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ACCRUED UTILITY OF NAVY ENLISTED PERSONNEL.(U)
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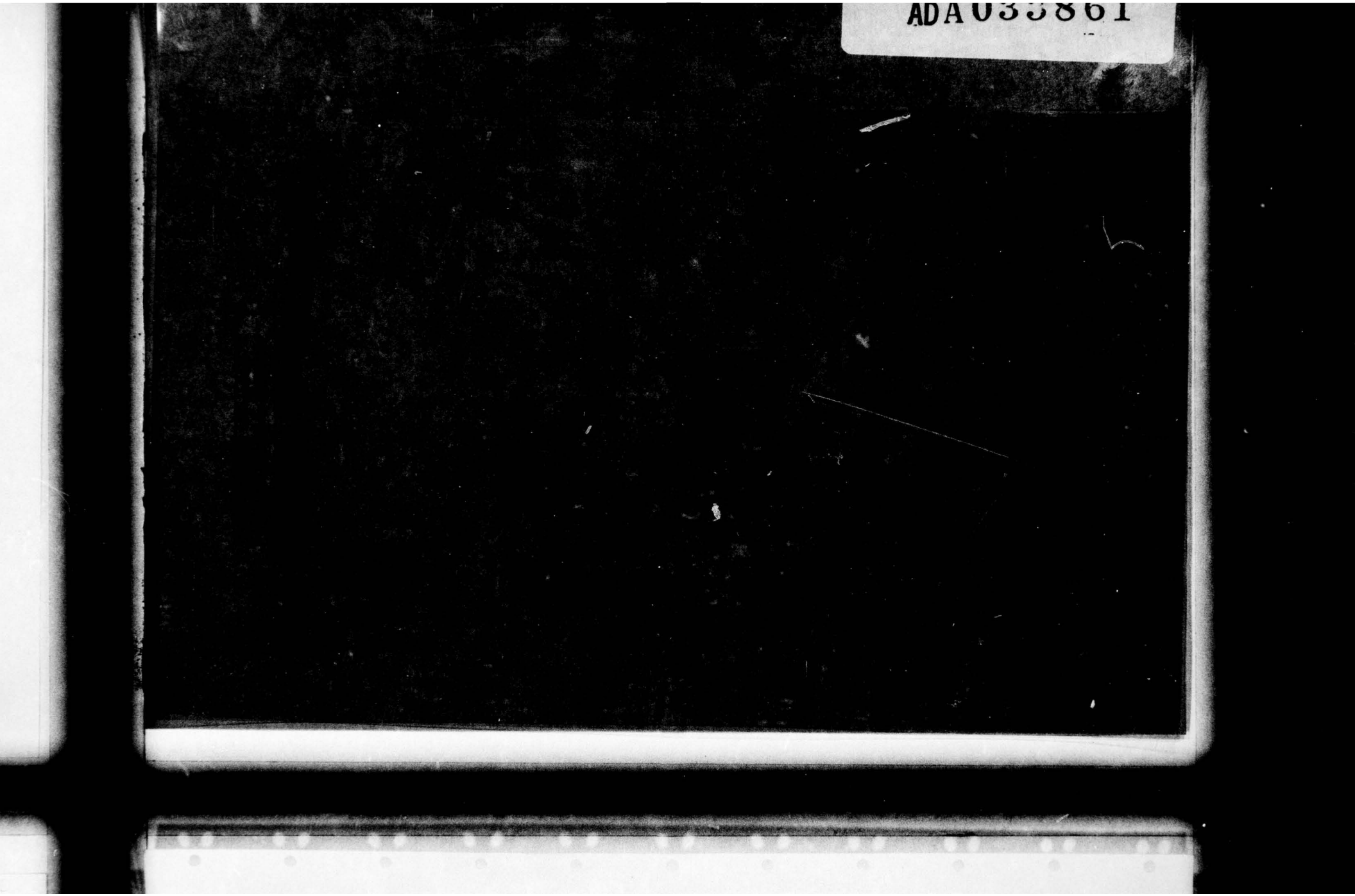

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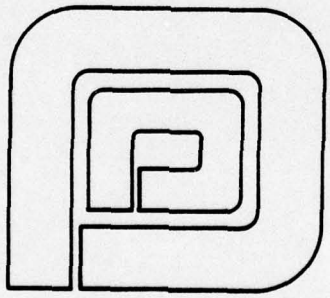

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SUMMARY

The purpose of this study is to determine the relative contribution to Navy missions of the accrued experience of enlisted personnel. For each Navy rating, the utility of a person with a particular length-of-service (LOS) and a particular pay grade is examined. The methodology employed consisted of in-depth interviews and resultant detailed justification for the utility functions obtained.

Differences among ratings in terms of the utility associated with a particular LOS/pay grade combination are a function of three main variables. These are the technical learning depth of the rating, the necessity for rapid unaided decisions in the task of the rating, and the probable loss associated with an error by a person in the rating. Fairly large differences exist among ratings in terms of the utility of a particular LOS/pay grade combination, the highest utilities occurring for ratings involving complex technical maintenance and operation of equipment where rapid unaided decision-making is required, and probable losses associated with errors are large. These utilities are obtained for a Sixth Fleet battle-ready type scenario and do not vary appreciably for other scenarios. Results also indicate that utility is highest for sea-duty intensive career patterns.

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ACCRUED UTILITY OF U.S. NAVY ENLISTED PERSONNEL

1.0 INTRODUCTION

1.1 Objective

The purpose of this study is to determine the relative contribution to Navy missions of the accrued experience of enlisted personnel. Of interest, for example, is the relative worth to the Navy of a Sonar Technician with 15 years length of service (LOS) as compared to a Sonar Technician with 10 years LOS. This change in usefulness or "utility" to the Navy as a function of experience and pay grade must be estimated in some fashion if the Navy is to plan policies which maximize the cost-effectiveness of the enlisted force. The cost factors are already known with adequate precision for general policy guidance. The quantification of effectiveness or utility presents a more difficult problem.

Another reason for the present study was the need to clarify reasons for utility changes with experience, especially if the changes vary among ratings or types of duty assignment. Qualitative analyses of the reasons for utility changes can increase confidence in the numerical estimates if the reasons for such changes are convincing. The reasons can also provide a more detailed guide to policy planning than would numerical utilities alone.

This study does not deal with changes in total force strength nor with trade-offs among ratings in terms of numbers of personnel [for example, trading more Sonar Technicians (ST's) for fewer Electronic Technicians (ET's). The number of personnel within each rating is taken as a given.] The study addresses only the utility gained by years in service and advancement, and how this utility may vary among ratings. For example, in the study it was found that experience beyond the first ten years increased the utility of personnel in the weapons ratings by 25%, but increased the utility of personnel in most administrative ratings by only 10%. This suggests exploring the feasibility of a policy which encourages a higher percent of career reenlistments by weapons personnel and a more junior administrative force. Of course, other factors might work against such a policy. Recruitment of capable administrative personnel might be more difficult and costly if the potential recruits knew that very few would be advanced far up a career ladder.

But such problems of policy implications are beyond the scope of this study, which is limited to estimating the utility currently gained by experience on the job (including training) in the various enlisted ratings. Defensible utility estimates provide a sounder basis for combining utility and cost to estimate total cost-effectiveness of enlisted personnel at different LOS/pay grade combinations, under present conditions. This, in turn, provides a better basis for considering different continuance and advancement policies.

1.2 Previous Studies

The U.S. Navy Enlisted Force Management System (EFMS), recently developed by the Bureau of Naval Personnel (BUPERS), is a computerized model designed to take inputs on utility and cost and quickly calculate cost-effectiveness implications. The intended use of the EFMS for optimization in personnel policy planning implementation is shown in Figure 1-1. As indicated, full use of the EFMS optimizer requires valid utility estimates.

Responding to the above requirement as part of the initial optimizer development, B-K Dynamics provided initial utility estimates based on quantitative judgments by enlisted and officer personnel.[1] The judgments were obtained by questionnaire, and the Delphi technique was used to seek consensus among the respondents. Substantial consensus was achieved regarding the rate of increase in utility for enlisted personnel in general, as a function of LOS and pay grade. The most rapid increase occurred in the early years, gradually leveled out, and then tailed off somewhat in the later career years (see Figure 1-2). Higher pay grades were given higher utilities in a pattern which closely approximated the enlisted pay scale. It is reasonable that utility might increase with pay grade in this regular manner, and, in fact, the present study yielded similar results. In both studies, however, it is possible that pay grade may have been a significant factor affecting the utility judgments.

It should be noted that the earlier studies did not examine potential differences among ratings in terms of the total increase in utility with experience. Ratings were

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[1] See J.R. Schmid and R.K. Hovey, Utility Theory and Optimization in Military Personnel Management, Report prepared for the Navy Manpower Research and Development Program, Office of Navy Research. (Rockville, Md.: B-K Dynamics, Inc., January, 1975).

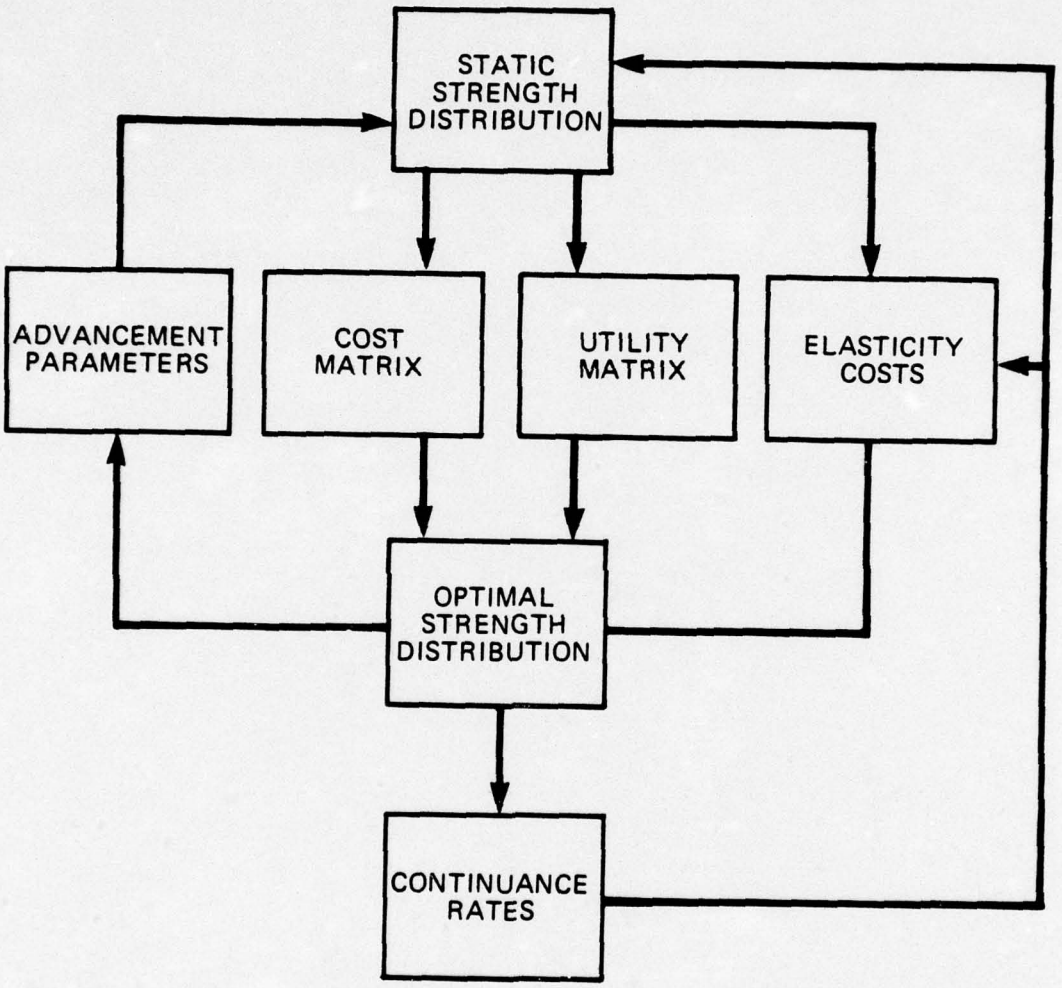
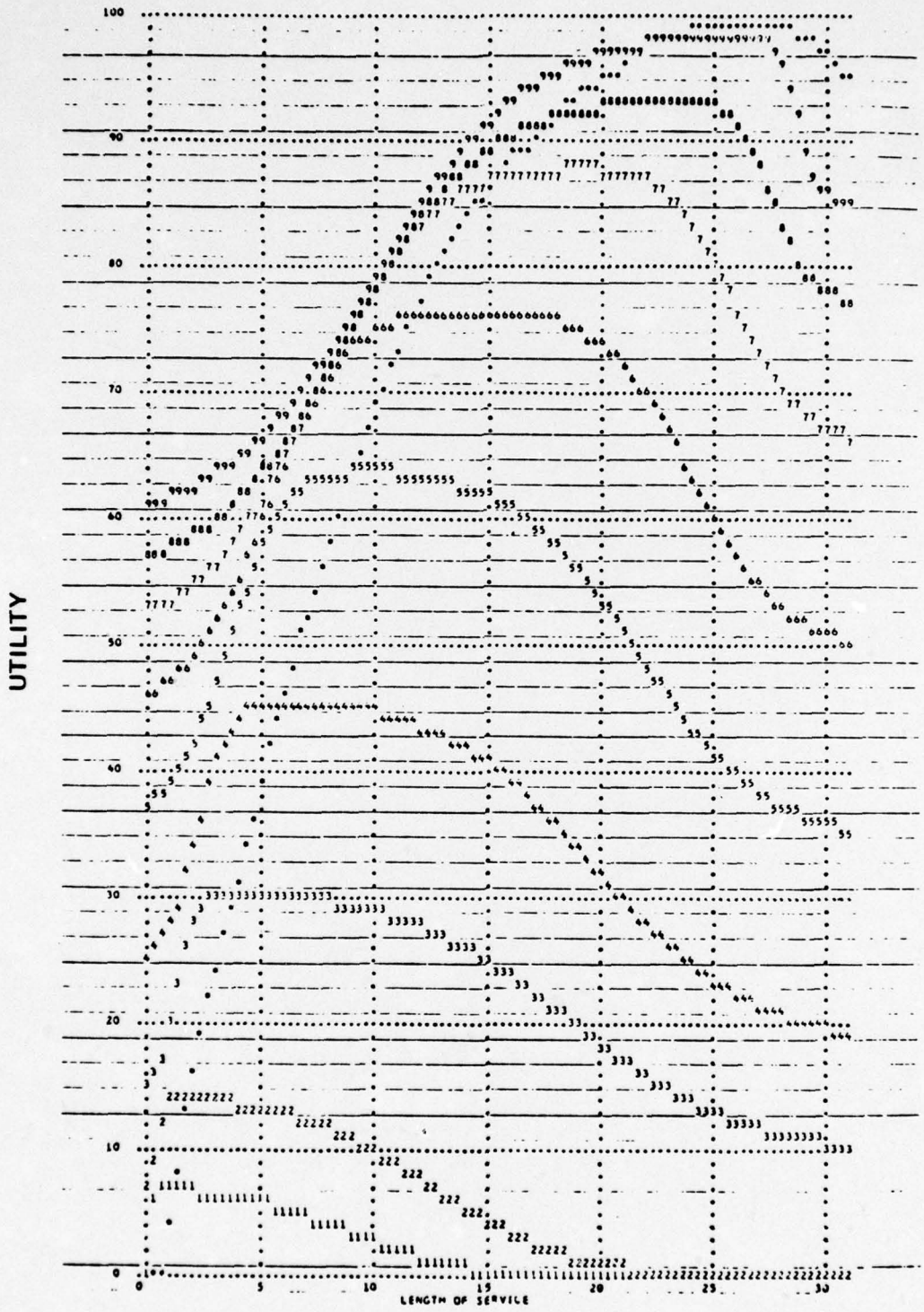


Figure 1-1

OPTIMIZATION MODEL OVERVIEW



From Schmid and Hovey, p. 51

Figure 1-2

UTILITIES, PAY GRADE BY LOS

divided into five reasonable groups and compared as to shape of the utility curve, that is, rate of change in utility with increasing LOS and pay grade (no statistically significant differences were found among rating groups). But in all cases the utility increase was scaled from 0 to 100, and no data were obtained to indicate whether the total career increase in utility might be greater for some ratings than for others. For example, the utility increase over the average career might be twice as great in one rating as in another. This will not be apparent if all utility functions must vary from 0 to 100.

2.0 METHOD

2.1 Dimensions of Analysis

In-depth interviews were chosen as the method of data collection because of the emphasis on qualitative analysis of the reasons for utility differences. Design of the interviews began with a thorough conceptual analysis of the factors which might influence utility of enlisted personnel. A search for related studies revealed little of direct relevance, other than the studies by B-K Dynamics, Inc. cited earlier, so the initial conceptual analysis drew its content expertise mainly from those members of the DDI staff with career naval experience and from meetings with several BUPERS project monitors and advisors.

2.2 Definition of Utility

The focus of this study is utility accrued as a function of experience, sometimes called "accrued utility." The meaning of accrued utility is clearer if it is considered to be part of the total utility of an enlisted person. That is, total utility can be divided into two parts: the contribution a person can make to Navy missions when he or she first enters the job, and the additional contribution (accrued utility) which he or she can make as a result of later training and job experience. The point in time dividing these two parts of total utility is defined for this study as the start of apprenticeship. This point is chosen, rather than the date of enlistment, because an individual's utility is difficult to imagine, let alone measure, until that individual goes to work in the job. Interviewees could not be expected to estimate the utility of a person who had not performed in any way that would permit evaluation of his contribution. So accrued utility is defined as beginning with apprenticeship. To simplify judgments regarding utility, accrued utility was further subdivided into two components: first, the <u>total</u> amount of utility accrued with experience and, second, regardless of total amount, the rate at which this utility changes with LOS and pay grade.

Preliminary analysis suggested that differences among types of jobs might be the most significant factor affecting utility of experience, and indeed this was the case. The results indicated that the ratio of total accrued utility for pairs of enlisted ratings varied by as much as 5 to 1. Other factors considered included whether the duty unit was battle-ready or stand-by, size of ship, and journeyman-versus-supervisor responsibilities. These and other factors

were mentioned by interviewees, but none were judged to be nearly as significant as type of rating. As a result, most interview time was devoted to explaining reasons for utility differences specific to a rating, that is, specific training, type of work, and critical performance requirements. Often, the important factors were considered to be quite similar for a group of ratings and, accordingly, the results are presented by rating groups.

2.3 Data Sources

The dimension of utility chosen for emphasis largely determined what data sources would be appropriate. For detailed qualitative analysis of the reasons behind career changes in utility, an attempt was made to interview those enlisted persons and officers in the Navy who were most familiar with the careers and critical performance requirements of personnel in specific ratings or rating groups. In order to compare total accrued utility among ratings, officers were interviewed who were not only familiar with the specific performance requirements but who also had considerable experience in command positions where they were responsible for the consequences of the performance of enlisted personnel.

Given the resources available for the study, tradeoffs had to be compared and choices made among size of samples, number of ratings examined, and amount of information that was obtained on each rating. B-K Dynamics, Inc., in earlier studies, had obtained all-Navy enlisted personnel utility curves showing rate of change through the career, and had found considerable consensus in three studies with a sizable number of respondents (70 in the final study). It was apparent that the most distinctive and useful contribution of this study would be greater in-depth qualitative analysis of the reasons for career changes in utility, especially comparative analyses among ratings as to overall career utility gain. This study, therefore, relied on a smaller number of respondents to provide considerable information. Each of the 13 principal respondents was interviewed from two to four hours.

Enlisted men interviewed were Chief, Senior Chief, and Master Chief Petty Officers with many years experience in the subject rating and some experience in BUPERS as coordinators or detailers for that rating. The nine principal officer interviewees varied in rank from Lieutenant Commander to Captain and were selected to represent a variety of duty assignments. In addition, seven of the nine had duties in BUPERS which involved various aspects of overseeing and

managing enlisted personnel planning. The duty types included surface, undersea and aviation duty settings, shore duty support functions, and ship sizes varying from small craft to aircraft carriers. In addition to the 13 principal interviewees, several other officers and enlisted men were present at one or more interviews and provided useful supplementary information. In addition, several DDI staff members with extensive Navy experience were consulted.

It can be argued that a larger number of respondents (if equivalent expertise were available) might yield more stable estimates of utility differences, but exact utility estimates cannot be expected realistically no matter how many respondents are obtained. Most interviewees found it difficult to assign exact numbers and considered their estimates essentially "ballpark" figures. For example, it is unlikely that a difference of 5% in an estimate would be considered noticeable by most respondents at the level of precision achieved. Thus, the more cost-effective strategy for this study seemed to be careful documentation of the reasons for approximate utility estimates, rather than to expend the same resources to obtain slightly more precise but undocumented estimates based on a larger number of respondents. If a larger number of respondents had been utilized, the resulting changes in utility estimates would most likely be too small to change policy conclusions.

2.4 Interview Procedures

All interviews were conducted by one or more of the authors of this report. The interviews were arranged for by BUPERS and conducted in the Naval Annex, the Pentagon, or DDI offices between June and September, 1976.

2.5 Enlisted Interviewees

The enlisted specialists in a particular rating were each interviewed for approximately two hours in a loosely structured interview organized in the following steps:

1. A review of the interviewee's own background and experience; critical performance dimensions in the rating; and descriptions of typical crews which include that rating.

2. A detailed chronological account of typical training and duty experiences throughout the career in a rating. Where substantially different accrued utility was thought to result from different career patterns within the rating, this was noted and a separate chronology for each career pattern was recorded.

3. The amount of utility gained in each portion of the career was estimated for the average progressor. In some cases a separate estimate was made of the proportion of utility accrued during apprenticeship, journeyman, and supervisory stages of duty.

4. At two or three widely spaced LOS points in the career, respondents were asked how much more or less utility had been accrued by persons who were one to two pay grades ahead and one to two pay grades behind the normal progressor in advancement.

5. Links between events in the chronology and changes in utility were considered, and additional reasons were solicited where a utility estimate did not conform to typical pattern.

The enlisted respondents represented four contrasting ratings (ST, ET, BT, YN) including technical weaponry, propulsion plant, and administrative duties.

2.6 Officer Interviewees

Eight of the nine principal officer respondents were each interviewed in two stages. The first-stage interviews, combined with those of the enlisted men, provided initial estimates of accrued utility as a function of both LOS and pay grade, as well as differences among rating groups in total accrued utility. These first-stage composite utility estimates were then prepared in graphic form and in the second-stage interview were shown to the same officers. They were asked to review and criticize the estimates, explain their disagreements, and provide additional reasons, if necessary, for particular estimates.

The specific interview procedure was as follows:

1. The interviewee was asked for background information about his own experience.

2. He was asked for critical performance dimensions in the rating. In particular, he was asked to specify the activities which an outstanding person does better in the rating than does an average person, to note the failures of performance most commonly observed, and to indicate which were most serious in terms of consequences. He was asked why he thought these failures occurred.

3. He was then asked to provide estimates of changing accrued utility at certain points in a career for a given rating. These points were: typical journeyman in his best year (the year in which he has mastered the "hands-on" labor aspect of his job and has accrued about 90 percent of the maximum utility that he will have at some later point in his career when he is doing both journeyman and supervisory tasks); apprentice with the least amount of Navy training; fully trained apprentice; a point from 4 to 8 years LOS; supervisor; journeyman with 18 years LOS. For certain of these points he was asked to estimate the relative utility of persons one pay grade ahead and one pay grade behind, in addition to the relative utility of the average progressor.

4. He was next asked for reasons behind the estimates of differences and for variations which he perceived within a group of similar ratings.

5. The interviewee was asked to compare several ratings or rating groups with regard to total utility accrued during the career. He was asked only about ratings with which he was familiar. He was first asked to choose the rating in which Naval training and job experience had greatest value to the Navy. This experience was given an arbitrary value of 100, and other ratings were then compared with this on a ratio scale, such that a rating assigned the number 50 would be one in which experience had only half the utility to the Navy of the experience in a rating given a utility of 100. The reasons for differences among ratings in total accrued utility were sought and discussed as the estimates were given. (In some instances, Step 5 was accomplished earlier in the interview process.)

6. Results of all first-stage interviews were combined and composite estimates were graphed for use in second-stage interviews.

7. In a return visit several weeks later, the interviewee was asked to discuss the ratings further and was shown the composite estimates. Where his own estimate disagreed markedly with another, he was told the reasons given by other interviewees for their estimates; these were discussed and weighed against counter-reasons that had influenced his

earlier opinions. For the sake of uniformity, all total utility estimates obtained in this stage were anchored to the career point immediately following boot camp, defined for this study as entry into apprenticeship. Each interviewee thus reviewed both total accrued utility estimates and career changes in rate of accrual for all ratings.

8. The extent to which total accrued utility might differ depending on the readiness scenario was discussed. Some respondents had been asked in the first stage to provide separate estimates for the 6th Fleet (battle ready) and 2nd Fleet (work-up).

9. In the first-stage interviews there was some disagreement about whether utility actually declined in the later years of the career. This question was re-examined with each interviewee in the second-stage interviews.

After the second-stage interviews were completed, estimates were adjusted to reflect judgments obtained in the second stage. Throughout the interview process, judgments influenced the final figures to the extent that they were backed by convincing reasons.

3.0 RESULTS

3.1 Total Accrued Utility

The most important finding of the study is that total utility accrued with experience in the Navy varies markedly among the service ratings. The amount of utility gained from the start of apprenticeship through the peak journeyman years is five times as great in some ratings as in others. Figure 3-1 displays the comparison among groups of ratings in total accrued utility and identifies the ratings in each group by code letters. Table 3-1 provides the full title for each rating code. A rating is subdivided into its specialty subgroups only for those ratings (CT, AB) in which subgroups were judged to have substantially different accrued utilities. (Specially trained teams such as UDT and SEAL were not taken into account.)

If an attempt had been made to measure utility exactly, the ratings would probably be distributed along a continuum from about 15 to 100, rather than lumped into seven groups (A to G in Figure 3-1). Clustering them into groups simply reflects, to a certain degree, the lack of precision in measures of utility, as well as genuine similarities in patterns of utility accrued. Any differences smaller than five percentage points would be misleading and would suggest finer discriminations than respondents were able to make. But even granting the approximate nature of the estimates, there is no doubt about the wide differences in accrued utility expressed by the interviewees.

Of interest is the source of the large differences in total accrued utility. Such differences do not simply reflect importance of the job, although that may be an element of accrued utility. Based upon the definitions given the interviewees, total accrued utility reflects the increase in contribution to the total Navy mission of an enlisted person at the peak of his or her career over that of a beginning apprentice. In addition to the criticality of the job to the Navy mission, accrued utility reflects how much must be learned about the job. Some of the reasons given for differences in total accrued utility were specific to the nature of the job in a given rating or group of ratings. However, there were three main criteria which emerged as important in comparing all ratings:

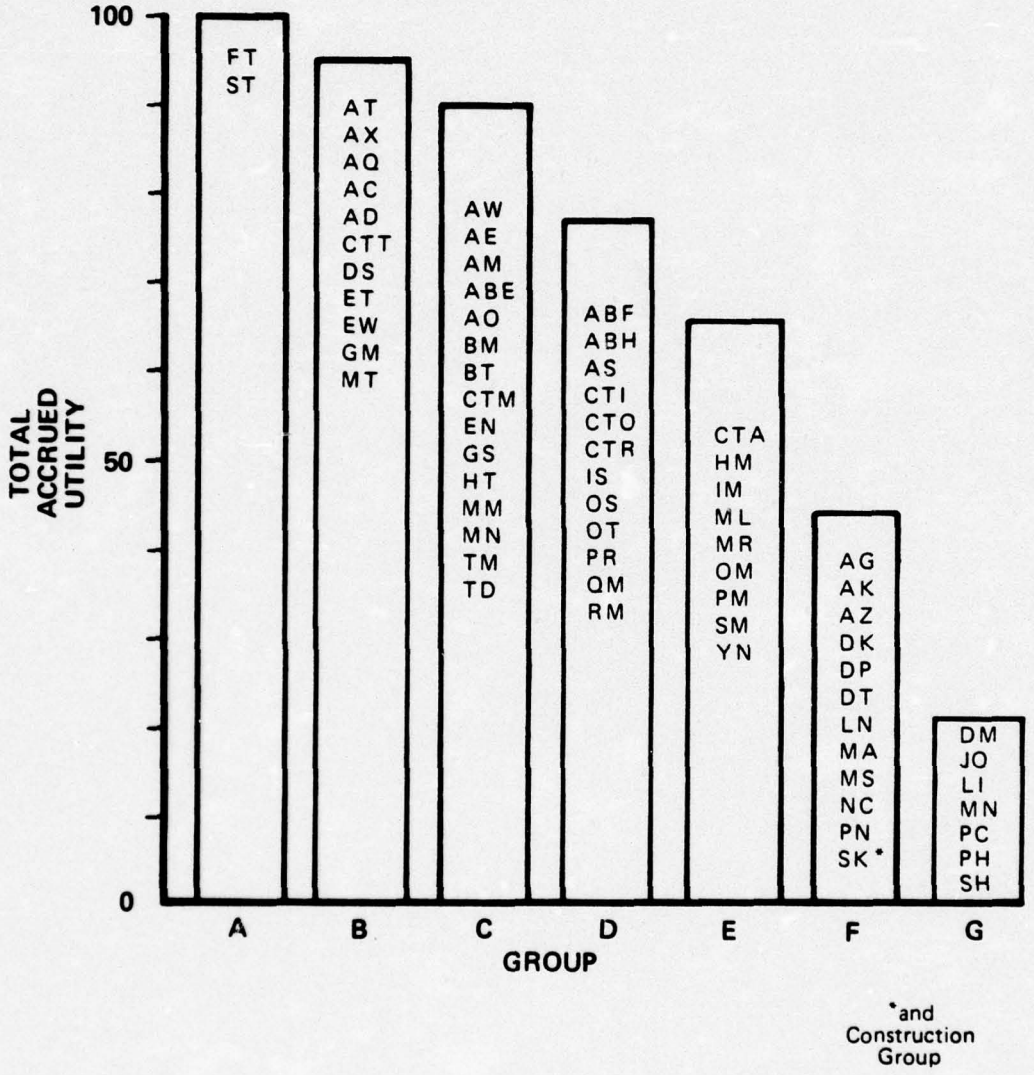


Figure 3-1

TOTAL ACCRUED UTILITY FOR SEVEN RATING GROUPS

AG	Aerographer's Mate
AC	Air Controlman
PR	Aircrew Survival Equipmentman
AW	Aviation Antisubmarine Warfare Operator
AX	Aviation Antisubmarine Warfare Technician
AB	Aviation Boatswain's Mate
AE	Aviation Electrician's Mate
AT	Aviation Electronics Technician
AQ	Aviation Fire Control Technician
AD	Aviation Machinist's Mate
AZ	Aviation Maintenance Administrationman
AO	Aviation Ordnance
AK	Aviation Storekeeper
AM	Aviation Structural Mechanic
AS	Aviation Support Equipment Technician
BM	Boatswain's Mate
BR	Boilermaker
BT	Boiler Technician
BU	Builder
CTA	Communications Technician Administrative
CTI	Communications Technician Interpretive
CTM	Communications Technician Maintenance
CTO	Communications Technician Communications
CTR	Communications Technician Collection
CTT	Communications Technician Technical
CE	Construction Electrician
CM	Construction Mechanic
DP	Data Processing Technician
DS	Data Systems Technician
DT	Dental Technician
DK	Disbursing Clerk
EM	Electrician's Mate
EW	Electronic Warfare Technician
ET	Electronics Technician
EA	Engineering Aid
EN	Engineman
EO	Equipment Operator
FT	Fire Control Technician
GS	Gas Turbine System Technician
GM	Gunner's Mate
HM	Hospital Corpsman
HT	Hull Maintenance Technician
DM	Illustrator-Draftsman
IM	Instrumentman
IS	Intelligence Specialist
IC	Interior Communications Electrician
JO	Journalist
LN	Legalman
LI	Lithographer
MR	Machinery Repairman
MM	Machinist's Mate
MA	Master-at-Arms
MS	Mess Management Specialist
MN	Mineman
MT	Missile Technician
ML	Molder
MU	Musician
NC	Navy Counselor
OT	Ocean Systems Technician
OS	Operations Specialist
OM	Opticalman
PM	Patternmaker
PN	Personnelman
PH	Photographer's Mate
PC	Postal Clerk
QM	Quartermaster
RM	Radioman
SH	Ship's Serviceman
SM	Signalman
ST	Sonar Technician
SW	Steelworker
SD	Steward
SK	Storekeeper
TM	Torpedoman's Mate
TD	Tradevman
UT	Utilitiesman
YN	Yeoman

Table 3-1: NAVY SERVICE RATINGS AND LETTER CODES

1. Learning Depth. Ratings which required more learning, either in school or on-the-job, were given higher accrued utilities, as might be expected. The more there is to learn, the more difficult it is to learn, and the more new learning required as a result of potential technological obsolescence, the greater in general will be the difference in job competence between the highly experienced journeyman and the beginning apprentice.

2. Sole Decision Reliance. If a job requires making quick decisions without the opportunity to consult manuals or other more experienced personnel, experience on the job generally has greater utility than in jobs in which others can be consulted before a decision, or in which many personnel make inputs for the same decision.

3. Probable Loss Resulting From Error. The losses of greatest importance are failures to carry out missions, and losses of ships, planes, personnel. This factor involves not only the magnitude of the possible error, but also the likelihood of disastrous consequences. For example, a moderately serious loss which has an associated moderate-to-high probability of occurrence might be equivalent to the loss associated with a major disaster which has a low probability of occurrence.

These three factors were weighed qualitatively in arriving at quantitative estimates of total accrued utility. In many cases the interviewee made no mention of one or more of the factors, and no attempt was made to force a judgment on each factor in each case. The factors served more as a framework for the analyst than for the interviewees. Following are more detailed rationales for differences in total accrued utility as a function of rating groups. Estimates for the construction group and CT ratings should be considered more tentative than the others because they were reviewed by only two career officers.

3.1.1 Group A (FT, ST) - Experience has slightly higher value for Group A than for Group B because in addition to operating or maintaining complex equipment, which is required in both Group A and Group B ratings, the FT and ST must make quick, decisive interpretations of data directly related to attack and to defense against enemy aircraft and submarines. Often there is no time for interpretations to be checked by another person, and there is great potential for loss of ship, personnel, and mission. The margin of Group A over Group B might have been a little greater were it not for the fact that the electronic equipment for tracking enemy craft is gradually becoming more automated.

3.1.2 Group B (AT, AX, AQ, AC, AD, MT, GM, ET, EW, CCT, ES) - Most of these ratings involve the maintenance and/or operation of complex electronic equipment. Extensive formal training is necessary to perform these jobs, and this training is often interspersed throughout the career. On-the-job experience is also quite important in that only at sea do individuals in these ratings learn the effects of sea forces and weapon discharge on operation of the equipment. Whereas formal schooling is most important for maintenance, on-the-job experience is more important for operation under combat conditions. Technological change is perhaps most rapid in the electronic field, so technicians in Groups A and B are more likely to need update training throughout their careers.

Group B accrues somewhat greater utility than Group C because Group B both maintains complex equipment and exercises control over effective functioning of main battery weaponry (where the airplane is considered the main battery of the carrier). The AC and AD ratings are included because of their critical necessity to the survival of planes in combat and hence to the success of mission and the survival of pilots. The DS rating is included because DS personnel operate and maintain equipment that links together operations of the entire fleet over an area of perhaps 1,000 square miles, and transmits sensor displays among all ships. Aviation ratings are sometimes included in Group B while a corresponding surface rating is in Group C (AD versus MM) because of the probable more serious consequence of an error. That is, an error by personnel in these aviation ratings is more likely to cause the loss of a plane than is a similar error in a related surface rating likely to cause the loss of a ship.

3.1.3 Group C (ABE, AE, AM, AO, AW, BM, BT, CTM, EN, GS, HT, MM, MN, TM, TD) - Most of these ratings deal with the engineering and propulsion of ships or with ordnance, and these ratings, on the average, represent an intermediate level of technical complexity. Ship propulsion is, of course, vital to overall mission accomplishment, but the time scale for making and changing decisions is usually somewhat longer than the time scale in weaponry. However, if these functions fail to the point where the ship cannot move, the mission will be lost, and in combat sometimes even the ship will be lost. It would be more usual, however, for only one piece of equipment to fail and for the ship to lose some power without total loss of mission or loss of ship. Most of these ratings require a great deal of on-the-job learning, and less formal schooling than is required in Group B. Interviewees claim that it takes many years to develop the ability to detect subtle changes in engine

sounds, an ability which facilitates immediate diagnosis and prevention of serious consequences. Effective ordnance is critical to mission success, and sometimes to survival of the ship and men, but since these men prepare weapons and do not operate them, their errors are more likely to be caught by others performing quality control checks. For the engineering and propulsion crew, the most difficult thing to learn is the dovetailing of various parts of the system. They may know their own specialty well, but it takes years to learn how each part of the system is affected by all others and to integrate this information.

The job of the Hull Technician (HT) is perhaps less complex and more like the work done by construction battalions, but it is included here because the HT not only directs damage control crews, but also must effect fast ship repairs during combat, both duties being critical to the survival of a ship. The Boatswains Mate (BM) rating also comprises less technical complexity but is key to the operation of the ship at all times, including during combat. The main point made by respondents was that the BM continues to learn a great deal and to improve his contribution to the mission by additional years of experience, perhaps continuing to accrue additional utility up to LOS 20. The ABE operates and maintains catapult and arrest equipment, which is, in effect, the main battery of the carrier. Because this is complex equipment, the ABE is rated here rather than with the other AB's in Group D. The AW is in Group C rather than in Group B because the equipment he operates is becoming more automated, with the exception of that on the helicopter.

The TD, Tradevman or training device man, is tentatively included in this group, although a fair amount of controversy exists about the relative importance of the rating. The TD maintains and operates simulation equipment. This function is particularly important to the success of the air mission. In fact, a decision has been made to increase simulator training and reduce in-flight training of pilots. Therefore, a lack of quality in the rating could indirectly lead to serious shortfalls in the quality of the air mission effort.

Raters familiar with the air ratings maintain that the air-sponsored TD rating is of critical importance. Raters in the surface and sub-surface areas attach lesser importance to the TD, emphasizing the possibility of replacing the TD with civilian personnel, since the TD is not a sea-going rating. The relevance of this point is questionable since the fact that non-sea-going ratings could be replaced by civilian personnel does not alter the fact that the

experience of the person in the rating is important as long as the decision has been made not to replace the rating with civilian personnel. Given that such a decision has been made, and that the work of the rating is indeed considered to be critical to mission success, experience then has great value, because the work is highly technical and complex, and this requires training of a technical depth about equivalent to that of the ST.

The issue is not resolved, and more research is merited. At this point, it seems best to group the TD with ratings that involve high levels of technical complexity even though the contribution of the TD to the 6th Fleet mission is indirect.

3.1.4 Group D (ABF, ABH, AS, CTI, CTO, CTR, IS, OS, OT, PR, QM, RM) - Though there are exceptions with individual ratings, Group D generally represents either less technical complexity than Group C and/or less decision urgency. Some of the Group D ratings require the operation of moderately complex equipment, generally in the areas of communications beyond the ship and sensors. The main difference between Groups D and C is that the Group D operators more often have time to check and verify their judgments with other persons because of the longer range nature of the communications. Also, the RM and the OS do not have to be responsible for maintenance of their equipment. In Group D, those who do maintain equipment, such as the OT and AS, are working with support equipment rather than weaponry or propulsion, as in Group C.

The Quartermaster (QM) is key to navigation, and a serious error on the part of a Quartermaster could result in loss of ship. He supervises safety and underway replenishment, and many others depend on him. The QM is not in a group with higher accrued utility because global navigation is becoming fairly automated, and thus the importance of years of experience is diminishing in that role. However, shore-based navigation still depends on substantial experience.

The PR, ABF and ABH are not highly technical ratings, but they provide important direct support for combat operations. Since lives and equipment may depend upon the individuals in these ratings, they must be careful in performing their duties and calm under pressure (ABH in particular).

3.1.5 Group E (CTA, HM, IM, ML, MR, OM, PM, SM, YN) - Groups E, F, and G primarily perform administrative and support functions. The administrative ratings YN, SM, and

CTA are given somewhat higher accrued utility than the administrative ratings in Group F because the former have more direct involvement in battle operations. The YN serves as the Captain's talker, for example. These administrators must learn a great variety of tasks (the YN in particular), and although no single task is very technical, the utility of the YN does increase substantially with years of sea experience.

The HM also increases in utility with experience because of both the difficulties and the subtleties associated with injuries and health problems. The serious nature of the work and the fact that occasionally the HM must act alone give his experience greater utility than that of the Dental Technician (DT) in Group F, who is not on independent duty.

The other ratings in Group E represent skilled craftsmen who produce equipment in a supporting role, often aboard a tender. Although experience is moderately important in their work, typically they are not required to make split-second decisions in battle. Skilled craftsmen ratings are given more utility than the construction ratings in Group F because the equipment skilled craftsmen produce is used directly in battle, and it is likely that an error on their part will show up only in the test of combat.

3.1.6 Group F (AG, AK, AZ, DK, DP, DT, LN, MA, MS, NC, PN, SK. Construction Group: BU, CE, CM, EA, EO, SW, UT) - These ratings have minimal involvement in battle operations and thus are less critical to ship survival than those in Group E. About half of these ratings involve administrative functions. Effective administration is important to the efficiency of the Navy, but life and death decisions are seldom required, and a failure is more likely to cause a slight drop in efficiency rather than a loss of mission, equipment, or life. Some tasks, such as those of the NC and AG, are subtle and difficult, but these personnel mainly provide advisory information and supplement the inputs of others, so that critical decisions do not depend upon a single judgment. Weather is important to naval operations, and the AG might have a higher accrued utility if the weather were more predictable.

The AZ maintains logs on aircraft maintenance which could potentially affect survival of the aircraft and the pilot. However, the tolerance limits on maintenance are large enough to make it very unlikely that an error would have serious consequences.

The total performance of the construction group is essential to the success of amphibious operations, but the single error of one person is not likely to have severe costs in terms of mission, equipment, or lives.

3.1.7 Group G (DM, JO, LI, MN, PC, PH, SH) - These ratings represent the lowest degree of accrued utility with experience even though their functions are useful to the Navy. Typically, performance errors have no noticeable bearing on the success of battle missions, or on the survival of equipment or personnel. Often accrued utility is lower in this group because enlisted personnel enter the Navy with the requisite skills for a specific rating. This is particularly true of the Musician (MU). The SH is given less accrued utility than the MS in Group F because the MS's performance may affect the health and normal functioning of the crew.

3.2 Scenario

In the preliminary analysis, a dimension which appeared to be relevant to accrued utility was whether the duty assignment was a battle-ready setting or a stand-by setting. Shore duty in the U.S. would represent a step further removed from battle-ready assignment than, for example, the 2nd Fleet standing by in the Atlantic; and a battle-ready scenario would be typified by the 6th Fleet in the Mediterranean. The nine officer interviewees who compared accrued utility across ratings were asked also to compare accrued utility in the 6th Fleet and the 2nd Fleet scenarios. The difference in total accrued utility among rating groups did not change significantly from one scenario to another. About half the respondents suggested a slight shift, and they were quite consistent regarding what that shift would be. Groups A and B, the weaponry ratings, would decrease somewhat in total accrued utility in relation to the other groups; the propulsion ratings would remain about the same; and the administrative and service ratings would increase slightly because of the effect of these ratings on motivation and morale in a work-up setting.

On the other hand, about half the respondents said the scenario distinction was not a valid one because the whole purpose of the work-up fleet is preparation for battle (or other action) or for deterrent effect. In three days' time, the 2nd Fleet could join the 6th Fleet in action. The ultimate value to the Navy lies in action readiness, so the battle-ready scenario should, in all cases, be the one used to assess utility. Even the respondents who gave differential weights to the two scenarios did not deny the merit of the argument that utility was ultimately measured in the front-action situation.

Because of this view, and the fact that it would be difficult to combine utilities from the two scenarios in a meaningful way, all utility figures presented here represent the battle-ready scenario. Generally, the shifts, where any were thought to exist, were on the order of five to ten percent. The reasoning behind the shifts was that the stand-by scenario allows substantially more time to correct errors.

3.3 Utility and LOS

There was general agreement that utility accrues rapidly in the early years and then slows down and levels off at some mid-career point. The peak value of a journeyman, pinpointed at the "knee of the curve," varied somewhat among rating groups. Generally, little or no utility was thought to be accrued after 15 years LOS, nor is little lost after that time if all pay grades are pooled.

Figure 3-2 shows the results pooled for all interviewees. A separate point, indicated by the group code letter, is shown for each of the rating groups discussed earlier. The different heights of the points on the graph reflect the differences among groups in terms of the total utility accrued as a journeyman. The differences from left to right are differences in the LOS at which each of the rating groups reaches the knee. Whatever additional utility is accrued after the LOS associated with the knee results from additional supervisory responsibilities and associated experience in leadership. As shown in Figure 3-2, maximum utility as a journeyman is reached later for the more technical ratings (Groups A, B and C). Groups A and B peak technically at 14 or 15 years, Group C at around twelve years, and Groups D, E, F and G at seven to ten years. There were exceptions to these patterns within the individual rating groups, but such deviations were considered too small to have any significant effect on policy implications and are not presented here.

Figure 3-3 presents the composite estimates of accrued utility over the entire 30 years LOS for each of the rating groups. These line graphs are for the "advancers" who progress up the pay grade scale at the normal intervals without failing advancement tests or being passed over. In this sense the figure represents the leading edge of the enlisted force curve. The accrued utility of the experience of personnel associated with this edge is somewhat higher than average. The way in which accrued utility varies for different pay grades across LOS is discussed in a later section. Figure 3-3 shows line segments rather than smooth

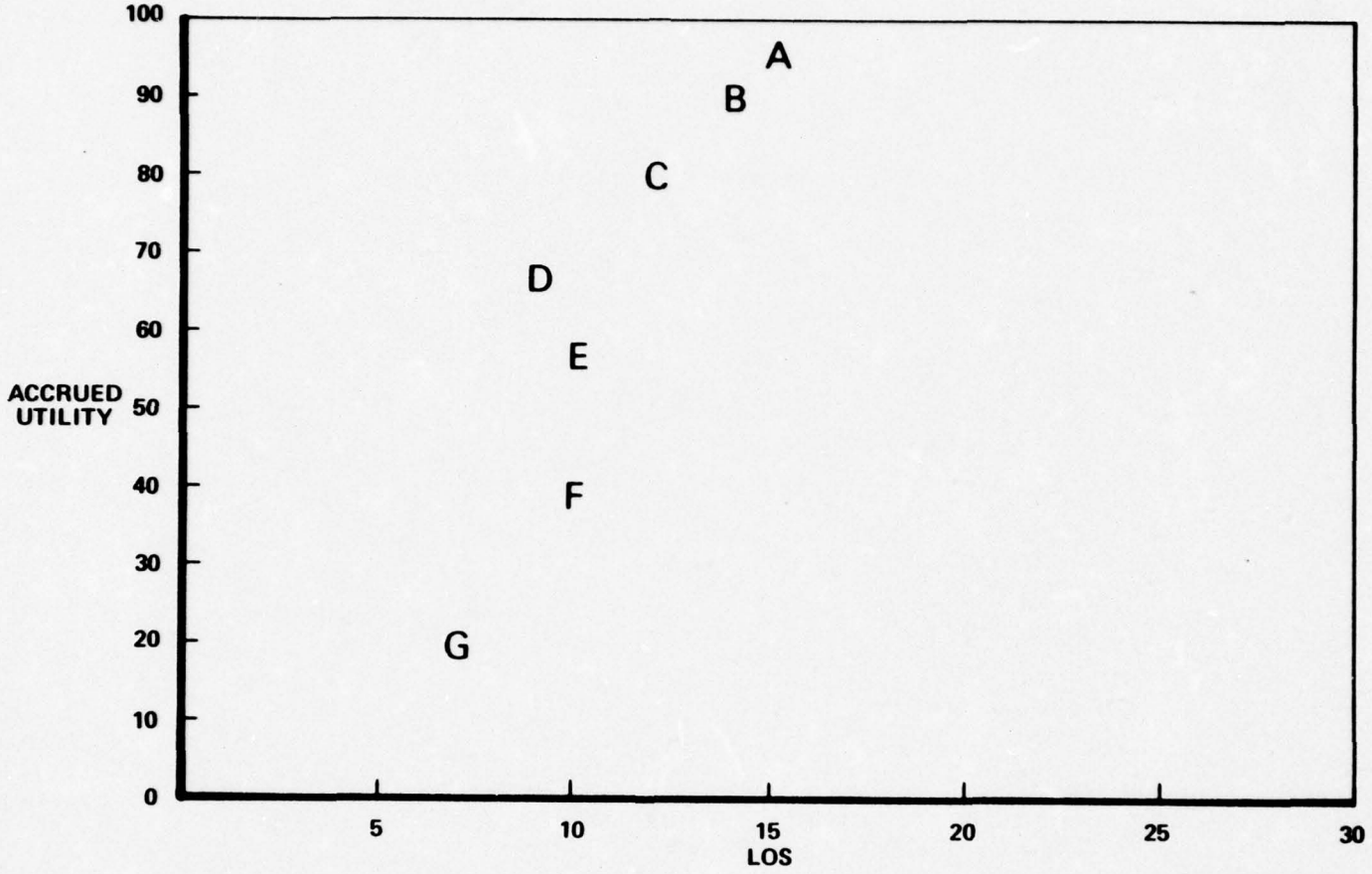


Figure 3-2

MAXIMUM JOURNEYMAN UTILITY AND LOS FOR SEVEN RATING GROUPS

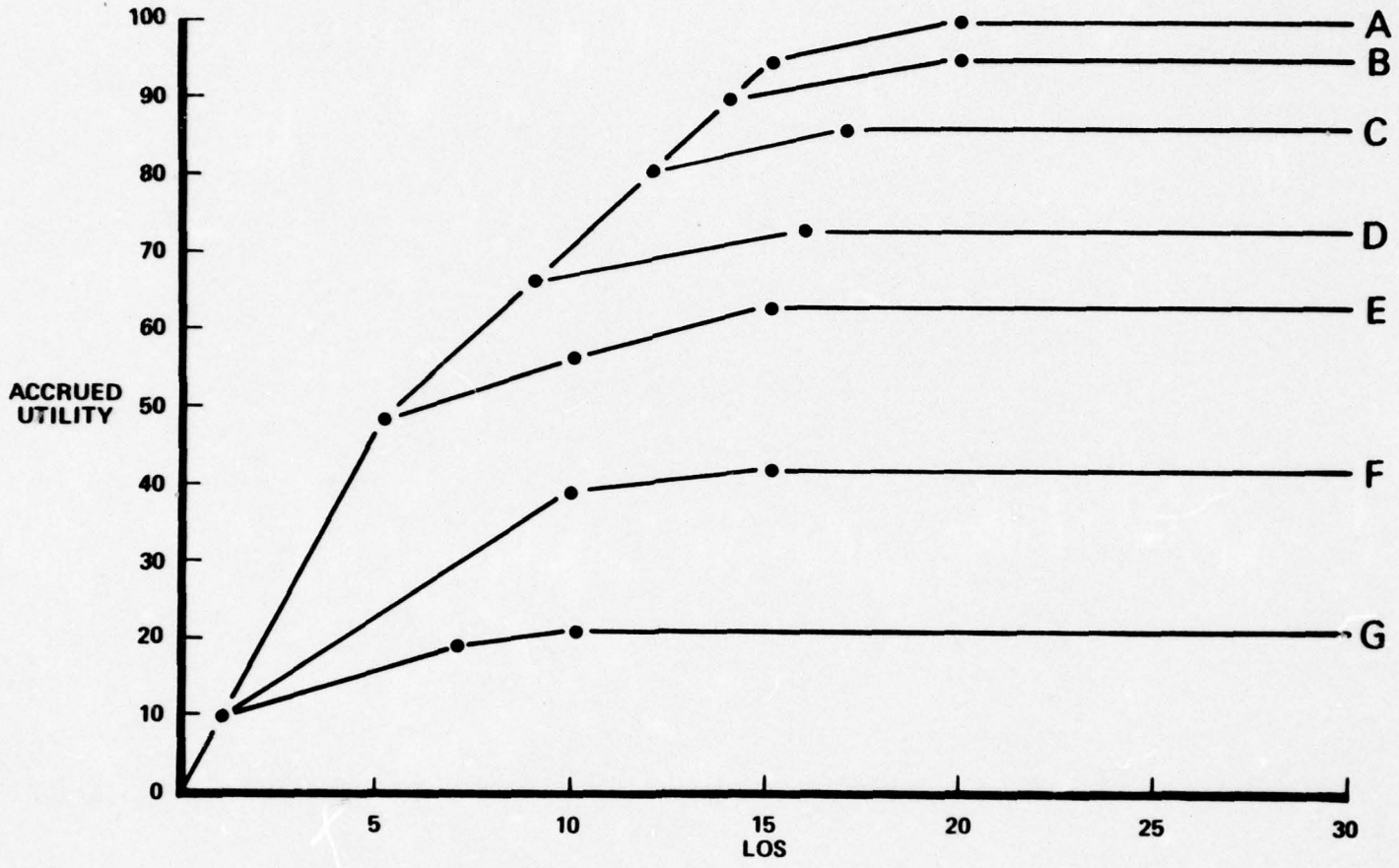


Figure 3-3

ACCRUED UTILITY OF ADVANCERS, AS A FUNCTION OF LOS, FOR SEVEN RATING GROUPS

curves, again to suggest the approximate nature of the numerical estimates. Even the drawing of a fine line suggests more precision than exists. A more appropriate depiction might be to draw the curves with a broad brush, but this becomes graphically confusing when the brush strokes overlap, as they would in this case.

The overall pattern is one of rapid gains in utility which slow progressively and eventually cease. The growth shape of these curves is generally consistent with those of previous studies (Figure 1-2 in Section 1.0), but there are some noteworthy differences. Most important, this study examined differences in total accrued utility among ratings which account for the marked differences in the total height of each curve. The previous study did not address this factor, thus comparative data on this point are unavailable. Regarding the shape of each curve, the only difference between the current study and the previous one is that the utility functions obtained in the current study do not tail-off toward the end of a career. But it should be kept in mind that the curves in Figure 3-3 are for advancers who progress through pay grades almost as fast as is normally possible. This means that as the curves move to the right in Figure 3-3, they represent a higher proportion of Senior Chief (E8) and Master Chief (E9) petty officers.

It is known that enlisted personnel in lower pay grades for a particular LOS tend to retire sooner, and to the extent that rank is based partially on competence, any decline in the performance of any given individual is compensated for by the selective retention in later years of more competent individuals. The net effect on the advancer curves is neither a decline nor an advance in accrued utility. Several respondents noted that decline in utility is greater in the more technical ratings both because of rapid technological change and the fact that schools to update competence are rarely attended after 18 years LOS. This would suggest a gradual downward slope in the right part of the curves for Groups A and B. However, the converse of this is that the more change there is in the requirements of the job, the less repetitiveness and boredom there is. Since this fact might compensate for the obsolescence factor, the utility functions for Groups A and B after 20 years LOS do not decrease.

Note that personnel in all ratings gain about the same amount in total utility to the Navy during their first year following boot camp. This estimate is based on the fact that any job requires initial orientation and training and/or on-the-job experience which normally improves utility

sharply in the first few months. For the next few months utility accrues more rapidly for those groups (A to E) whose utility depends most heavily on battle readiness and action at sea. The lower slopes for Groups F and G do not necessarily mean that members of these ratings are learning less during these years, only that the value of what they learn is less crucial to accomplishment of the Navy missions. The less technical rating groups (D through G) approach their maximum journeyman utility by LOS 10. Groups A, B, and C require more formal schooling as well as on-the-job experience to reach their peak as journeyman, and as a result, utility continues to climb fairly rapidly for another two to five years.

Experience in supervision was thought to add some utility to all rating groups beyond the utility associated with the knee of the curve. The utility accrued with supervision experience continues to increase gradually for perhaps five years for most groups, and from then on utility is essentially constant for the remainder of their careers. In Groups D, E, F and G, the supervision increment is estimated to be 10% of the journeyman peak value, the idea being that value of supervisory experience is more or less proportional to the criticality of the supervised work to the mission. Groups A, B and C are given an increment of less than 10% because the value of supervisory experience is offset by greater technological obsolescence in later career years in these ratings.

3.3.1 Sea-intensive duty - Two or three respondents thought that utility is accrued more rapidly for some ratings when a greater amount of time is spent at sea. For example, they thought this to be true for the Yeoman (YN) whose responsibilities in a shore assignment may comprise only a comparatively narrow segment of the total responsibilities he would have on a ship. The Yeoman who does not go to sea was judged to have accrued less than half the utility of a Yeoman with extensive sea duty. Since this factor was not explicitly discussed with most interviewees, the working assumption was that the utility estimates given reflect averages across career patterns and types of duty.

3.4 Utility and Pay Grade

Respondents uniformly agreed that personnel in higher pay grades have higher accrued utility to the Navy. It is apparently the view that advancement is based largely upon merit, and/or that promotion itself has a salutory effect on performance. These are the most reasonable explanations for

the very substantial differences among pay grades in accrued utility. Figure 3-4a shows, for example, that in Group A at LOS 15, Chief Petty Officers (E7) are judged to have accrued twice as much utility as E4's and over four times as much as E3's.

Figures 3-4a to 3-4g, for rating Groups A to G, display the estimated relationship of accrued utility to LOS for each pay grade. The pattern is quite similar for all seven rating groups. The main difference is that for the groups with lower total accrued utility, F and G in particular, the leveling off of total accrued utility for the entire rating after the first few years necessarily squeezes together the utility curves for the different pay grades. E3's and E4's were judged to have small but significant accrued utility to the Navy throughout their careers in all groups, which leaves little room for superiority among the higher pay grades in the groups having low total accrued utility. This can be seen most clearly in Figure 3-4g, in which the curves from LOS 10 to LOS 30 are nearly indistinguishable for pay grades E5 through E9.

For Groups A and B, in contrast, much more utility is gained during the first 15 or 20 years, and the amount gained is strongly related to pay grade. It is natural that where a rating requires a great deal of formal schooling and on-the-job learning, those who excel are promoted faster and more often. Apparently, these differences in quality of performance are not transitory, for the differences among pay grades persist throughout the later career years.

The results in Figures 3-4a to 3-4c are generally consistent with those found in the earlier utility study (Figure 1-2, Section 1.0). That is, there were marked differences among pay grades following a fairly consistent pattern, and some tail-off in the right side of the curves, indicating that personnel with a great deal more time in grade than is normal have less utility than those with normal time in grade. It should be noted that all pay-grade curves in Figures 3-4a to 3-4g begin at 0 accrued utility at LOS 1 because this study addressed only advancement in the Navy, and did not assess utilities for personnel recruited at higher pay grades.

It should be understood that the tail-off of the pay grade curves in Figures 3-4a to 3-4g does not necessarily indicate a decline in the performance of a given individual. As LOS increases, the percentage of the total enlisted force in pay grades below E7 decreases. For example, at LOS 5 about half the enlisted force are in pay grade E4 or lower,

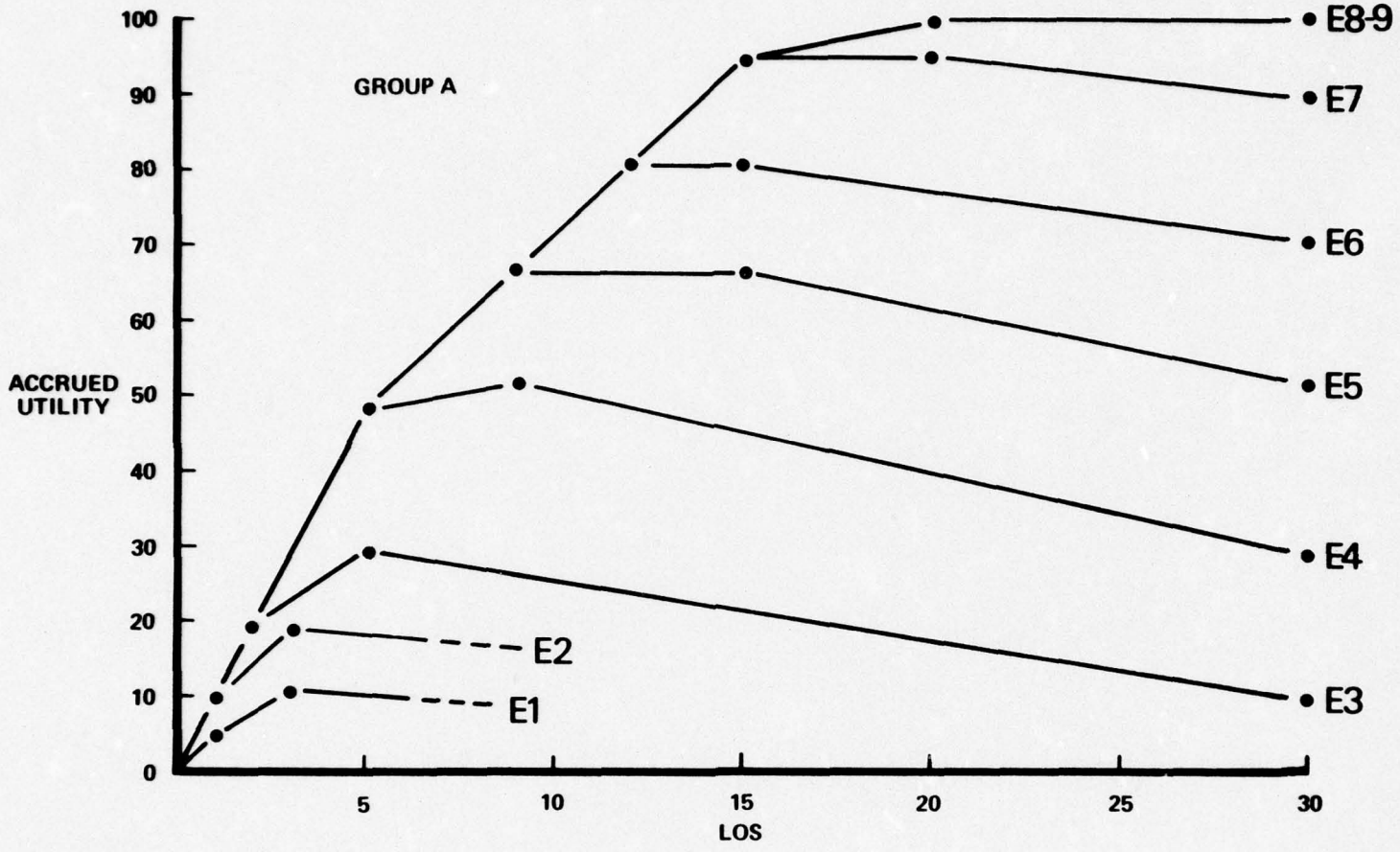


Figure 3-4a

ACCRUED UTILITY BY LOS AND PAY GRADE – RATING GROUP A

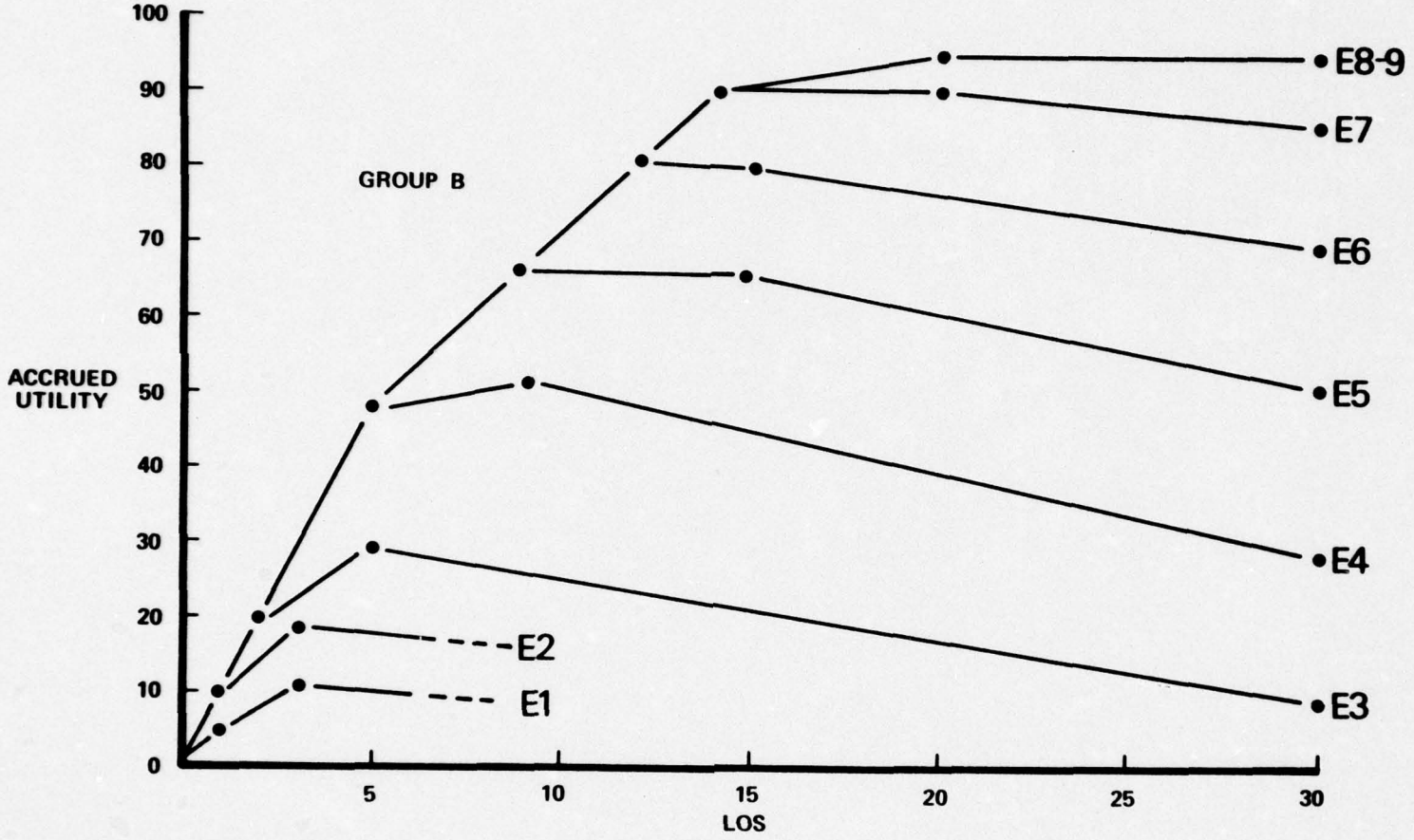


Figure 3-4b

ACCRUED UTILITY BY LOS AND PAY GRADE –
RATING GROUP B

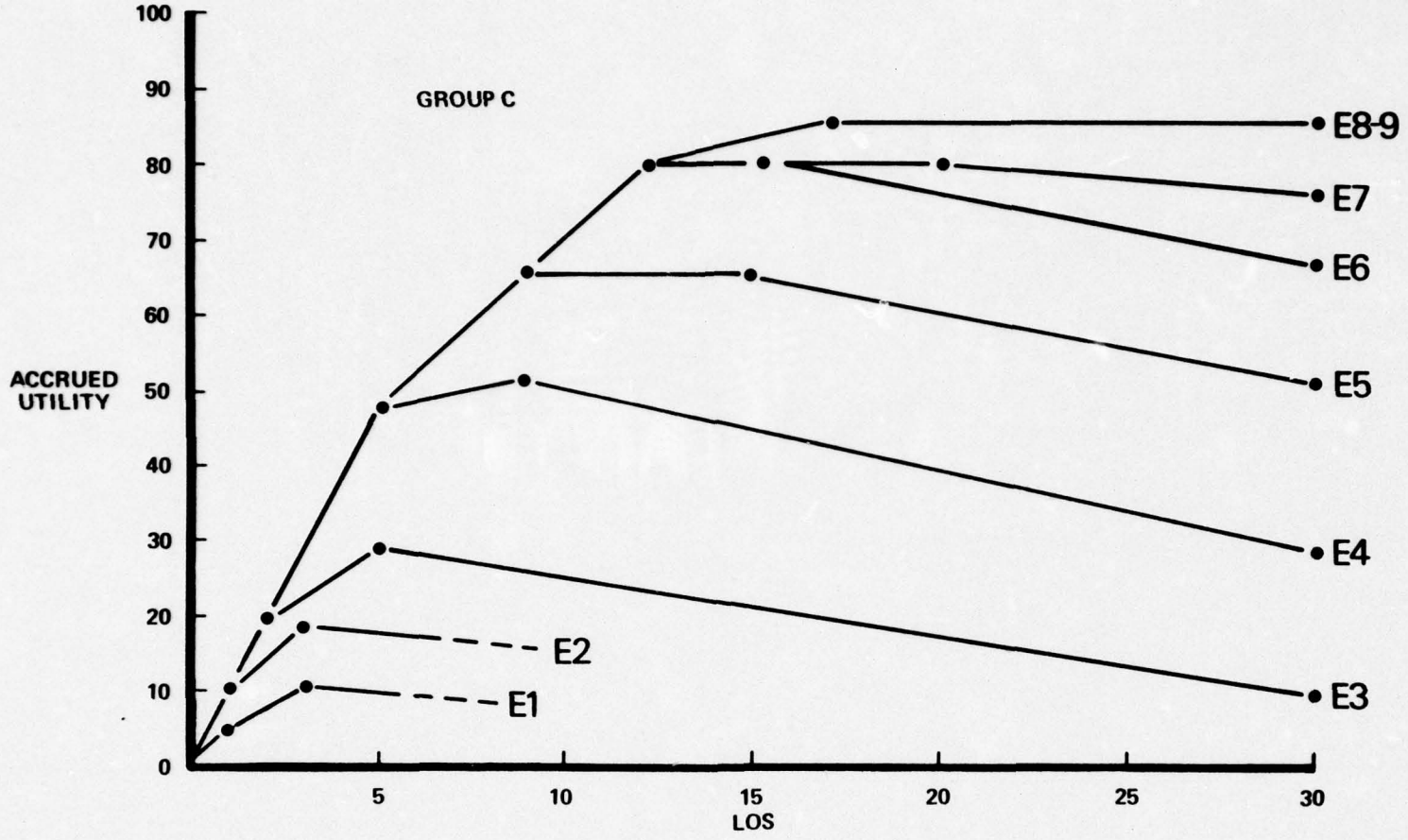


Figure 3-4c

ACCRUED UTILITY BY LOS AND PAY GRADE – RATING GROUP C

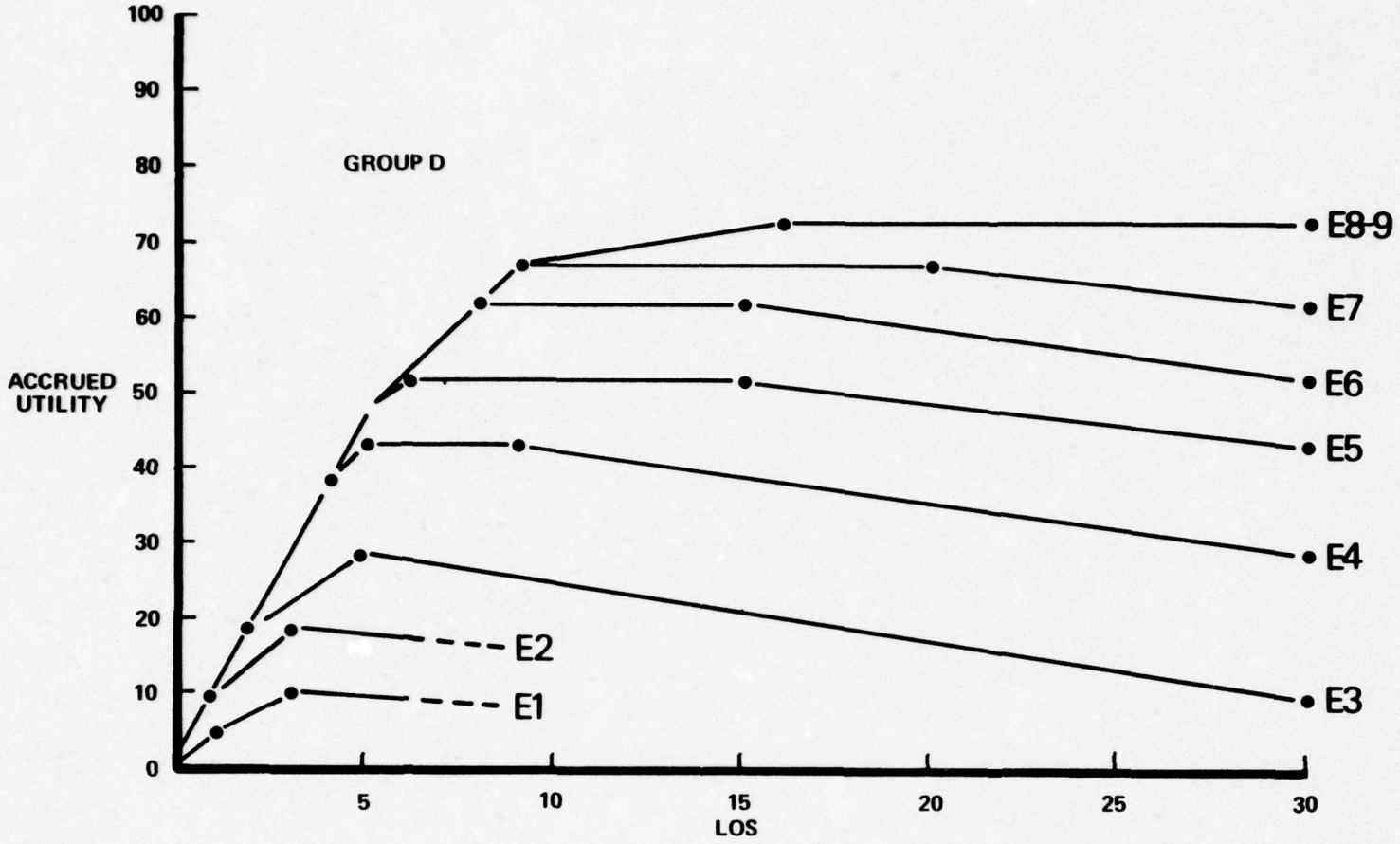


Figure 3-4d

ACCRUED UTILITY BY LOS AND PAY GRADE –
RATING GROUP D

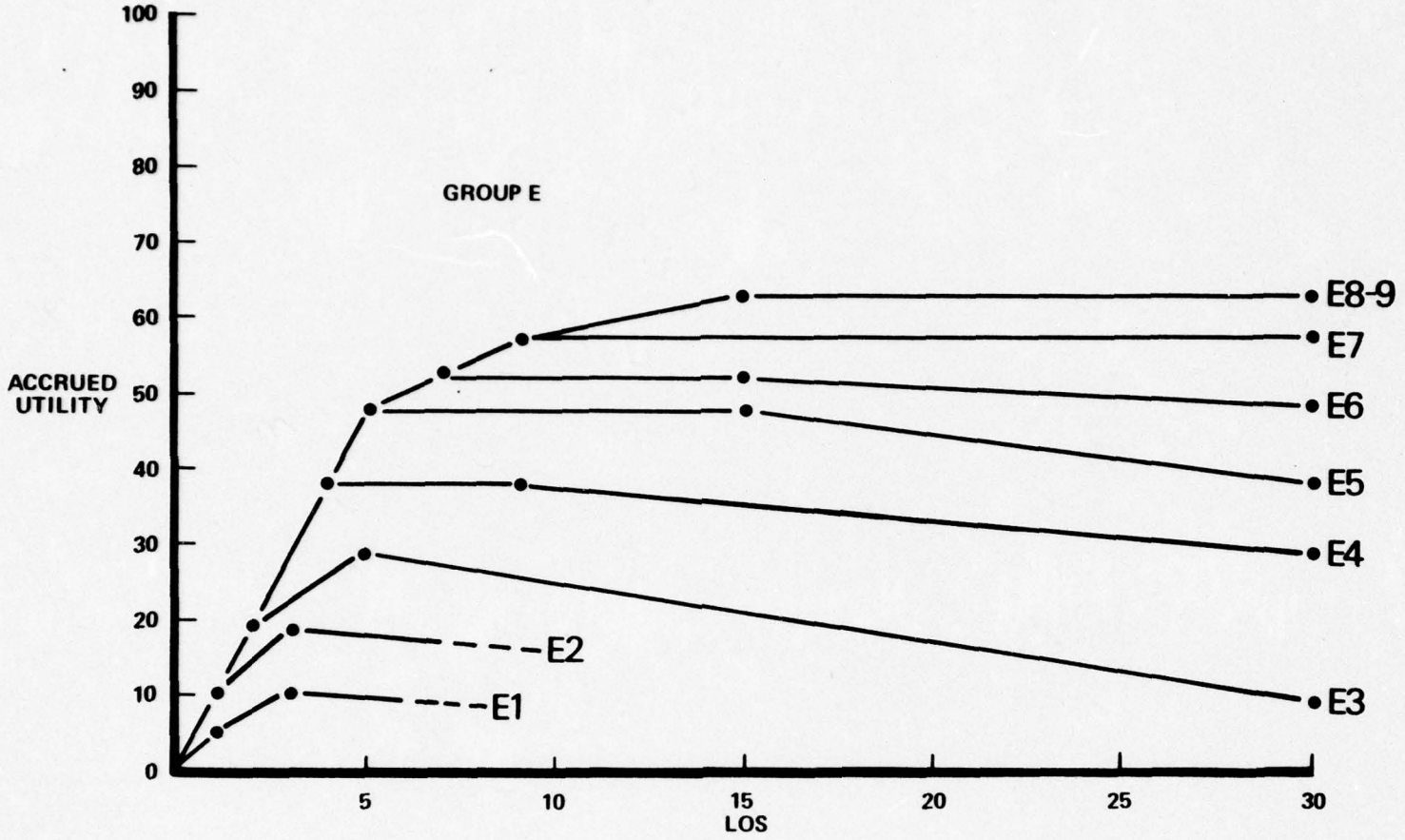


Figure 3-4e

ACCRUED UTILITY BY LOS AND PAY GRADE –
RATING GROUP E

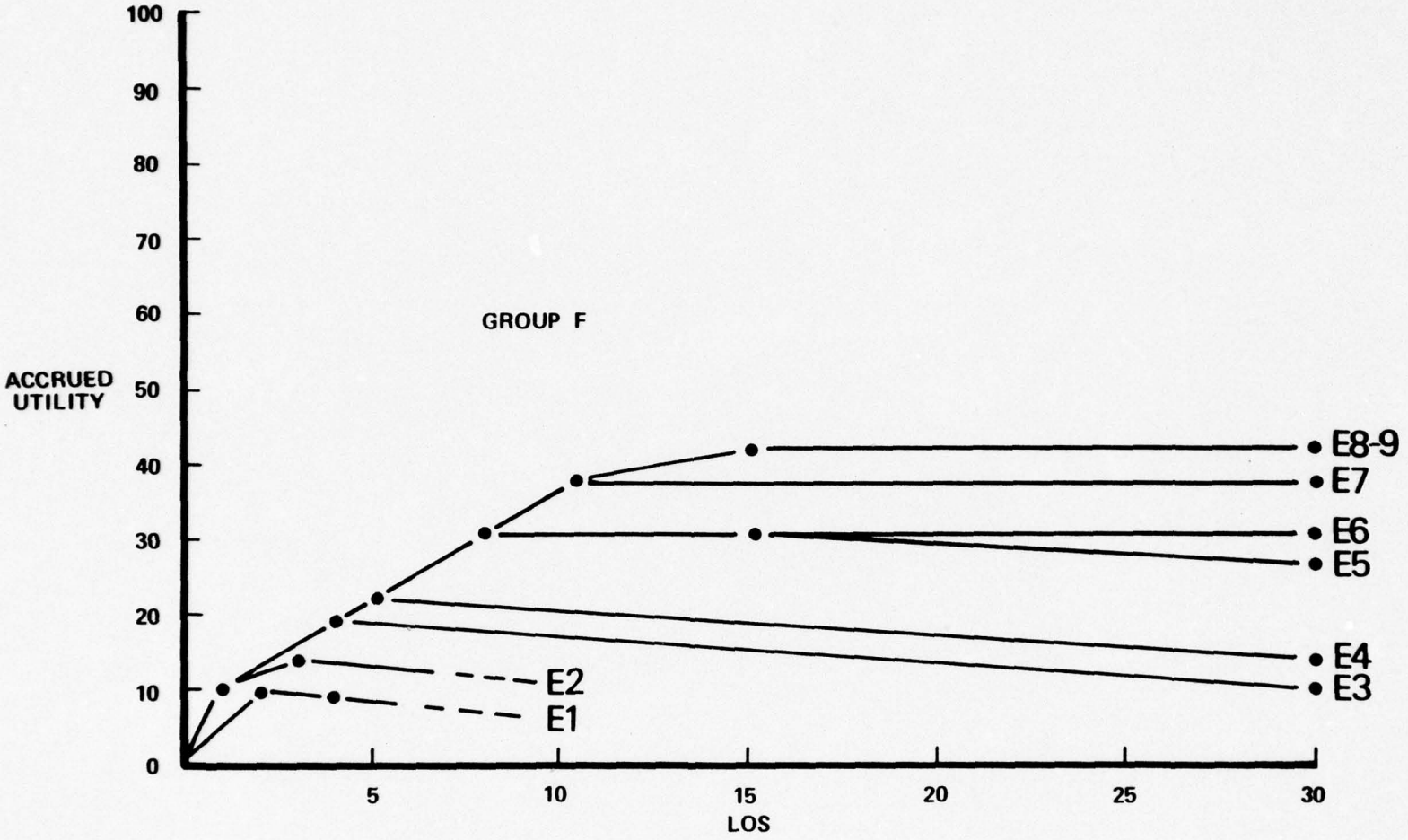


Figure 3-4f

ACCRUED UTILITY BY LOS AND PAY GRADE–
RATING GROUP F

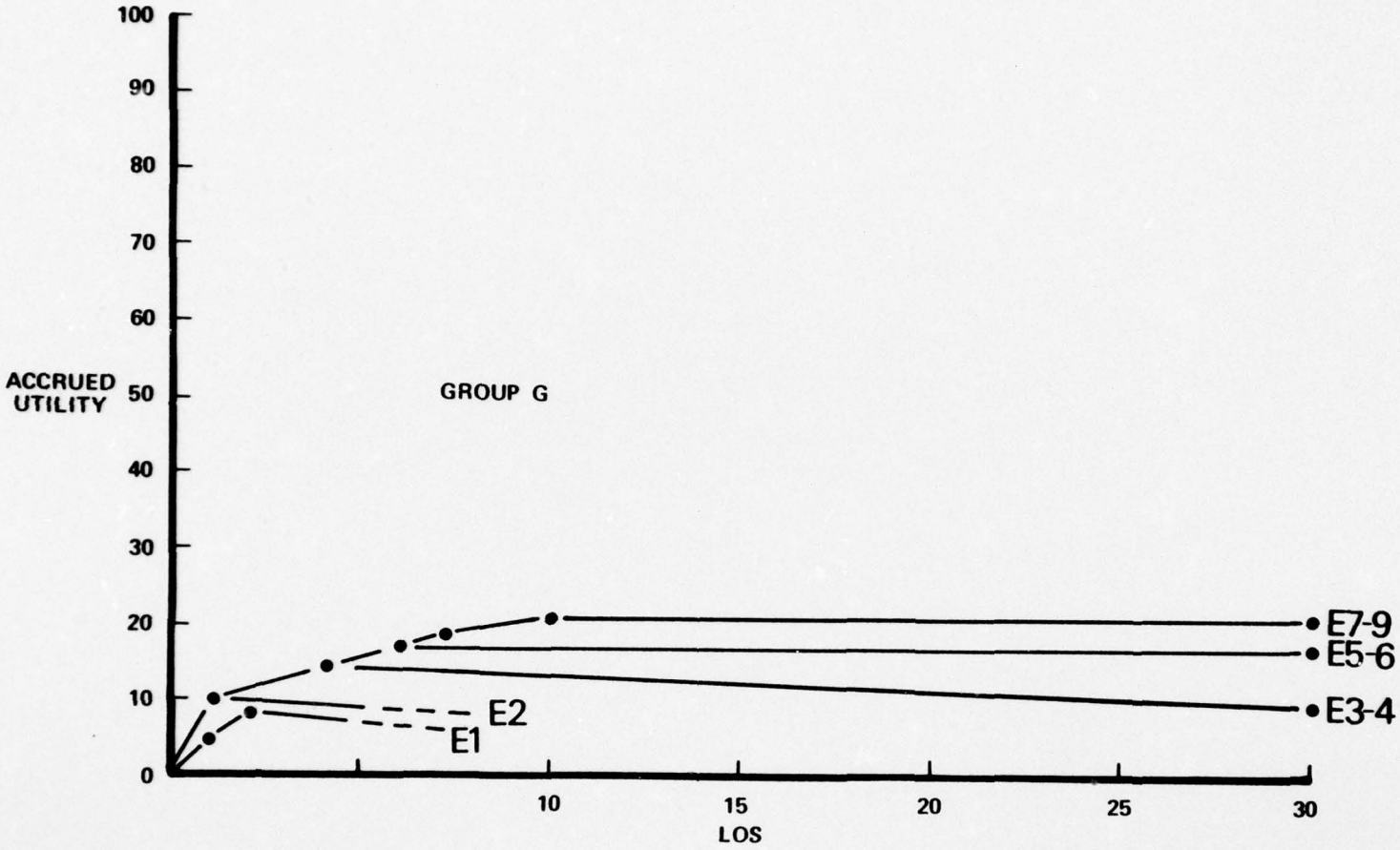


Figure 3-4g

ACCRUED UTILITY BY LOS AND PAY GRADE –
RATING GROUP G

while at LOS 20 only three percent of the total force are in pay grade E4 or lower. The fact that accrued utility is estimated to be higher at LOS 5 than at LOS 20 for E4's is probably determined mainly by this advancement pattern. That is, at LOS 5, E4's fall at the middle or just below the "middle of the pack"; they are average progressors, or almost so. But at LOS 20 E4's represent the few very slowest progressors, those who have been passed over for promotion many times for many years. The lower right-hand half of Figure 3-4a represents so few individuals, in fact, that it can almost be ignored. This is shown more clearly in Figure 3-5, in which accrued utility is displayed for the average progressors in two contrasting rating groups, A and G. Average progressors in this case represent the middle 80% in pay grade at any given LOS. This excludes the 10% who advance most rapidly and the 10% who advance most slowly. As shown, the range of accrued utility is rather small for the middle 80%. The top edge of each shaded band represents the advancers (fast progressors) depicted earlier in Figure 3-3. Thus, neither the curves in Figures 3-4a to 3-4g nor the curves in Figure 3-5 should be interpreted as the change in utility for a given individual throughout his career. Figures 3-4a to 3-4g ignore the advancement patterns of individuals, while Figure 3-5 ignores the large number of personnel who leave the service at intermediate points in their careers. This probably explains why the lower edge of the average progressor band (shaded area) for Group A in Figure 3-5 continues upward rapidly after five years LOS. The majority of the enlisted force leaves the Navy at this time, and those who stay probably demonstrate greater utility because they feel most suited to the Navy and are better motivated to perform competently. A more visible and similar change occurs at LOS 20, probably for the same reason.

It is a reasonable estimate that the individual utility curves fall somewhere between those shown in Figures 3-4a to 3-4g and those shown in Figure 3-5. If so, this would suggest that individual utility neither gains nor loses much after the individual reaches his peak as a journeyman at 10 or 15 years LOS. In fact, several interviewees said they thought there was no appreciable change in the utility of enlisted personnel during this period.

In general, interviewees indicated that a decline in performance in the later years occurs mainly in the lower pay grades, E6 or E5 and below. The reasons given for such a decline were largely motivational ones. For the lower pay grades, work tends to be repetitive and boring, and so members of these grades are not as attentive to their tasks. Once it is clear to members of these ratings that they are

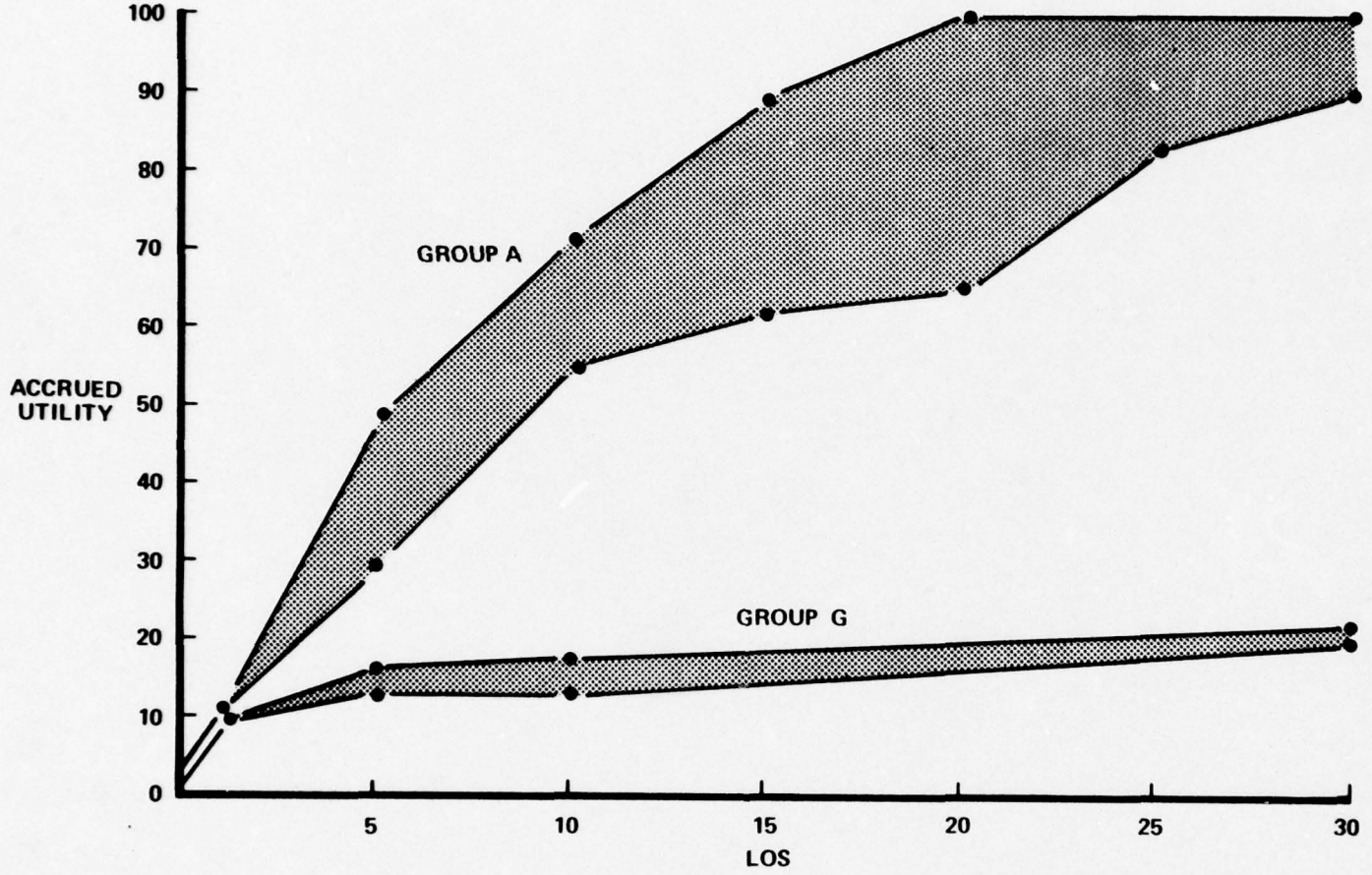


Figure 3-5

ACCRUED UTILITY OF AVERAGE PROGRESSORS – RATING GROUPS A AND G

not going to be promoted, they feel there is little hope for the future. They are often under the orders of younger men, which sometimes breeds resentment. At all pay grades, personnel late in their careers are likely to lose familiarity with equipment, especially equipment that is given to rapid technological change. And the later it is in their careers, the less likely it is that these personnel will be retrained.

The above utility estimates indicate that the adverse effects of a lengthy time in service beyond the peak cannot be too great. If there are adverse effects, they may be compensated for by equally strong positive effects, such as increasing leadership skills, the wisdom which comes with age, and the simple fact of a greater variety and depth of on-the-job experience. The net effect in this case would be the level slope of utility in later years, as found here.

3.5 Utility Matrix

Tables 3-2a through 3-2g present the estimates of accrued utility for each combination of LOS and pay grade. Results for each rating group are presented in a separate table. The entries in the utility matrices were derived directly from the results presented in Figures 3-4a to 3-4g. Anchor points in the line graphs of Figures 3-4a to 3-4g are those corners or angles where the line changes slope, and the end points of each line. These anchor points were derived from the interview data. The derivation did not utilize a mathematical formula for at least two reasons: First, interviewees often gave estimates only in verbal terms, (for example, "Utility declines gradually thereafter"); and second, the analyst gave greater weight to those judgments supported by convincing reasons. The derivation of utility estimates was therefore a complex and partly subjective process. The estimates of most interviewees were fairly consistent with each other, however, so if errors in the final utility estimates exist, they are probably not large enough to change resultant implications.

Once the anchor utilities had been entered into the matrices, the remaining values were calculated arithmetically, using the fact that they fell on straight lines between the anchor points. Values for LOS 31 were calculated by extending the straight line from LOS 20 to LOS 30 for an additional year at the same slope.

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	8	14	19	19					
3	11	19	22	29	29				
4	11	19	26	38	38	38			
5	10	18	29	48	48	48			
6	10	18	28	49	53	53			
7		17	27	50	58	58	57		
8			27	51	62	62	62		
9			26	52	67	67	67		
10			25	51	67	72	72		
11			24	50	67	76	76	76	
12			24	49	67	81	81	81	
13			23	48	67	81	86	86	
14			22	47	67	81	90	90	
15			21	45	67	81	95	95	95
16			21	44	66	80	95	96	96
17			20	43	65	80	95	97	97
18			19	42	64	79	95	98	98
19			18	41	63	78	95	99	99
20			18	40	62	78	95	100	100
21			17	39	61	77	95	100	100
22			16	38	60	76	94	100	100
23			15	37	59	76	94	100	100
24			15	36	58	75	93	100	100
25			14	34	57	74	93	100	100
26			13	33	56	74	92	100	100
27			12	32	55	73	92	100	100
28			12	31	54	72	91	100	100
29			11	30	53	72	91	100	100
30			10	29	52	71	90	100	100
31				29	52	71	90	100	100

Table 3-2a - ACCRUED UTILITY MATRIX - Rating Group A

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	8	14	19	19					
3	11	19	22	29	29				
4	11	20	26	38	38	38			
5	10	19	29	48	48	48			
6	10	18	28	49	53	53			
7		17	27	50	58	58	57		
8			27	51	62	62	62		
9			26	52	67	67	67		
10			25	51	67	72	72		
11			24	50	67	76	76	76	
12			24	49	67	81	81	81	
13			23	48	67	81	86	86	
14			22	47	67	81	90	90	
15			21	45	67	81	90	91	91
16			21	44	66	80	90	92	92
17			20	43	65	80	90	92	92
18			19	42	64	79	90	93	93
19			18	41	63	78	90	94	94
20			18	40	62	78	90	95	95
21			17	39	61	77	90	95	95
22			16	38	60	76	89	95	95
23			15	37	59	76	89	95	95
24			15	36	58	75	88	95	95
25			14	34	57	74	88	95	95
26			13	33	56	74	88	95	95
27			12	32	55	73	87	95	95
28			12	31	54	72	87	95	95
29			11	30	53	72	86	95	95
30			10	29	52	71	86	95	95
31				29	52	71	86	95	95

Table 3-2b - ACCRUED UTILITY MATRIX - Rating Group B

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	8	14	19	19					
3	11	19	22	29	29				
4	11	20	26	38	38	38			
5	10	19	29	48	48	48			
6	10	18	28	49	53	53			
7		17	27	50	58	58	57		
8			27	51	62	62	62		
9			26	52	67	67	67		
10			25	51	67	72	72		
11			24	50	67	76	76	76	
12			24	49	67	81	81	81	
13			23	48	67	81	81	82	
14			22	47	67	81	81	83	
15			21	45	67	81	81	84	84
16			21	44	66	80	81	85	85
17			20	43	65	79	81	86	86
18			19	42	64	78	81	86	86
19			18	41	63	77	81	86	86
20			18	40	62	76	81	86	86
21			17	39	61	75	81	86	86
22			16	38	60	74	80	86	86
23			15	37	59	74	80	86	86
24			15	36	58	73	79	86	86
25			14	34	57	72	79	86	86
26			13	33	56	71	78	86	86
27			12	32	55	70	78	86	86
28			12	31	54	69	77	86	86
29			11	30	53	68	76	86	86
30			10	29	52	67	76	86	86
31				29	52	67	76	86	86

Table 3-2c - ACCRUED UTILITY MATRIX - Rating Group C

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	8	14	19	19					
3	11	19	22	29	29				
4	11	20	26	38	38	38			
5	10	19	29	43	48	48			
6	10	18	28	43	52	52			
7		17	27	43	52	57	57		
8			27	43	52	62	62		
9			26	43	52	62	67		
10			25	42	52	62	67		
11			24	42	52	62	67	69	
12			24	41	52	62	67	70	
13			23	40	52	62	67	70	
14			22	40	52	62	67	71	
15			21	39	52	62	67	72	72
16			21	38	51	61	67	73	73
17			20	37	51	61	67	73	73
18			19	37	50	60	67	73	73
19			18	36	50	59	67	73	73
20			18	36	49	59	67	73	73
21			17	35	48	58	67	73	73
22			16	34	48	57	66	73	73
23			15	34	47	57	66	73	73
24			15	33	47	56	65	73	73
25			14	32	46	55	65	73	73
26			13	32	45	55	64	73	73
27			12	31	45	54	64	73	73
28			12	30	44	53	63	73	73
29			11	30	43	53	63	73	73
30			10	29	43	52	62	73	73
31				29	43	52	62	73	73

Table 3-2d - ACCRUED UTILITY MATRIX - Rating Group D

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	8	14	19	19					
3	11	19	22	29	29				
4	11	20	26	38	38	38			
5	10	19	29	38	48	48			
6	10	18	28	38	48	50			
7		17	27	38	48	52	52		
8			27	38	48	52	55		
9			26	38	48	52	57		
10			25	38	48	52	57		
11			24	37	48	52	57	59	
12			24	37	48	52	57	60	
13			23	36	48	52	57	61	
14			22	36	48	52	57	62	
15			21	35	48	52	57	63	63
16			21	35	47	52	57	63	63
17			20	35	47	51	57	63	63
18			19	34	46	51	57	63	63
19			18	34	45	51	57	63	63
20			18	33	45	51	57	63	63
21			17	33	44	50	57	63	63
22			16	32	43	50	57	63	63
23			15	32	43	50	57	63	63
24			15	32	42	50	57	63	63
25			14	31	41	49	57	63	63
26			13	31	41	49	57	63	63
27			12	30	40	49	57	63	63
28			12	30	39	48	57	63	63
29			11	29	39	48	57	63	63
30			10	29	38	48	57	63	63
31				29	38	48	57	63	63

Table 3-2e - ACCRUED UTILITY MATRIX - Rating Group E

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	10	12	12	12					
3	10	14	16	16	16				
4	9	14	19	19	19	19			
5	9	13	19	22	22	22			
6	8	13	18	22	26	26			
7		12	18	22	29	29	29		
8			18	22	31	31	31		
9			17	22	31	31	35		
10			17	21	31	31	38		
11			17	21	31	31	38	39	
12			16	21	31	31	38	40	
13			16	21	31	31	38	41	
14			16	21	31	31	38	41	
15			15	21	31	31	38	42	42
16			15	21	31	31	38	42	42
17			14	21	30	31	38	42	42
18			14	20	30	31	38	42	42
19			14	20	30	31	38	42	42
20			13	20	30	31	38	42	42
21			13	20	29	31	38	42	42
22			13	20	29	31	38	42	42
23			12	20	29	31	38	42	42
24			12	20	29	31	38	42	42
25			12	20	28	31	38	42	42
26			11	19	28	31	38	42	42
27			11	19	28	31	38	42	42
28			11	19	27	31	38	42	42
29			10	19	27	31	38	42	42
30			10	19	27	31	38	42	42
31				19	27	31	38	42	42

Table 3-2f - ACCRUED UTILITY MATRIX - Rating Group F

Length of Service	Pay Grade 1	2	3	4	5	6	7	8	9
1	5	10	10						
2	8	10	11	11					
3	8	10	12	12	12				
4	8	9	14	14	14	14			
5	7	9	14	14	16	16			
6	7	9	14	14	17	17			
7		8	14	14	17	17	19		
8			13	13	17	17	20		
9			13	13	17	17	20		
10			13	13	17	17	21		
11			13	13	17	17	21	21	
12			13	13	17	17	21	21	
13			13	13	17	17	21	21	
14			13	13	17	17	21	21	
15			12	12	17	17	21	21	21
16			12	12	17	17	21	21	21
17			12	12	17	17	21	21	21
18			12	12	17	17	21	21	21
19			12	12	17	17	21	21	21
20			12	12	17	17	21	21	21
21			11	11	17	17	21	21	21
22			11	11	17	17	21	21	21
23			11	11	17	17	21	21	21
24			11	11	17	17	21	21	21
25			11	11	17	17	21	21	21
26			11	11	17	17	21	21	21
27			11	11	17	17	21	21	21
28			10	10	17	17	21	21	21
29			10	10	17	17	21	21	21
30			10	10	17	17	21	21	21
31				10	17	17	21	21	21

Table 3-2g - ACCRUED UTILITY MATRIX - Rating Group G

4.0 DISCUSSION

4.1 Results

Major findings of this study may be summarized as follows:

1. Ratings differ markedly in the total amount of utility to the Navy accrued as a result of training and experience on the job. The more technical ratings generally gain more utility, as do those with more critical functions in combat action.

2. For nearly all ratings, utility gained in the Navy is accrued almost entirely in the first 15 years, and for the less technical ratings in the first 10 years. After either point in the career, there is very little gain or loss in utility in the years which follow.

3. At any given LOS beyond the first two or three years, pay grades differ substantially and predictably in the amount of utility accrued with experience. Advancement is, therefore, strongly associated with relative contribution to the Navy missions, either as cause or effect or both.

Results of this study are based on thoughtful judgments of individuals with in-depth knowledge of the enlisted ratings based on 15 to 25 years experience with those ratings. None are expected to be perfect judges, and biases are no doubt included. For example, interviewees sometimes appreciated the value of experience in their own fields of specialty more than in others. Such biases probably tended to cancel each other in that respondents were chosen to represent all major occupational areas and duty settings.

If the whole group had a common bias, that bias was not apparent to the analysts, unless it was possibly a tendency to overvalue sea duty. Invisible biases are still possible, of course, and could be considered in any further study of utilities. For example, research could be undertaken to obtain on-the-job evaluations of quality of performances of specific individuals, and correlate these evaluations with actual pay grade and LOS. The problem is that measuring quality of performance of a person typically still involves subjective judgments, and the same biases (if any) might occur in these judgments as would occur in the more general judgments provided by the interviewees in this study. The general consensus of social scientists, however, is that the

degree of bias is smaller in measures of more concrete and explicit behavior. The value of studies of individual performance would have to be weighed against their cost. Other types of verification studies may also be worth considering, such as offering unit commanders choices of personnel to fill billets where different options combine different lengths of experience in different ratings.

Throughout this report it has been stressed that the utility measured in this study is the utility gained by experience in the Navy, and not the total utility of a rating or a person in that rating. Illustrator-draftsmen, musicians and certain other ratings (mostly in Group G) typically enter the Navy with substantial skill in these occupations. In such cases the amount of utility gained by further experience in the Navy is necessarily small compared to those ratings such as Sonar Technician for which the new apprentice has no prior training or skill. These differences in utility to the Navy at the time of entry no doubt account for part of the large differences in total accrued utility among rating groups. Many interviewees provided adjunct information regarding entry utility. Asked what percent of his maximum utility as a journeyman a beginning apprentice had at the time of entry, responses averaged around 20% for the less technical ratings in Groups D, E and F; and around 5 to 10% for the more technical ratings. This suggests that on the average, 80%-90% of the utility of enlisted personnel to the Navy is gained on the job or in related schools for most ratings. The Navy, therefore, may potentially make appreciable gains in the cost-effectiveness of the enlisted force by examining continuance and advancement policies in light of utilities and costs.

4.2 Policy Directions

Since most enlisted personnel leave the Navy after four to six years of service, a major policy question concerns the utility to be gained by offering more incentives to extend time in service. The findings here suggest that the advantage to the Navy of encouraging reenlistment may be greater in the groups with higher total accrued utility, such as Groups A, B, and C. Whether the utility gained is worthwhile for Groups D through G depends to some extent on the costs of recruiting and training these personnel to the point of beginning apprenticeship. Such costs are taken into account in the Navy enlisted optimization program, but are beyond the scope of this study. It would appear that for Groups D to G there is little to be gained by encouraging reenlistment beyond two terms (8 to 12 years).

Any change in policy may, of course, have feedback effects that would either nullify or enhance the intended results. For example, it is conceivable that policies to encourage remaining in service for two terms rather than one would not encourage reenlistment by competent personnel if they were led to expect that nearly all would be forced out after a second term without retirement benefits. On the other hand, as long as the percent retained for an entire career is not too small, such a policy might encourage the less competent to leave, and the more competent to stay with the expectation of being promoted and retained until retirement. It is possible to investigate the feedback effects of policy changes by implementing them experimentally on a small scale and then studying the consequences.

Another relevent policy area is service beyond 20 years. If the estimates of accrued utility in this report are accurate, it appears there is little or nothing to be gained by encouraging continued service beyond 20 years, or even beyond 15 for that matter. It is true that earlier retirement may incur greater retirement costs to the Government. If utility remains essentially the same throughout these years, it is a fairly simple matter to compare increased retirement costs with the corresponding costs of advancement in pay grades. If advancement costs are greater, the argument is stronger for discouraging service beyond 20 years. If early retirement costs are greater, perhaps service beyond 20 years should be encouraged for those who surpass some minimum level of competence. This assumes that current retirement rules and benefits are left intact. If retirement policy were changed to eliminate the costs of early retirement, then in any case there would be little argument for retaining personnel beyond 20 years except in ratings where a shortage of personnel is hard to fill.

The implications of the findings for advancement policy and pay grade distribution are not so clear. They depend in part on whether a greater utility leads to promotion or is caused by it. If the greater utility of higher pay grades results primarily from selecting for advancement those who perform well, then the selection criteria must be fairly good. In this case the greater gain in cost-effectiveness of the Navy might be achieved by forcing out those who do not pass the criteria within a few years, rather than by retaining them at low pay grades.

On the other hand, if selection for advancement is not very valid and utility gains result mainly from the motivational effects of being rewarded by promotion and given more responsibility, the implications are quite different. One promising direction

in this case would be to search for ways to motivate personnel to better performance. Obviously, there are limits to the reward value of a promotion, since if everyone is promoted, promotion confers no special recognition. The higher pay that everyone would receive thereby might make each person more satisfied with the quality of his life, but it is doubtful that performance on the job would be enhanced much. A more promising approach would be to search for better methods of selection for advancement. In any case, further evidence is needed to clarify the cause-effect relationship between pay grade and utility gains.

These few suggestions regarding possible policy changes are not meant to be comprehensive or conclusive, even in the focal policy area of continuance and advancement. In other areas such as recruitment, training, and management, findings may also have implications not explored here.

The most important conclusion of this study is that there are very substantial differences in accrued utility among rating groups, LOS intervals, and pay grades. Currently, there are only slight differences among ratings in continuance and advancement policies, except in responding to temporary shortages. Policies which differentiate sharply among ratings and which help to *retain only* the more competent personnel might significantly increase the overall cost-effectiveness of the Navy enlisted force.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this study is to determine the relative contribution to Navy missions of the accrued experience of enlisted personnel. For each Navy rating, the utility of a person with a particular length-of-service (LOS) and a particular pay grade is examined. The methodology employed consisted of in-depth interviews and resultant detailed justification for the utility functions obtained.

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Differences among ratings in terms of the utility associated with a particular LOS/pay grade combination are a function of three main variables. These are the technical learning depth of the rating, the necessity for rapid unaided decisions in the task of the rating, and the probable loss associated with an error by a person in the rating. Fairly large differences exist among ratings in terms of the utility of a particular LOS/pay grade combination, the highest utilities occurring for ratings involving complex technical maintenance and operation of equipment where rapid unaided decision-making is required, and probable losses associated with errors are large. These utilities are obtained for a Sixth Fleet battle-ready type scenario and do not vary appreciably for other scenarios. Results also indicate that utility is highest for sea-duty intensive career patterns.