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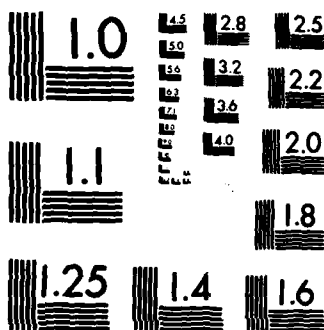
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# SKILL MIX, EXPERIENCE, AND READINESS

Stanley A. Horowitz

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# SKILL MIX, EXPERIENCE, AND READINESS

Stanley A. Horowitz

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*Naval Planning and Management Division*

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↓  
The management of military manpower should focus on producing military readiness as cheaply as possible. Doing this requires information on the expected contribution to readiness of different kinds of people, and on how they can substitute for each other. That is, in economic terms, the implications for output of different skill mixes. The choice of a skill mix should depend, of course, on relative prices--how much various people are paid. The compensation system should, in turn, be determined by people's marginal contribution to output.

This sounds nice, but it's not how the system works now. Today's military personnel system is put together in a rather constrained way. First, required manning levels, disaggregated by occupation and pay-grade, are determined using methods heavily dependent on current practice. Then, if we're lucky, compensation levels are set to fill the requirements. The notions of substitutability and tradeoffs between costs and productivity play no role.

✓  
The system evolved as it has because of the paucity of information on the contribution of people to military readiness. My purpose is to argue that we can do better. We know enough to begin to manage military manpower with an eye on readiness. We can begin to choose who we want based on what we expect to get from them, and to modify the compensation system accordingly. ↑

Skill has many facets, and many predictors. In the rest of this discussion I will concentrate on the relationship between experience and skill, and its implications for Navy manpower policy. I do this for three reasons. The system already focuses on experience and paygrade, which is closely related, as two of the principal determinants of pay. Shifting toward a more senior force, as I shall suggest, can help offset the effects of the shrinking youth population. Finally, I have relevant research to draw on. The Center for Naval Analyses has been doing studies on the productivity of enlisted personnel in the Navy for over 10 years. This paper reviews some of this work and discusses its implications for manpower policy.

Three broad questions will be addressed. Can it be shown that the experience and paygrade mix of military personnel generally affects the military performance of units? Can the magnitude of the effects be determined? How should this sort of information influence policy, in terms both of the experience mix of the force and the premium we are willing to pay for experience.

To answer these questions, I will start by describing two studies that relate experience to unit performance. The first of them examined the performance of maintenance personnel aboard surface combatants [1]. We looked at the readiness of 91 ships over a 3-year period. Our measure of ship readiness was the amount of mission degrading downtime suffered by the equipment maintained by men in each of six occupations.

Such downtime is routinely reported on casualty reports, or CASREPs. These were the source of our readiness data. The occupations studied were boiler technician (BT), machinist's mate (MM), gunner's mate (GM), fire control technician (FT), torpedoman's mate (TM), and sonar technician (ST).

We developed aggregate statistics describing the characteristics of each crew by occupation. This required weighting the characteristics of individuals by the fraction of the observation period they were assigned to the ship. The enlisted manning characteristics examined for our designated occupations were crew size, education, test scores, training, length of service, paygrade, turnover, race, and marital status.

Manning is not the only factor that affects material condition. The amount of time that equipment fails to function can also be expected to depend on the age of the ship, the length of time since it was last overhauled, and differences in the kind of equipment, among other things. We included these nonpersonnel factors in our analysis to hold them constant.

Table 1 summarizes the results we have obtained regarding the determinants of the condition of shipboard equipment for equipment operated and maintained by men in each of the six ratings. The equipment areas are listed across the top, and the determinants of readiness down the side. A check means that we found a relationship, and that its

direction was not unexpected. An X indicates an unexpected result.

Blanks mean that no important relationship was found. The results are largely as expected, though they differ by occupation.

TABLE 1

DETERMINANTS OF PERSONNEL PRODUCTIVITY AND EQUIPMENT CONDITION  
AS MEASURED BY CASREPT DOWNTIME

<u>Crew Characteristics or Other Determinant of Material Condition</u>	<u>BT</u>	<u>MM</u>	<u>GM</u>	<u>FI</u>	<u>TM</u>	<u>ST</u>
Crew size . . . . .	✓	✓		✓	✓	
High school graduation . . . . .				✓		✓
Entry test scores . . . . .	✓		✓	✓		
Paygrade . . . . .	✓	✓	✓	✓	✓	✓
Length of service . . . . .	✓	✓	✓	✓	X	
Prior sea experience . . . . .		✓	✓			✓
Turnover . . . . .		✓				
Training . . . . .	✓	✓	✓		✓	✓
Marital status . . . . .	✓					✓
Race . . . . .				✓		
Ship age . . . . .	✓	✓			✓	
Time between overhauls . . . . .			✓	✓	✓	
Equipment complexity . . . . .	✓	✓	✓	✓	✓	✓



Experience is reflected in the three outlined factors in the middle of the table. It is the most consistent predictor of readiness. It enters in some way for every occupation. Almost all these effects are statistically significant, and only one is unexpected. For TM's longer service, holding paygrade constant seemed to hurt readiness. If paygrade is allowed to vary with length of service, as it actually does, this apparent anomaly is erased. It appears that experience does consistently contribute to the output of military units.

What are the implications of this for policy? To address this question, I'd like to turn to the results of another study, by my colleague, A. J. Marcus [2]. The work examines the performance of A-7 squadrons aboard aircraft carriers. Observations were obtained for 292 quarters of squadron operations between 1977 and 1980.

As noted earlier, the Navy's process for determining manpower requirements provides detailed descriptions of manning levels and experience mixes by paygrade. In an independent process, the Navy also sets minimum requirements for education and mental ability for incoming recruits. They are based on the probability of successfully completing the first enlistment and on estimates of probable A-school success. Neither process considers directly the possibilities for substitution that exists among personnel with different experience levels and other characteristics or the cost. The Marcus paper analyzes the tradeoffs among personnel with different characteristics with respect to their productivity and cost.

Squadron performance is measured principally by the number of flights (or sorties) flown by A-7s off the carrier in a quarter. The effect on the squadron's sortie rate of changing the experience level of enlisted personnel was estimated. Since we had no strong beliefs about how different levels of experience substitute for each other, a flexible production function was desired. The generalized Leontief production function suggested by Diewert was chosen [3].

Experience was characterized both in terms of years of service and paygrade. The latter formulation gave slightly better results, which are summarized in table 2. Notice that, on the margin, an additional junior person actually seems to harm squadron performance, presumably by requiring the attention of more senior people. In general, people in both of the more senior groups were found to enhance the performance of the junior group. The most senior group, which is relatively small, had by far the largest impact on the flying rate. This effect was quite statistically significant.

TABLE 2  
MARGINAL PRODUCT OF PAYGRADE GROUPS IN GENERATING SORTIES

<u>E1-E4</u>	<u>E5-E6</u>	<u>E7-E9</u>
-0.5	6.2	29.1

In order to determine the implications of the analysis for squadron manning, costs needed to be brought into the picture. The costs of people in different paygrade classes were developed from the Navy's Enlisted Billet Cost Model [4]. The production function was used to determine alternative ways of achieving the same sortie rate. These were then costed out. The results of this procedure are shown in table 3.

TABLE 3

CURRENT AND LEAST-COST FORCE BY PAYGRADE FOR 12-PLANE A-7 SQUADRONS

	<u>E1-E4</u>	<u>E5-E6</u>	<u>E7-E9</u>	<u>\$ Cost (10<sup>3</sup>)</u>
Current . . . . .	129	65	12	4,304
Least cost . . . . .	86	60	23	3,796
Difference . . . . .	-43	-5	+11	508

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Cost/Man (10<sup>3</sup>) E1-E4 (16.6), E5-E6 (24.5), E8-E9 (34.5)

It appears that moving to a force much heavier in the most senior people could maintain squadron performance with 18 percent less manpower at a life-cycle cost savings of 12 percent.

The squadron-effectiveness analysis balances the cost and effectiveness of people with different amounts of experience by varying their mix, but not their compensation. This makes the shift look easier than

it really would be. We couldn't nearly double the number of people in paygrades E7-E9 without paying them more. Would it still be a good buy? Another study we performed sheds some light on this question.

This analysis, by Ellen Balis, was concerned with changing both the experience mix and the level of reenlistment bonuses in order to maximize the output of that portion of the enlisted force with less than 8 years of service [5]. Once again, the issue is balancing cost and effectiveness.

Three kinds of personnel costs are involved: (1) the cost to get a recruit to the reenlistment decision, which includes recruiting, AFEES processing, recruit and initial skill training, and 4 years of regular military compensation; (2) the cost of first-term selected reenlistment bonuses for 4-year reenlistments, and (3) the costs of second termers, which is regular military compensation for years 5 through 8. Earlier CNA work is drawn on to calculate recruiting costs and to calculate how retention responds to reenlistment bonuses [6], [7].

The effectiveness of first termers is estimated from the Enlisted Utilization Survey of Navy supervisors. It is expressed as the productivity per eligible reenlistee relative to that of the average 4-year specialist. For second termers, productivity after 4 years is assumed to remain constant, surely an underestimate.

Cost and effectiveness data were developed for eight groups covering 20 Navy occupations. Both technical and nontechnical groups are included in the analysis. For each group, optimal levels of both accessions and reenlistment bonuses are derived for different assumptions about reenlistment decisions and recruiting costs. Table 4 shows the results of this derivation under one of the most conservative sets of assumptions.\*

TABLE 4  
IMPLICATIONS FOR ACCESSIONS AND BONUS LEVELS

Occupational Area	Cohort Size		Bonus Level	
	Current	Optimal	Current	Optimal
Health Care . . . . .	2,503	2,117	0	5.0
Logistics . . . . .	3,609	2,873	1.1	5.1
Aviation Mechanical .	1,691	1,398	2.7	9.1
Marine Engineering .	2,190	2,058	6.0	7.8
Radioman . . . . .	550	384	6.0	13.1
Mechanical . . . . .	4,553	3,766	0	5.0
Aviation Electronics	2,825	1,936	1.4	9.5
Electronics . . . . .	<u>1,763</u>	<u>1,484</u>	<u>0</u>	<u>6.1</u>
Total . . . . .	19,684	16,706	1.5	6.5

\* Indeed, the optimal bonus levels shown here are below any shown in the paper because I have used a zero discount rate.

Optimal bonus levels are all above current levels and some are well above the legal maximum of 6. This means that increasing the number of second termers relative to first termers is cost effective. The total number of people serving in the first two terms, however, decreases with optimal policies, because the increase in second termers is more than offset by the decrease in first termers that can accompany it without a loss in effectiveness. Accession levels could be cut 15 percent among these groups. This is of some interest in an era of fewer potential recruits. The resultant savings for these groups average 4 percent.

This substantially understates the full potential savings. If the Navy took in 15 percent fewer people each year, it could maintain the quality of its incoming people without paying them as much. The elasticity of high-quality accessions is probably about one [8]. If first-term pay is cut 15 percent, major savings will accrue.

It seems to me that the research described in this paper should play an important role in shaping both manpower policy and manpower research. The relationship between experience and military performance can be quantified, and we should take advantage of it. It should play an important role in how we set our requirements for people with different levels of experience and on how we design the military compensation system. All the evidence indicates that we'd be better off with a more senior force. We should take fewer people into the Navy and do a better job of keeping those we take. We should pay more for experience, and

less for inexperience. This would save money, insulate us from the relative dearth of potential new recruits over the next 15 years, and ease the problem of manning the growing Navy.

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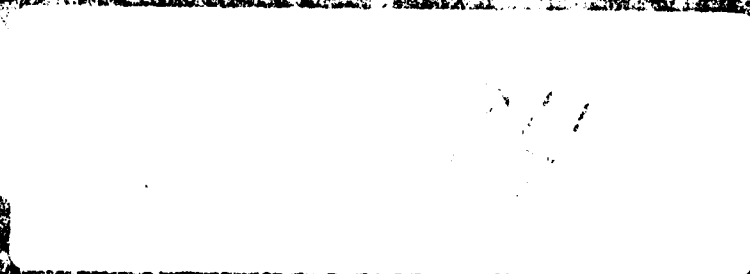
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