for unit training. The subelements have standards that are tracked and measured by units throughout training in preparation for external ARTEP evaluation. The external evaluation provides objective information on operational performance. Although ARTEP evaluation results have sometimes been used for analysis of policy issues, the Army has been reluctant to use them systematically.

b. The National Training Center (NTC). In effect, the NTC is a large-scale combat simulator located at Fort Irwin, California. Armor and mechanized units train in live-fire exercises and in force-on-force engagements. They are confronted by a well-trained opposing force. Exercises involve the combined operation of tanks, mechanized infantry, artillery, air defense, engineers, electronic warfare, nuclear, biological and chemical warfare, attack helicopters, and close air support aircraft. They use laser-based instrumentation to assess casualties when a weapon fires and the laser hits the target. For the most part, data from NTC training are used like that from the Navy's TACTS system, to provide feedback to the unit being trained. The Army recognizes that it is developing a data base with considerable potential to support training research, as well as research in other areas.

c. Hands-on Individual Performance Data. The Army gives Skill Qualification Tests (SQTs) to individuals in a wide range of occupational specialties and skill levels. Critical tasks within an occupational specialty are usually tested in three ways: written tests; hands-on performance; and supervisors' certification that the tasks have been successfully performed during duty. In addition, the Systems Analysis Activity of the Army's Training and Doctrine Command (TRASANA) developed a set of tests for a variety of military occupational specialties (MOSs). These included both written and hands-on components. The written part of both the TRASANA tests and of SQTs are conceptually similar to the Navy's advancement exams. The hands-on part of the tests is interesting because it breaks the link between success and the ability to take written tests.

d. The Marine Corps Combat Readiness Evaluation System (MCCRES). This system divides the mission of every kind of unit in the Marine Corps

into myriad elements. Over 1000 elements exist for the Corps as a whole. Each element is designed to address a task that is distinct enough to be evaluated on a yes-or-no basis. The purpose of the system is to go beyond evaluating whether a training operation was successful to identifying the strong and weak points of execution. It is well suited to help experienced commanders evaluate readiness and plan training programs. It could also be used as a management tool for comparing units and identifying trends in readiness and determinants of readiness.

5. Using Data on Measures of Performance

It is evident that measures of unit and individual performance abound in the Navy and in the other services. It is also evident that there is a possibility of MPT policies being substantially improved by systematically evaluating them according to their impact (or expected impact) on such measures. There are, however, two reasons why it might not be such a good idea to embark on a program of systematic evaluation. First, using performance measures in this way could possibly negate their value for the jobs they were originally designed for. Second, it could turn out to be a waste of time. It might just be too difficult to identify the effect of personnel characteristics and training experience on measures of performance that are influenced by many other things as well. These are both serious objections and deserve discussion.

The objection to using performance data for central management purposes seems confined to information on operational performance. Information on maintenance performance and individual performance is already available centrally, and, especially in the case of maintenance performance, is used to develop, assess and justify policy. There is concern, though, that making data on operational performance more widely available would dilute the incentives of commanders in the field to evaluate their subordinate units accurately because of fear that bad performance would reflect badly on them. Of course, the value of improved management information might outweigh this cost, but the choice is not clear cut. A decision to use measures of operational performance as the basis for analyzing MPT policies, on the other hand, is much clearer. That is because the analysis can be done without making the performance data widely available. The identity of the units that lie behind the data can be suppressed without damaging the analysis. The idea is

not to put units on report, it is to determine factors that are associated with good performance.

But is existing information on performance good enough to use for analyzing MPT policies? The strongest possible evidence on this question would be to show that it has been used successfully, if sporadically, to investigate a wide range of MPT questions in the Navy and in other services. In the next section such evidence will be developed.

D. ANALYSES OF THE DETERMINANTS OF PERFORMANCE

The thesis of this paper is that the Navy would be well served by a comprehensive effort to tie MPT policies to credible indicators of performance in the fleet. Although no such effort has yet been begun, there have been more than isolated, but less than extensive, attempts to relate MPT factors to performance in the Navy and in other services. These attempts have been fairly successful. Taken together, they form a body of literature that engenders optimism about the feasibility of giving MPT policy making more of a performance orientation. In this section the purpose is to review this literature. Studies that deal with the determinants of operational performance, maintenance performance, and individual performance are all addressed. Some relevant studies are undoubtedly omitted, but the reader should remember that the point here is to demonstrate the feasibility of this kind of research, not to exhaustively survey the field.

1. The Determinants of Operational Performance

Relationships between aspects of MPT policy and indicators of operational performance have been developed for air, sea and ground units. Six analyses will be reviewed. Those that deal with Navy units will be discussed first, followed by Air Force and then Army studies.

a. Unit training and the performance of aviation units. Recent work at the Center for Naval Analyses has examined the hypothesis that aircraft squadrons that have had a greater amount of recent flying time (and hence, presumably, a greater amount of unit training) perform better [2]. Two sources of performance information were used: Operational Readiness Evaluations (OREs) and bombing scores. The ORE results were quite striking. Remember that OREs are tests of operational performance that are graded by observers from outside the air wing. The tests are conducted shortly before deployment is

scheduled to take place. The study looked at the results of 90 OREs. It found that squadrons that flew more in the period before the ORE had significantly higher and more predictable boarding rates (fewer aborted landing attempts), significantly better landing grades, and substantially better average overall scores on the evaluation.

The bombing analyses--while less comprehensive--also yielded good results. The data set was built up from over 2,500 bombing runs of four kinds over a nine month period for a medium attack squadron. Average bombing accuracy in a month was examined as a function of the amount of time spent practicing bombing in the previous month. The results indicate that a 2-percent reduction in flying hours spent practicing bombing is associated with a 1-percent increase in average miss distance for this squadron.

b. Unit training and ship performance. The Operational Propulsion Plant Examination (OPPE) provides an objective measure of ship performance in the area of mobility, a primary mission area for all ships. It is administered to each ship once every 18 months by a team of outside observers, the Propulsion Examining Board. CNA recently examined the results of 22 OPPEs to see whether steaming provides quantifiable training benefits for a ship's crew [3]. Ships with less than 24 days of steaming in the quarter before the OPPE had a 22 percent chance of scoring average or above on the exam. Ships with more than 24 days of steaming had a 46 percent chance of scoring average or above. It appears that the intensity of training made a quantifiable difference.

c. Personnel factors and ship performance. The earliest work seeking to relate crew characteristics to ship performance was the *Navy Readiness Analysis System Methodology Study* [4] which was completed in 1969. It relied on data from Operational Readiness Inspections (ORIs) performed at Fleet Training Group in Guantanamo Bay, Cuba for 82 destroyers. Analyses were carried out for 21 subsections of the ORI. For each subsection, hypotheses concerning the number of relevant personnel on board, how long they had been on board, the presence of certain specialized skills, and the number of weeks of training received were examined. The type of equipment aboard individual ships and the availability of supplies were also considered. The conclusion of the work was that, "Certain personnel, training, equipment and supply resource measures are substantially associated with performance on the ORI subsections. In some cases, higher resource levels were not associated with increases in performance. Most of the relationships appear to be logical, but a few are hard to explain and must be interpreted with caution until more

is known about the underlying processes involved." After almost seventeen years, this remains the most wide-ranging study of the relationships between MPT factors and the operational performance of ships.

d. Training and pilot proficiency in the Air Force. A recent Air Force study [5] investigated the relationship between flying hours and pilot proficiency. Weapons delivery data from an active duty A-10 squadron and an Air National Guard A-10 squadron were analyzed. Both long-term and recent pilot training experience were examined as potential determinants of bombing accuracy. Total mission time by the pilot was found to have the highest correlation with performance. A measurable increase in capability appeared to occur after approximately 1,200 hours of mission flying time in the A-10. No correlation was observed between bombing accuracy and either monthly flying activity or the number of events accomplished by pilots with low levels of experience.

While this work is not fully consistent with either the Navy work cited above [2] or with some unpublished Air Force work that covers additional types of aircraft, it would have strong implications for the personnel management policies applied to the pilot community if it were confirmed by further analysis. In particular, it would seem to argue for keeping pilots in flying billets longer into their careers. This would have the additional benefit of permitting a reduction in the number of new pilots who have to be trained every year.

e. Mental group and the performance of Army tank crews. As part of its efforts to determine the appropriate quality mix for Army personnel, the Army performed a statistical analysis of the relationship between the individual characteristics of tank-crew members and tank-crew range firing performance [6]. Performance was scored by Corps teams at the Grafenwoehr Training Area in Germany as part of the external evaluation portion of the Army Training and Evaluation Program (ARTEP). The analysis covered both M60 and M1 tanks. The mental group of both the gunner and the tank commander was found to be significantly related to performance for both kinds of tanks, but less so for the newer M1. The Army used this study to support its request for high quality manpower in its submission to Congress in May 1985.

f. Personnel characteristics and training readiness in the Army National Guard. The standard measure of training readiness in the active Army comes from the UNITREP system. It is widely felt to be highly subjective. In the Army

National Guard, however, the number of weeks to C-1 training readiness is derived from a fairly objective standardized evaluation of training readiness performed by an active Army evaluation team observing the annual training performance of units. An analysis by Rand [7] sought to relate these evaluations to a wide range of personnel factors for both officers and enlisted personnel. Many factors proved to be both highly significant in a statistical sense and also important quantitatively. These included actual manning relative to the level authorized, the seniority of both officers and enlisted personnel, educational level, unit stability, matches between actual and required occupational specialties, and the marital status and sex of enlisted personnel (married individuals and men performed better, other things equal). While it would probably have been a good idea to allow the determinants of performance to vary according to the kind of unit being observed, the results obtained were strong enough to be considered valid.

2. The Determinants of Maintenance Performance

Showing a connection of MPT factors to operational performance, as the studies discussed above were able to do, is very appealing. It has two drawbacks, however. First, it depends on using performance information that is usually not centrally available; although much of the relevant data does routinely exist somewhere in the field. Second, it does not lend itself to capturing the contribution to performance of maintenance personnel. It is true that equipment must be working before it can be used effectively, but most of the data on operational performance in the analyses cited above was developed from the use of equipment that was known to have a very high probability of working properly. Both of these problems can be overcome by performing analyses of the material readiness of equipment, a measure of the performance of maintenance personnel. Of course, maintenance personnel cannot keep equipment in good condition without proper technical manuals, test equipment and spare parts, but given the environment in which the personnel are working, their skill is likely to be the key determinant of material readiness. Studies have successfully used generally available data to relate the characteristics of enlisted

maintenance personnel to the readiness of Navy equipment. Two of them are discussed below.²

a. Maintenance performance aboard surface combatants. A study completed at CNA in 1977 [9] looked at the amount of down time associated with CASREPs suffered by equipment maintained by men in each of six maintenance ratings. A sample of 91 cruisers, destroyers and frigates was analyzed. The enlisted manning characteristics examined were crew size, education, entry test scores, training, length of service, pay grade, turnover, race and marital status. Non-personnel factors were included in the analysis in order to hold them constant. The determinants of material readiness were found to vary substantially across both ratings and the complexity of the equipment being maintained. The most consistent result regarding personnel characteristics was the importance of having senior people. In all six ratings, a higher fraction of personnel in higher pay grades was associated with less CASREP down time. This effect was particularly pronounced when complex equipment was dealt with. These results would seem to have implications for policy regarding the proper mix of experience in the Navy, for the level of reenlistment bonuses, and for assignment policy.

b. Maintenance performance in naval aviation. A later CNA study [10] examined the material readiness of A-7 squadrons aboard aircraft carriers. Information was gathered on both the mission capable (MC) rate of the squadrons and on the number of sorties they were able to fly. Observations were obtained for 292 quarters of squadron operations. Both of the measures of performance were examined as a function of the distribution of pay grades among squadron maintenance personnel. Squadrons with a higher proportion of more senior personnel tended to do substantially better. Additional personnel in pay grades E-7 and above made a particularly large contribution to performance. It was estimated that moving to a more senior pay grade mix could achieve the level of performance observed in the sample with 18 percent fewer personnel, and at lower cost.

²The studies cited here did not use or require information on the characteristics of people who performed particular maintenance work. An IDA paper [8] notes that there are analyses that could benefit from such information.

3. The Determinants of Individual Performance

It is clearly better to be able to relate MPT factors to the performance of units than to the performance of individuals. After all, if a unit performs poorly, it doesn't really matter how proficient some individuals are at their tasks. Our goal is to tie MPT policies to outputs that really matter. However, it will not always be possible to quantify the impact of MPT policies on either the operational or maintenance performance of units. Sometimes, as in the case of administrative personnel, little direct effect on measured unit performance can be expected. Sometimes analysis of unit performance will just not give usable results. Many non-personnel-related factors influence unit performance, and it will not always be possible to disentangle the impact of personnel. In such cases, an attempt should be made to judge the success of MPT policies with reference to the performance of individuals--in the actual work environment, if possible; in a more artificial setting, if necessary. Most of the analyses relating MPT factors to performance have been done at the individual level. A review of a sample of this work should serve to demonstrate the broad applicability of this approach.

a. Analysis of supervisor evaluations. Supervisor evaluations, although subjective, provide a summary measure of how well individuals perform in their work environment. A 1974 survey asked supervisors to assess the net productivity of individual first termers, relative to typical fully-trained personnel with four years of experience, at various times during their term of service. Net productivity means how much someone contributes to the work group when the amount of supervisor time lost to other endeavors is considered. Over 7,000 responses were analyzed for the Navy [11,12]. Although there were some anomalous findings, the results were generally supportive of the notion that individuals with higher entry test scores and more pre-service education are significantly better performers. A related paper [13] estimates the time path of productivity growth within the first term. The implications of this work were examined [14] to gain insight into the proper mix of first-termers and careerists. A program of higher reenlistment bonuses was recommended.

b. Performance of Navy sensor operators in flight simulators. Recent work at CNA [15] used simulator exercise results for nine P-3 long-range ASW patrol squadrons. The squadrons were all in the Selected Reserve. The sample included over 1,000 individual exercise grades. The grades were developed from a review of tapes made

during the exercises. The performance of sensor operators was analyzed as a function of education, entry test scores, pay grade, number of years spent on active duty, the number of previous recorded simulator trials, and whether the individual was a TAR (full time on active duty). The most important predictors of performance were total time spent on active duty (more was better), experience in simulator exercises, and TAR status (TARs did worse, other things equal). The effect of pay grade was statistically significant, but quantitatively of little consequence.

c. Performance on advancement exams in the Navy. An early study [16] of the relative costs of formal and on-the-job training in the Navy used attainment of a passing score on the E-4 advancement exam as its indicator of successful completion of training. It had to take into account the fact that individuals who had received formal initial skill training had higher entry-test scores than those who had not. It estimated relationships between performance on the advancement examination and scores on portions of the battery of entry tests taken by recruits, by rating, for both school attendees and non-attendees. These relationships were used to estimate how the non-attendees would have fared on the exams if they had attended school, given their entry test scores. Although the study report does not explicitly display the results of the estimation procedure, the entry test scores did tend to be significant predictors of performance on the advancement exams.

d. Performance on Skill Qualification Tests in the Army. As was noted earlier, SQTs contain hands-on and paper-and-pencil components. They are mostly objective, but include a subjective supervisor's assessment. They may present a somewhat biased view of the level of individual proficiency because the tasks on the tests can be selectively prepared for, but the results have been found to behave similarly to indicators of individual skill that do not have this drawback. A Rand study [17] looked at the SQT performance of infantrymen as a function of scores on portions of the ASVAB (Armed Services Vocational Aptitude Battery) taken by new entrants into the services. The entry test scores were very strong predictors of SQT performance. The level of pre-service educational attainment also played a role, but it was not as important. A follow-on study [16] extended the analysis to four Army jobs and investigated the implications of the results for setting recruiting standards and determining job assignments. An Army Research Institute study [17] of seventeen MOSs also confirmed the existence of highly significant correlations between ASVAB and SQT scores.

e. Analysis of other indicators of hands-on individual performance in the Army. The Systems Analysis Agency of the Army's Training and Doctrine Command (TRASANA) designed a variety of MOS-specific hands-on tests that were administered under controlled conditions by TRASANA personnel to individuals serving with Army units. Performance was studied as a function of the Armed Forces Qualification Test (AFQT) score, education level, sex, pay grade, time in service, and time in MOS [20]. Soldiers in AFQT categories in I-III A performed approximately 10 percent better than III B soldiers. AFQT was a more important influence in virtually all instances than either education or experience. This finding, linking AFQT scores with individual hands-on performance, was consistent with a 1969 analysis performed by the Human Resources Research Office [21].

4. The State of the Literature on People and Performance

For both the Army and the Navy, modest bodies of literature exist that link the characteristics and experience of personnel with performance. The work for both services gives broad but shallow coverage to a range of occupations. The Navy analyses have the virtue of being more oriented toward the performance of units rather than individuals. The Army results tend to highlight the performance of entry-test scores as predictors of performance. The Navy results give more prominence to experience. Not surprisingly, the predictors of performance vary substantially with the task being performed. While some valuable policy insights can be gained from this literature, many key issues remain very much in need of further analysis. Prominent among them are the appropriate level of accession quality in the Navy and the relative efficacy of different approaches to training.

E. CONCLUSIONS AND RECOMMENDATIONS

Conceptual links exist between MPT policy and the kinds of outputs the country seeks to buy from the Defense Department as a whole--military performance, readiness and defense capability. The use of explicit *quantitative* links to such outputs could lead to the development of improved MPT policy.

Failure to undertake the development of quantitative relationships between MPT policy and aspects of military performance has traditionally been blamed on the lack of performance data. But plenty of performance data exist for the Services in general and for

the Navy in particular. Information on the operational and maintenance performance of units, as well as information on the performance of individuals is gathered routinely. Indicators of operational proficiency are generally not available from any central repository, but indicators of maintenance and individual proficiency are centrally available.

Even though building relationships between people and performance is a relatively under-researched area, over the years a modest literature has developed on the topic. Over fifteen studies have been identified that quantify links between MPT factors and performance. Taken together they address the payoff to training, experience, mental ability and education, among other things. They bear on the Navy, Army and Air Force. They examine reserve as well as active forces. All rely on statistical techniques to establish approximate relationships. This body of literature demonstrates conclusively that the information needed to begin to manage MPT polices with an eye toward military performance can be obtained.

The development and use of links between MPT factors and performance should become a central focus of the Navy's MPT research. While this could be accomplished in a decentralized fashion, establishment of a separate identifiable program to spearhead this development is worth considering. Such a program would minimize the problem of wasted duplication of effort and would serve as a storehouse of institutional knowledge.

However the effort is organized, it ought to proceed along several tracks simultaneously. Analyses should be initiated using information on both maintenance and individual performance for as wide a range of ratings as possible. Whatever operational performance data can be obtained should also be pressed into service. At the same time, a centralized data base on operational performance should be developed. Research should both try to quantify relationships involving the determinants of performance and look at the policy implications of known or hypothesized links between MPT factors and performance. It is important to determine the extent to which giving a performance orientation to MPT policy making could make a difference. Harking back to the policy areas identified at the beginning of this paper--requirements determination, compensation, retirement and training--the following specific projects could be undertaken.

- Requirements determination. Use data on the operational performance of ships to study the value of having more individuals in higher mental groups and the value of having more experienced personnel, for a variety of operating ratings. Individual performance data should be used if operational performance data is not

available. Perform a similar analysis using information on material readiness (probably "4855" data) for individuals in selected maintenance ratings. Existing analyses have identified these as areas with potentially high payoffs.

- **Compensation.** Build a model for developing efficient compensation packages from information on the relationships between experience and productivity. Apply the model to the results of existing studies, such as [10]. This could give some insight into whether today's pay profile makes sense.
- **Retirement.** Analyze the effectiveness, and cost, of various retirement packages for meeting alternative sets of requirements for people by length of service. These first three studies could indicate ways in which requirements, compensation and retirement might be changed in mutually supportive ways.
- **Training.** Study pilot proficiency as a function of both recent training history and accumulated flying time, as well as the personal characteristics of pilots. This work could have implications for the selection, compensation and career management of pilots, and for management of the flying-hour program.
- **Data development.** Initiate construction of a central repository of information on the operational performance of units. This should encompass the results of training inspections, selected exercises and excellence award competitions, as well as information on bombing accuracy and performance on TACTS ranges. Since the purpose of developing this data base is to build generally applicable relationships, not to evaluate individuals or units, a strong commitment should be made to eschew its use for such evaluation purposes. This commitment should include destroying identifying codes as quickly as is feasible.
- **Long-term research planning.** Just as a ship cannot be turned on a dime, it will take time for the Navy to move to a performance orientation in MPT management. Developing a research strategy to make the change as quickly as possible could be most fruitful.

This program strives for balance between studying the determinants of performance and learning to use the information from such studies, as well as balance between developing insights quickly and building for the long run. Its adoption would imply a commitment to seriously consider changing the orientation of MPT policy-making in the Navy, to make it steer by the star of improved performance. Substantial benefits can be foreseen. The rather sparse analysis done to date already builds a strong case for greater experience in the Navy's enlisted force--and for the level of bonuses necessary to get it. As additional research is performed, the Navy would increasingly be in a position to focus on getting the most for its MPT dollars.

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**EVALUATING NAVY MANPOWER, PERSONNEL AND TRAINING POLICIES
IN TERMS OF PERFORMANCE**

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