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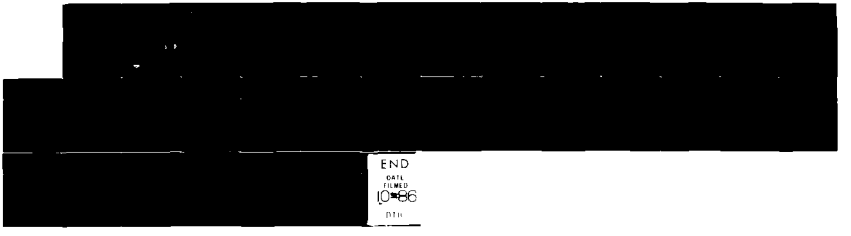

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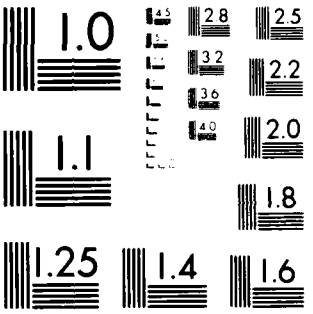

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A COST OF LEAVING MODEL FOR FORECASTING CIVILIAN ENGINEERS' RETENTION BEHAVIOR UNDER ALTERNATIVE RETIREMENT SYSTEMS

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1. This report was prepared as part of work unit WR 35844 (Civilian Personnel Planning). It discusses the development and utilization of mathematical models for forecasting Navy civilian retention behavior. The models provide a method for objective evaluation of changes in the compensation and retirement system.

2. Five alternatives to the present retirement program were applied to the mathematical model for cost of leaving (COL). The results show different retention levels by length of service, age, and pay grade for Navy civilian engineer employees. The model has application to other career fields within the civilian work force.

3. Requests for additional copies should be addressed to the Navy Personnel Research and Development Center, Code 61.

Martin F. Wiskoff

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A COST OF LEAVING MODEL FOR FORECASTING CIVILIAN ENGINEERS' RETENTION BEHAVIOR UNDER ALTERNATIVE RETIREMENT SYSTEMS

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A general methodology for analyzing compensation issues of civilian federal employees has been developed. The method has been applied to the engineer occupation series. Five alternative retirement systems were analyzed using the model. Differences in retention by length of service, age, and grade level of the civilian employees were calculated. This allows for comparisons of retirement plans for specific subgroups of the population as well as overall.

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SUMMARY

Problem

Civilians comprise more than one-third of total Navy manpower and two-thirds of the support establishment. Research on the size and distribution of the civilian work force has been hampered by the lack of a data base and models to project force structure under alternative personnel policies. There is a need to develop long-term civilian work force modeling capability supported by a structured data base.

Objective

The objective of this effort was to develop an econometric model, using alternative retirement systems, to forecast the retention behavior of the Navy civilian engineers under alternative retirement and compensation systems.

Approach

A two-stage approach was used. First, a cost of leaving (COL) model was developed to calculate the present value of expected lifetime earnings from remaining in the government. This model compared the value of government retirement with the value of resignation for private sector employment. Second, a regression model was developed to estimate retention rates as a function of COL. The impact of alternative retirement systems on retention was assessed by computing COL values for the present and alternative systems, and then comparing retention predictions using the regression model.

Five alternative retirement systems were analyzed using the model: four defined benefit plans, including Grace Commission, Dottie, private sector, and NAVMAT plans, and one defined contribution plan, the Stevens Bill plan. Differences in retention by length of service, age, and grade level of the civilian employees were calculated so that comparisons could be made for specific subgroups as well as for the overall population of engineers.

Results

COL was determined for the five alternative retirement programs as a function of grade level, length of service, and age. In general, the model predicts only modest changes in retention under these five alternative retirement plans.

Conclusions

A general methodology for analyzing compensation issues for civilian federal employees has been developed. The automated, interactive retention and compensation model was applied to engineers but it is easily adaptable to other occupations.

The conclusions drawn from the model must be reviewed in light of the limited historical data base and the somewhat atypical nature of the engineering population. Further data base development is required before additional research can be productive.

Office of the Secretary of Defense (OSD) has undertaken an extensive effort to build a COL model for Department of Defense personnel. This report is part of that extensive research effort for OSD. The results of the OSD effort should be evaluated to determine the validity of the overall approach in projecting civilian retention behavior.

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INTRODUCTION

Problem

Civilians comprise over one-third of total Navy manpower and two-thirds of the support establishment. There exists however, little analytic basis to support this size and distribution. Research has been hampered by the lack of a civilian data base and models to project the impacts of current and proposed personnel policies on force structure.

Efforts to forecast the impacts of policy changes on Navy civilians have been limited to short-term studies and analyses of the impact of a specific policy on a specialized group of the work force. Blanco, Kissler, and Woon (1980) developed a mathematical model to forecast the work load at seven supply activities in the Pacific Fleet based on number of ships, fleet mix, deployment status, and maintenance activity work load. Charnes, Cooper, Lewis, and Niehaus (1979) formulated a mathematical programming model to analyze recruiting plans and equal opportunity issues for large naval shore activities. Liang (1982) used regression analysis to determine the extent to which high-grade promotion limitations affected the attrition of scientists and engineers in the Navy research and development (R&D) centers. Corbet and Devaney (in press) implemented a systems dynamics model to project the effects of a continued pay cap on the Senior Executive Service (SES) force structure.

There is a need to develop a long term civilian work force modeling capability supported by a series of mathematical models and structured data bases. Development by McGonigal (1983) at the Defense Manpower Data Center on civilian cohort files is a step in the right direction with respect to the data base. This report develops a general methodology for analyzing compensation issues for civilian federal employees. The methods are applied to the engineer occupation series but are easily adapted to other occupations.

Objective

The specific objective of this effort is to develop an econometric model to forecast the retention behavior of the Department of the Navy civilian engineers under alternative retirement and compensation systems. The model needs to be flexible enough to cover a wide range of compensation issues including changes to the retirement system and the salary structure.

APPROACH

A two-stage approach was used to model civilian engineers' retention behavior. First, a dynamic programming model was developed to calculate the present value of expected lifetime earnings from remaining in the government instead of retiring or resigning for private sector employment. This value is called cost of leaving (COL). Second, a regression model was developed to estimate retention rates as a function of COL. The impact of alternative retirement systems on retention was assessed by computing COL values for the present system and the alternative system and then comparing predictions using the regression model.

The COL is defined as the difference between the present value of expected lifetime earnings between staying in federal service for one more year and resigning from federal service immediately. This definition of COL has been used in analyses of Air Force

Officers' retirement decisions by Gotz and McCall (1979, 1983), and Navy enlisted retention behavior by Chipman and Mumm (1978, 1979). A similar COL value was proposed by Warner (1979) for evaluating alternative military retirement systems. Unlike previous research, however, the COL model developed here applies to civilian government employees. Additionally, the model was expanded to include private sector retirement plans, social security, and entrance into government service at any age. The original Gotz model assumed everyone entered the military at the same age.

The COL values were related to retention rates using weighted least squares regressions (Rao, 1973). A logistic transformation of the retention rates was used as the dependent variable in the regression model to assure predictions between zero and one. Historical data on retention and COL were used to carry out this part of the research.

Data Collection and Organization

The primary source for Navy civilian engineers' data was the Department of Defense Civilian Personnel Data File (DCPDF). Both master and transaction files were used. Master files contain personnel information as of the end of a fiscal year. Transaction files contain changes that were made to the master file during a fiscal year. Only full time, professional engineers were included in the model. The Defense Manpower Data Center (DMDC) in Monterey, California, provided the data.

Figures 1 through 6 contain plots of the engineer data by age, length of service (LOS), and grade level. Figure 1 shows number of engineers by fiscal year and age group. The age groups are: 20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60+. The number of engineers in each age group has remained fairly constant except for the recent increase in the 20 to 29 group. Figure 2 shows the annual retention rate for these same age groups. The retention rate is calculated as the number of personnel who have left during the fiscal year divided by average strength. Average strength is the average of beginning fiscal year and end fiscal year strength. Except for the decline in FY80, when there was a larger than normal number of retirements, retention by age group has also been constant over this time frame. Figure 3 presents the number of engineers by fiscal year and LOS. There has been an increase in LOS 1 to 5 since FY79. Figure 4 shows the annual retention rate by LOS group. There has also been an increase in LOS 1 to 5 retention since FY79. Figure 5 shows the number of engineers by fiscal year and grade level. The grade level populations have remained relatively constant over time. GS-12 is the largest single grade level. About 1000 personnel have been in the demonstration project (DP)[1] pay plan since FY80. Figure 6 contains retention rates by fiscal year for GS-5 through GS-12 grade level. There has been an increase in GS-5 and GS-7 retention in recent years.

COL Model

COL values were calculated by grade level, age, and LOS. The grades covered included GS 5, 7, 9, 11, 12, 13, 14, 15 and SES. Ages ranged from 22 to 64 while LOS was restricted to 1 to 43 years. As a result of these limitations, 243 out of 24,793 engineers in FY82 were excluded from the sample. Personnel in the demonstration project pay plan were also excluded because their grade levels cannot be translated to an equivalent GS level. Therefore the effect of the DP on retention cannot be addressed using this model. The equations defining COL are contained in the Appendix.

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[1] The DP is an experimental pay plan which has fewer pay grades than the standard GS system. The DP pay plan allows more flexibility in salary determination.

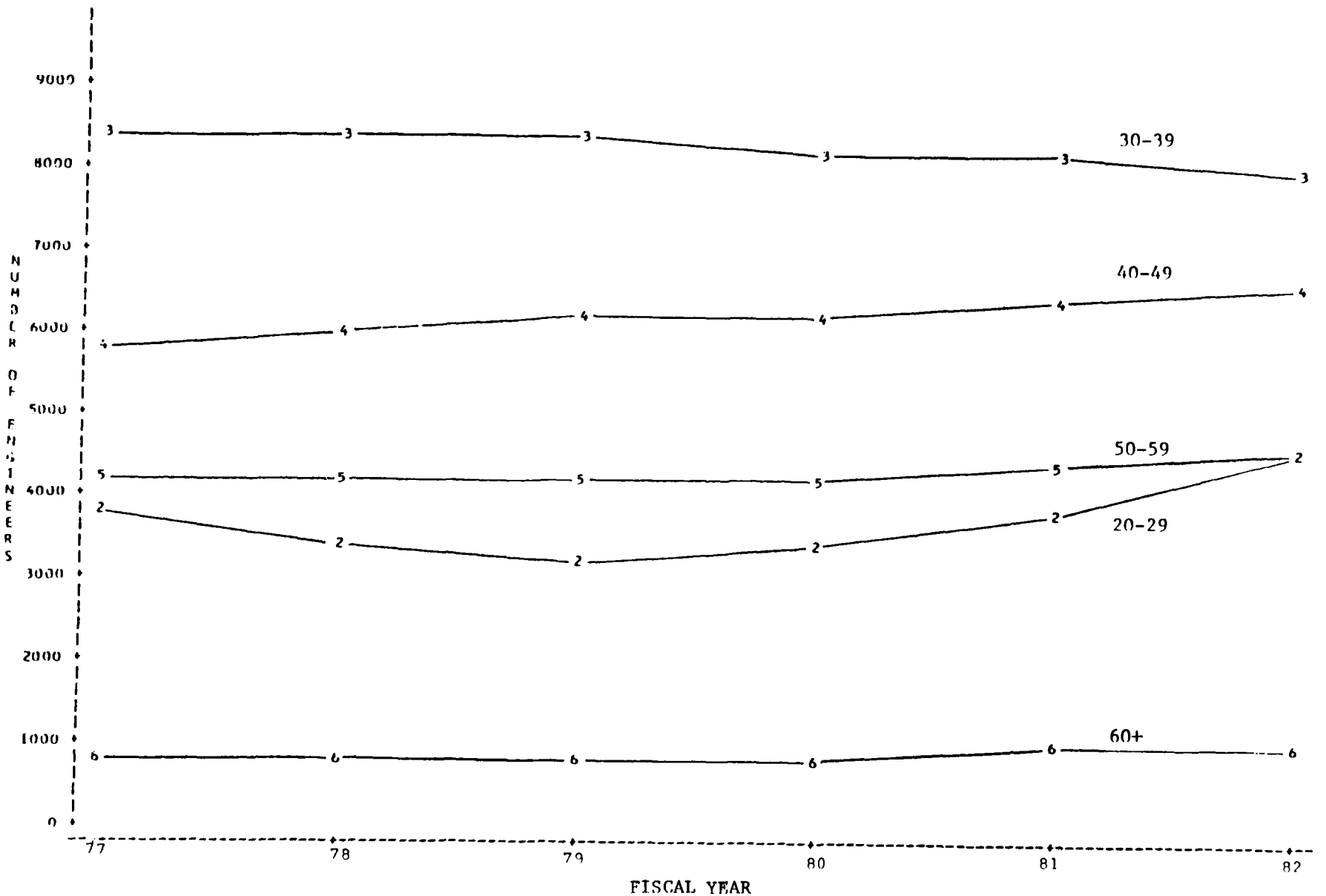

Figure 1. Number of engineers vs. fiscal year by age group.

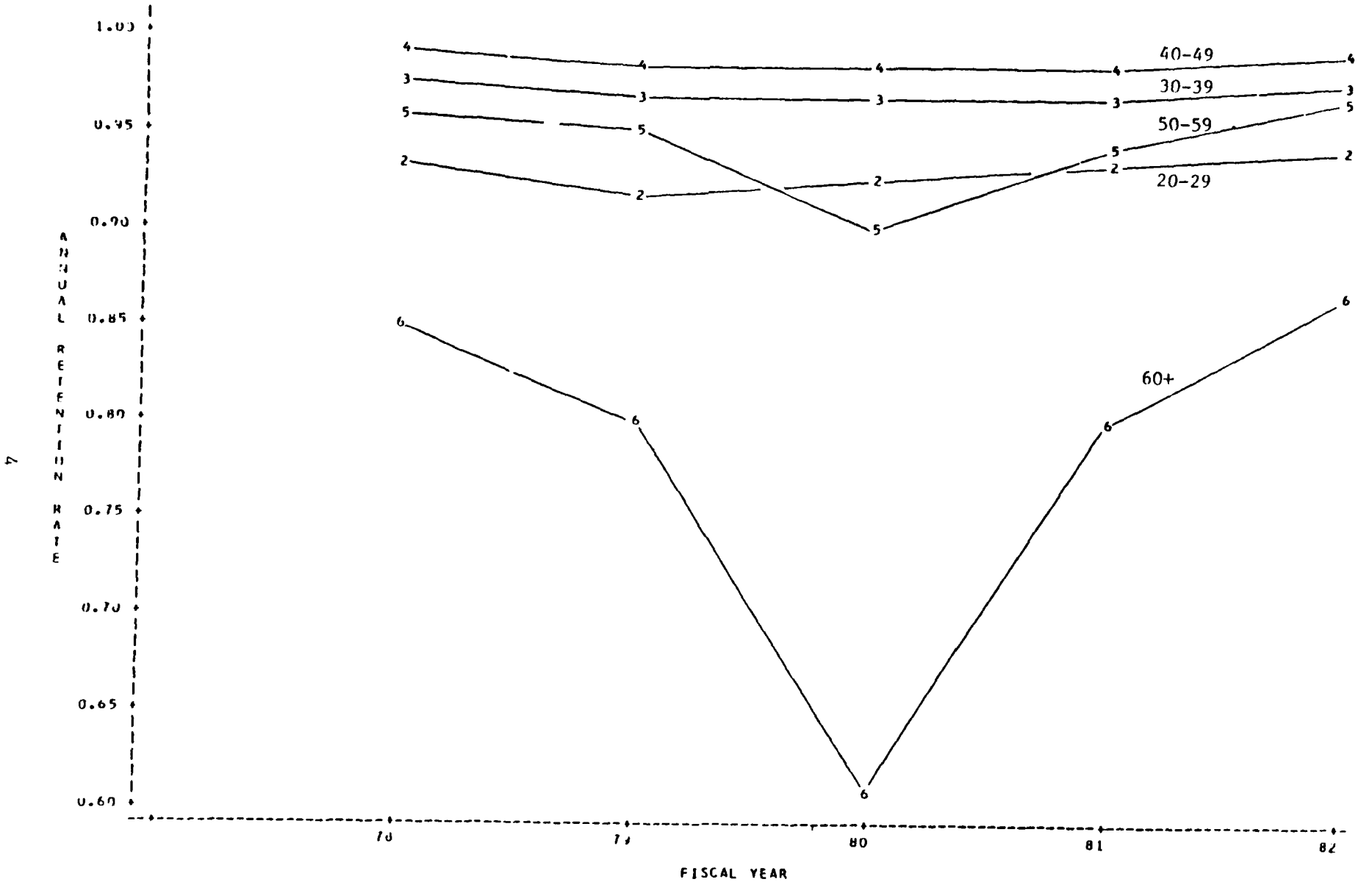

Figure 2. Annual retention rate vs. fiscal year by age group.

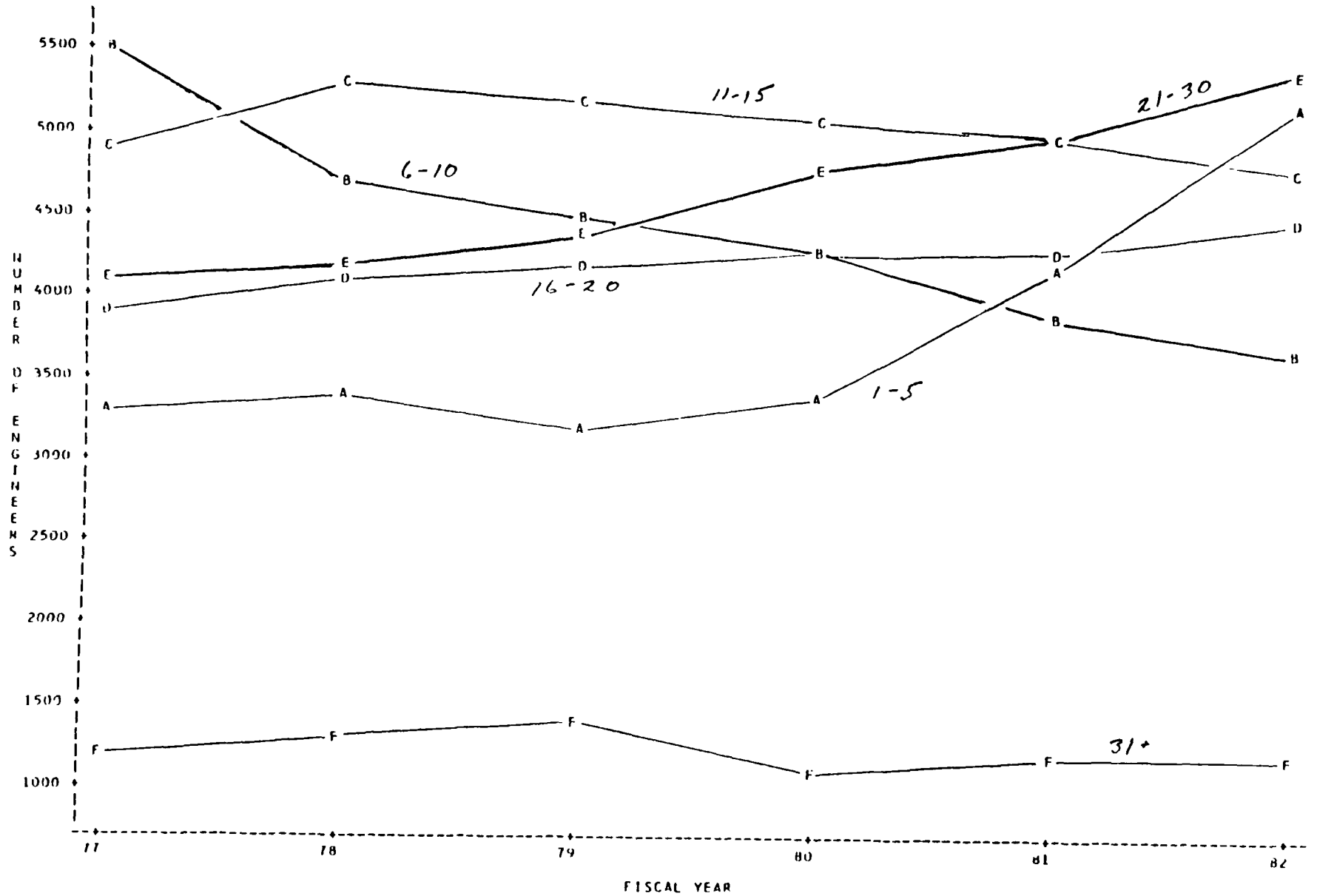

Figure 3. Number of engineers vs. fiscal year by length of service group.

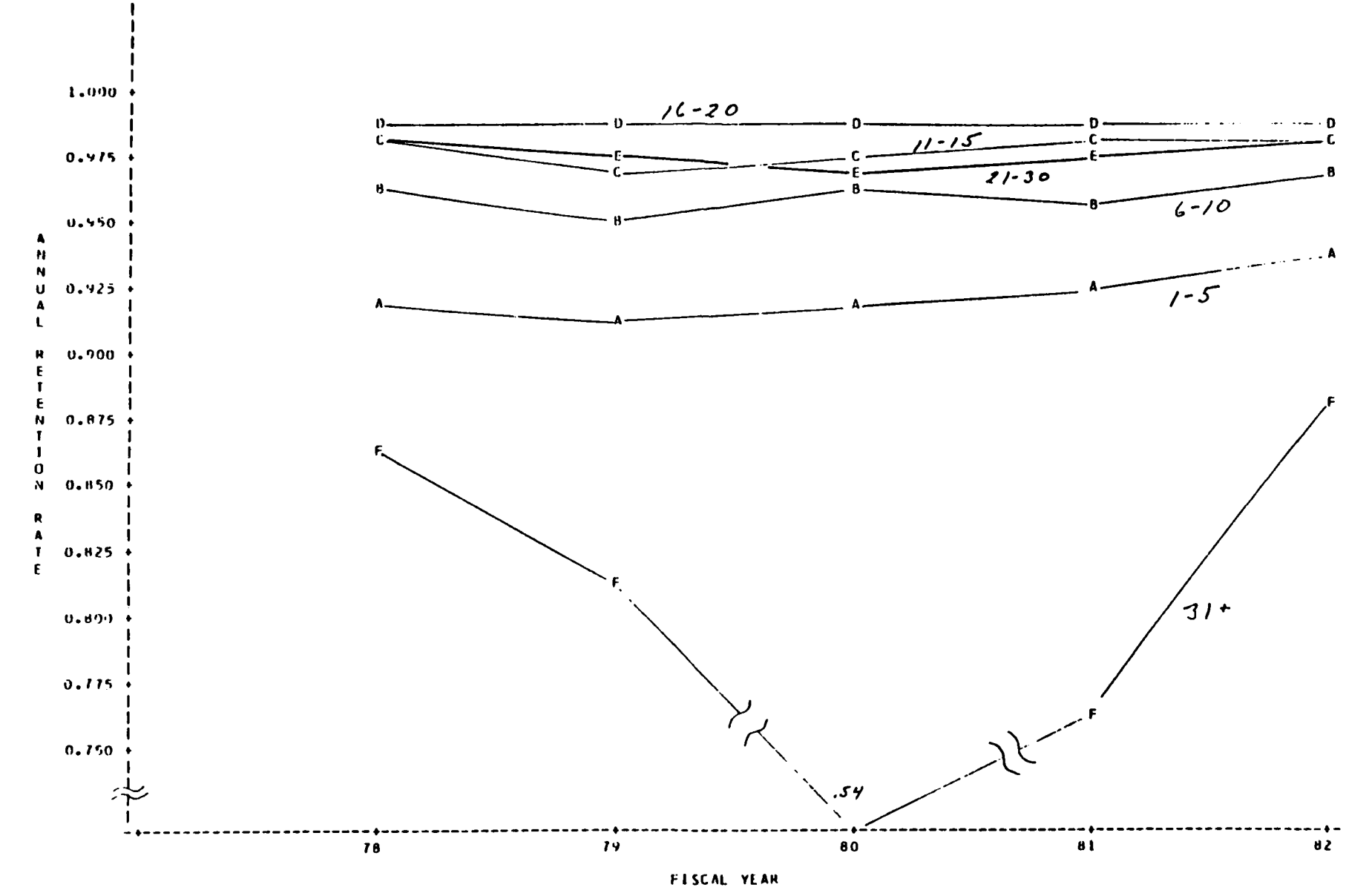

Figure 4. Annual retention rate vs. fiscal year by length of service group.

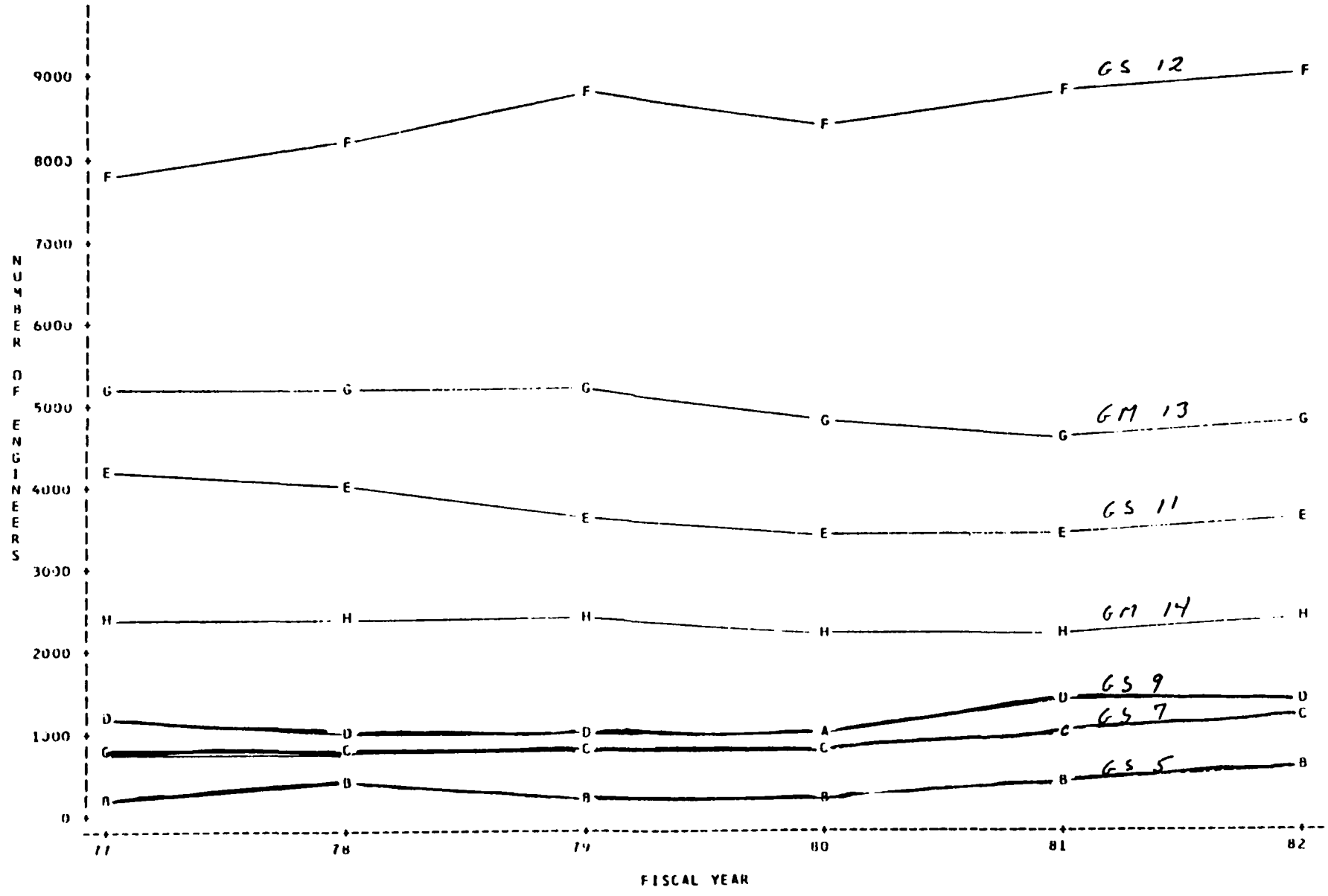

Figure 5. Number of engineers vs. fiscal year by grade level.

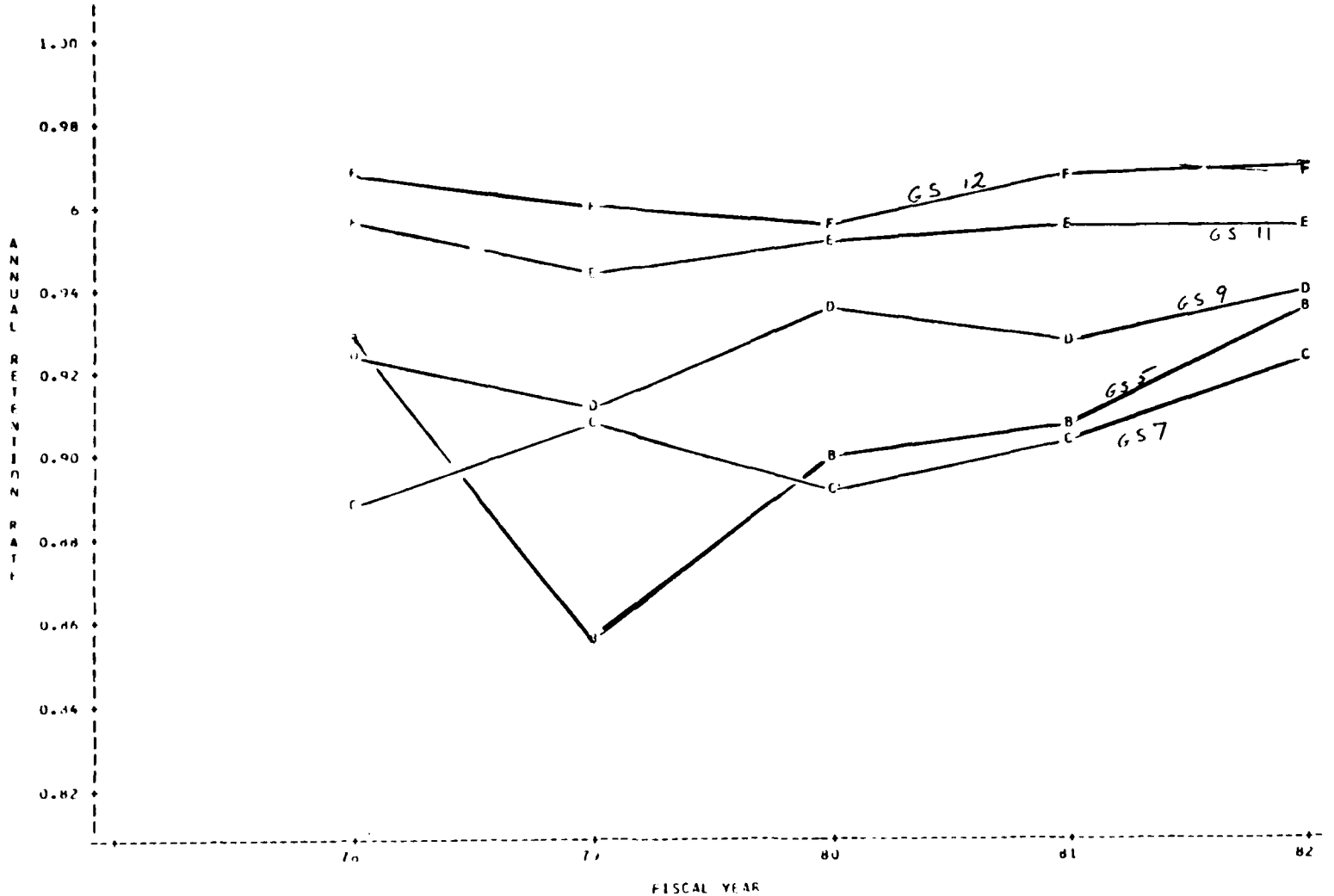

Figure 6. Annual retention rate vs. fiscal year by grade level.

Historical COL values were calculated for three fiscal years: 1980, 1981, and 1982. The data requirements for the COL model include private sector unemployment rates, survival probabilities, a personal discount rate, government wages, private sector wages, government retirement benefits, private sector retirement benefits including social security, and government transition probabilities. Transition probabilities relate to promotions, demotions, and involuntary separations.

A private sector engineer unemployment rate of 2.4 percent was used. This value was obtained from the March 1982 Current Population Survey. The unemployment rate is used to discount the chance of finding private sector employment after leaving the government. Survival probabilities were calculated using standard mortality tables. A discount rate of 10 percent was used. Discount rates of 5 percent and 15 percent were investigated and some results were presented in the Appendix. A change in the discount rate does change the COL values. However, since the basic shape of the curve (COL vs. LOS) remained the same, retention predictions derived from the regression model were not sensitive to discount rate assumptions. Average government wages by grade level and LOS were calculated from the DCPDF. Government retirement amounts are a straightforward calculation giving wage values. Private sector salary data was obtained from Engineers' Salaries Special Industry Report (1980, 1981, 1982). A "typical" retirement system was assumed for the private sector. These assumptions include: defined benefit plan, vesting with 10 years of service (YOS), replacement rate of 1.75 percent per year of service, no cost to employee, and offset by social security. Average promotion, demotion, and involuntary separation rates were estimated from the DCPDF. These rates are necessary for estimating typical career paths.

Figure 7 illustrates two typical COL functions for FY82. These functions relate the COL to grade level, holding constant LOS and age. A negative COL value implies that life stream earnings are maximized by leaving civil service; a positive value implies they are maximized by staying. Thus the "critical" point with respect to retention behavior is the grade at which the COL turns from negative to positive. As shown in Figure 7, this critical point is GS-12 for LOS 10, age 31, and GS-9 for LOS 3, age 24. These differences by age and LOS are due in part to the fact that private sector engineering wages are a function of experience. Age and LOS are in turn "proxy" variables for on-the-job training.

The average COL is plotted against LOS in Figure 8. The COL values were calculated using the actual FY80 through FY82 engineer data. The plots have a peak at LOS 30 because of retirement eligibility. In other words, the closer to the retirement point, the greater the COL.

Retention Model

A weighted least squares approach was used to model retention as a function of COL. The retention rates (r) were transformed by using the empirical logistic transform (Log(r/1-r)). The transformation is used to assure predictions between zero and one and to stabilize the variance of the dependent variable in the regression model.

Preliminary model building was carried out on the FY82 data only. A model that provided reasonable results involved first grouping the data by LOS and then applying a model with terms for COL, age, and LOS. The model was applied using the FY82 data and then tested on the FY81 and FY80 data. Results of this initial estimation and testing are in the Appendix.

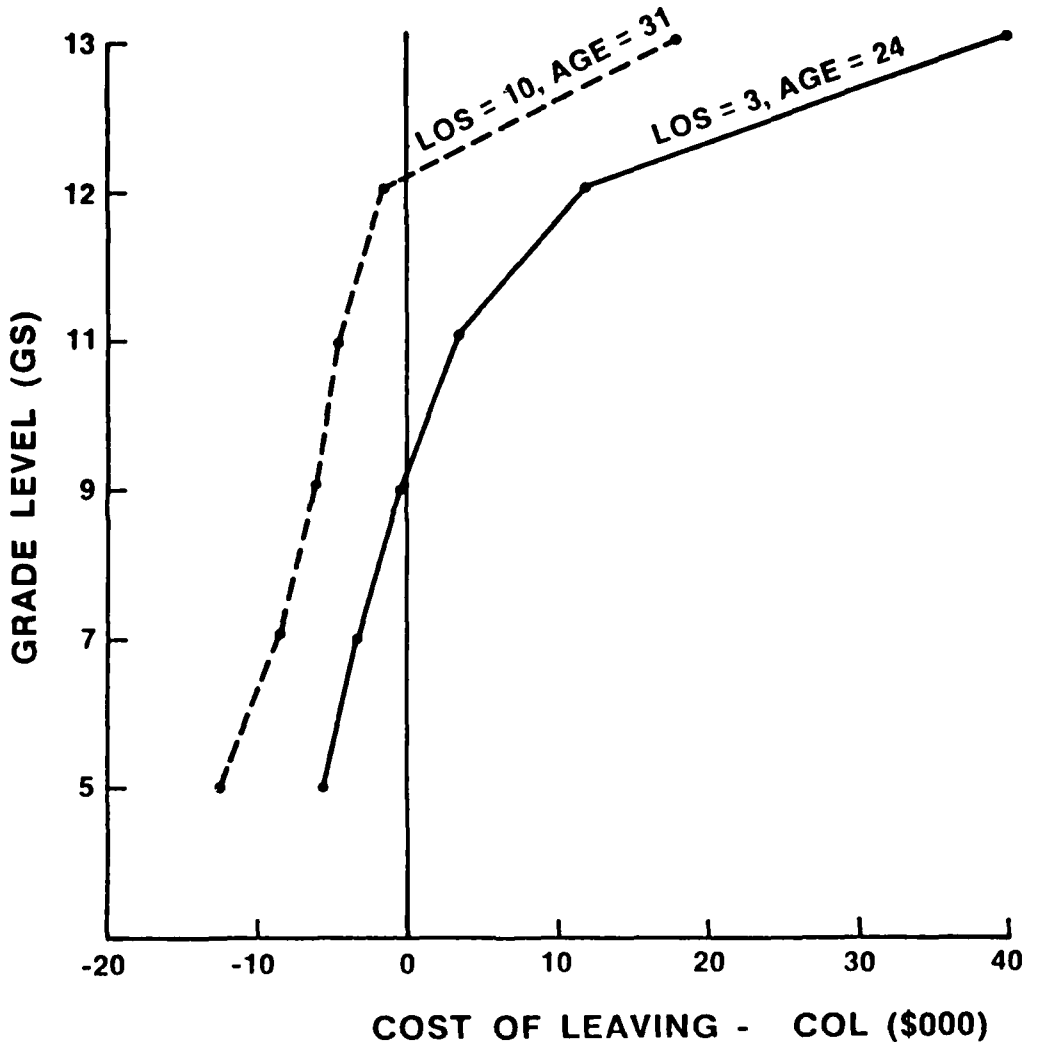

Figure 7. Grade level vs. cost of leaving for selected length of service and age groups.

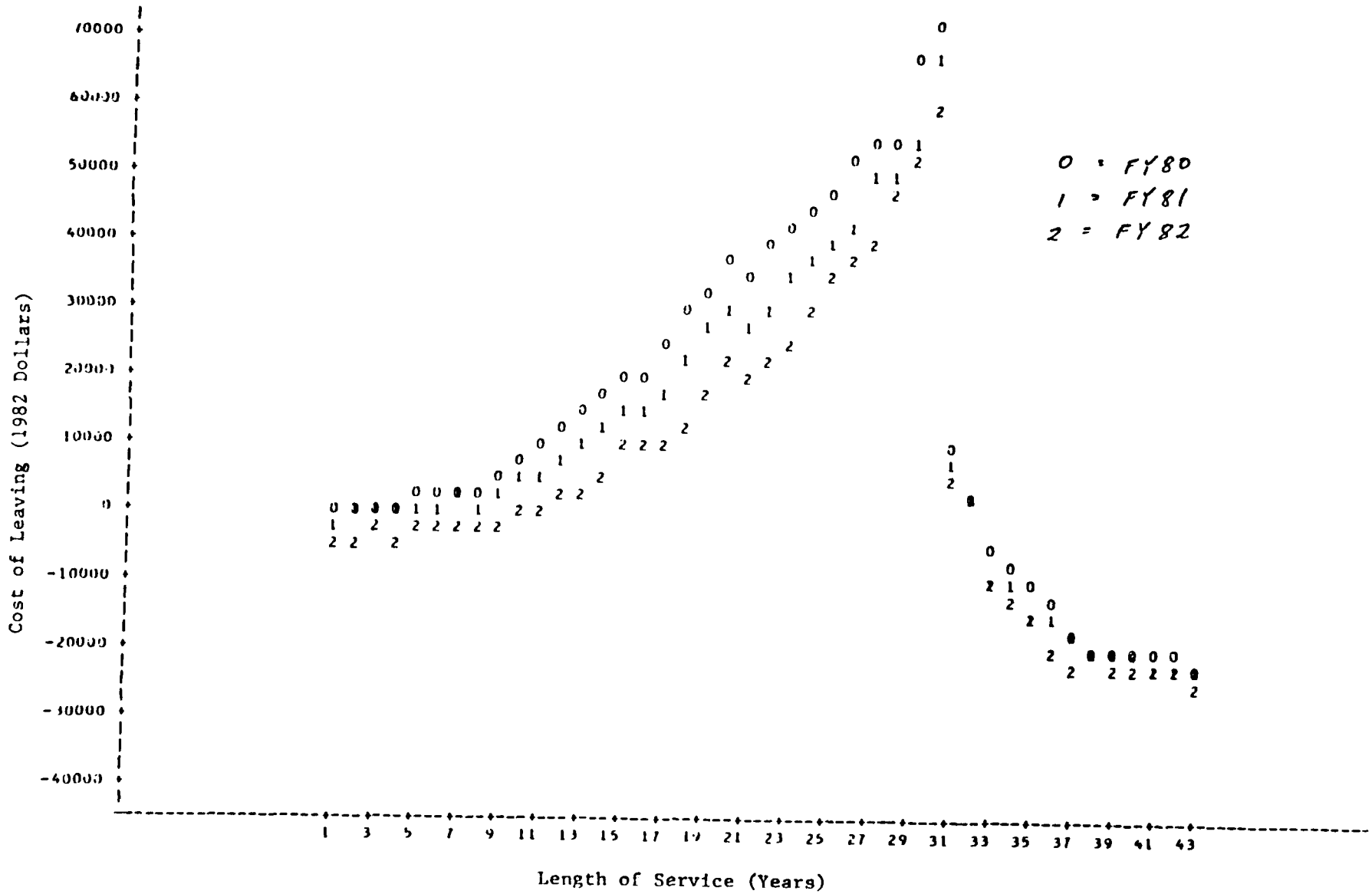

Figure 8. Cost of leaving vs. length of service.

The retention model was then applied to the combined FY80-82 data. The parameters in the model are: INTERCEPT, COL, I_1, I_2, I_3, AGE*I_1, AGE*I_2, and AGE*I_3. I_1 equals 1 if LOS is between 1 and 11, 0 otherwise. I_2 equals 1 if LOS is between 12 and 21, 0 otherwise. I_3 equals 1 if LOS is between 22 and 31, 0 otherwise. LOS is grouped in this manner because of the nonlinear relationship between retention and LOS. Parameter estimates and test statistics are presented in Table 1. The model has an overall R^2 value of 0.84.

Table 1

Retention Model Parameter Estimates and Test Statistics

Parameter	Estimate	T	p-Value
Intercept (I)	1.03	8.94	0.0001
COL	2.38x10-5	4.77	0.001
I_1	-1.54	2.51	0.01
I_2	2.25	1.61	0.11
I_3	15.74	6.71	0.001
AGE*I_1	0.11	4.77	0.0001
AGE*I_2	0.01	5.50	0.000
AGE*I_3	-.29	0.20	0.84

RESULTS

Retirement Policy Analysis

Five alternative retirement systems were analyzed. A more comprehensive analysis is contained in an earlier letter report (Thompson, 1983) to the Chief of Naval Operations (OP-14).

The application of this model involves making retention predictions based on the present retirement system and FY82 strength data. Retention is predicted by grade level, LOS, and age. Next, COL values for the alternative plan were calculated. These values were used to make retention predictions under the alternative plan. These two sets of predictions provide a quantitative comparison of the effect of changing the retirement system.

The characteristics of the present retirement system and five alternatives provided by OP-14 are contained in Table 2.

Table 2

Retirement Plan Characteristics

Characteristic	Defined Benefit Plans									
	Present System		Grace Commission		Dottie		Private Sector		NAVMAT	
Vesting YOS	5		5		5		10		5	
Benefit Formula YOS 1-5	1.50%		1.75%		1.50%		1.75%		1.50%	
YOS 6-10	1.75%		1.75%		1.75%		1.75%		1.75%	
YOS 11+	2.00%		1.75%		2.00%		1.75%		2.00%	
High	3		5		5		5		3	
Eligibility	YOS	AGE	YOS	AGE	YOS	AGE	YOS	AGE	YOS	AGE
	30	55	30	55	30	55	30	55	30	55
	20	60	20	60	20	60	20	60	20	60
	5	62	5	62	5	62	10	65	5	62
Early Retirement	%	AGE	%	AGE	%	AGE	%	AGE	%	AGE
	0		4.0	62	2.0	60	5.5	65	2.0	60
Social Security	No		Yes		No		Yes		No	
Employee	7%		7%		7%		7%		7%	

Characteristic	Stevens Bill Defined Contribution Plan
Vesting YOS	5
Employer Contribution	9% first $20,000
Thrift Plan	
Employee	0%
Employer	0%
Interest Rate (in reference to inflation)	0%
Social Security	Yes

The plans fall into two general categories: Defined benefit plans and defined contribution plans. Under defined benefit plans, the benefits an individual receives are fixed, usually as a percentage of some average salary. Under defined contribution plans, the amount contributed to the plan is fixed. Benefits are based upon the value of this amount, plus interest earned, at the time of retirement.

The Naval Material (NAVMAT) alternative is closest to the present system. The only difference is a 2 percent per year reduction in benefits prior to age 60. The Dottie plan is identical to the NAVMAT plan except for the benefit formula being based on the high 5 salary years instead of the high 3. The Grace Commission and private sector plans are similar. Both include Social Security coverage and both benefit formulas use 1.75 percent for all YOS. The private sector plan requires more years for full vesting and has higher early retirement penalties. The Stevens Bill plan, a defined contribution plan, is structured differently than all of the other plans and is not easily comparable.

A couple of points need to be noted concerning the analysis of these plans. The model used is static. Retention is predicted under a given set of conditions at a point in time. The "phase in" type criteria for an alternative retirement system cannot be explicitly evaluated. During a phase-in time period personnel are gradually changed over to a new system. Special incentives may be used to persuade people to voluntarily change to a new system. Thus, the alternative plans evaluated assume that there is no "grandfathering" under the new system. Grandfathering is allowing personnel under the old system to stay under that system. Only new hires would go under the new system.

Input requirements for defined benefit plans include the interest rate that contributions to the plan earn for employer and employee. This rate is a calculated net of anticipated inflation. A rate of zero percent means the interest rate equals the inflation rate. A rate of -1 percent implies the interest earned is 1 percent below inflation. A rate of 2 percent implies the interest is 2 percent above inflation. The Stevens Bill plan was evaluated using a rate of 0 percent. Moreover, the rate at which an employee contributes to the thrift plan and the amount of that rate matched by the government are required inputs. This analysis assumes a zero employee contribution to the thrift plan.

Each of the five alternative retirement systems was compared to the present system. A few comparisons follow. Figure 9 compares the COL values by LOS for the present system, the Grace Commission plan, and the Stevens Bill. Note the differences in COL values at LOS 5 and 30. These values correspond to predicted annual retention rates at LOS 5 of 93.4 percent for the present system, 93.0 percent for the Grace Commission plan, and 94.9 percent for the Stevens Bill. At LOS 30 the predicted rates are 88.5 percent for the present system, 84.2 percent for the Grace Commission plan, and 75.7 percent for the Stevens Bill.

Table 3 contains the predicted change in the number of people staying in civil service for at least one more year by grade level and alternative retirement plan. Using total change or total high-grade change as a measure, the retirement plans providing the best to worst retention are: present system, NAVMAT, Dottie, Grace Commission, private sector, and Stevens Bill. However, for grades GS-5 through GS-9, the Stevens Bill is the best plan.

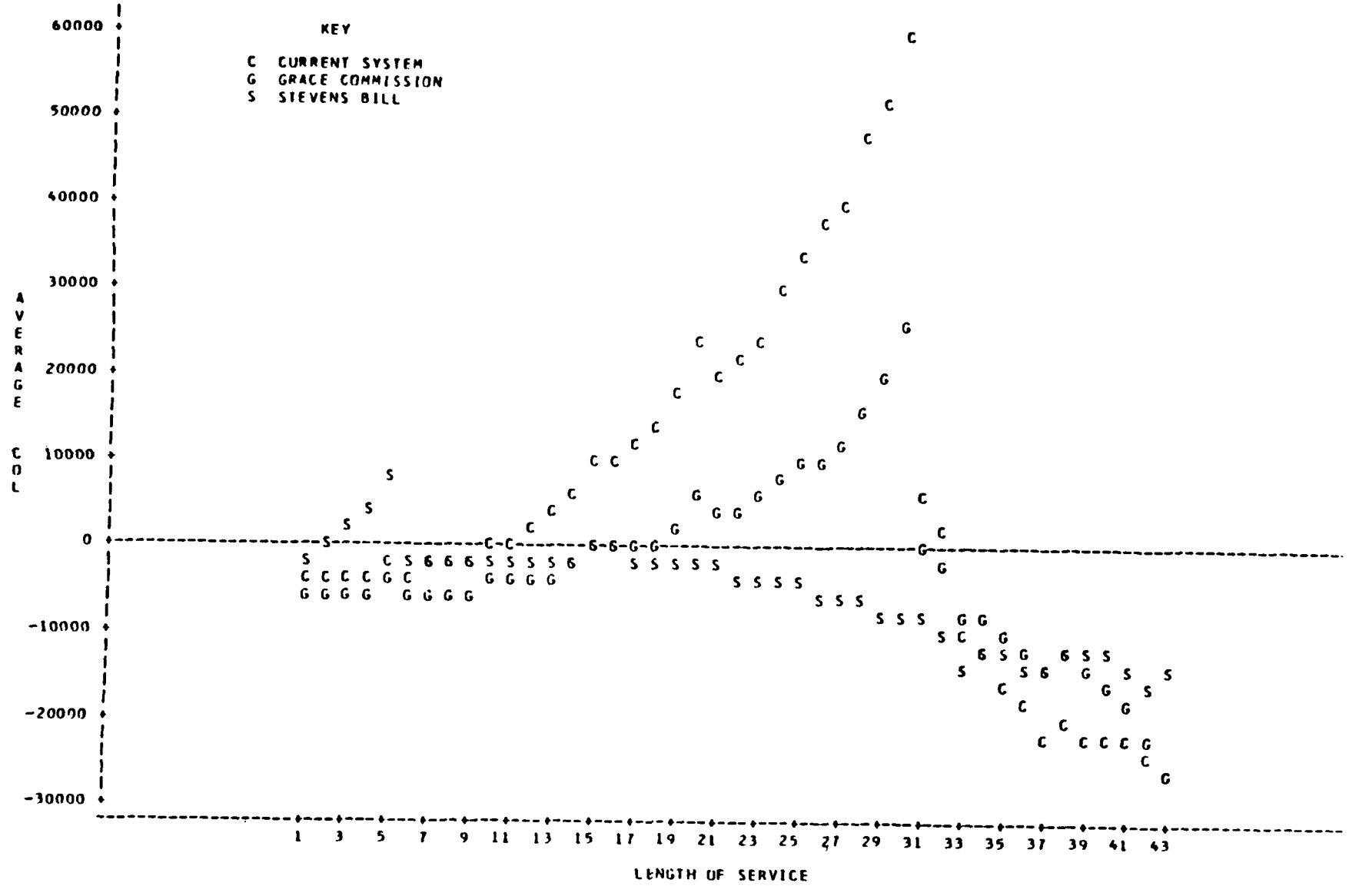

Figure 9. Cost of leaving vs. length of service for the current system, Grace Commission, and Stevens Bill.

Table 3

Predicted Change in Number of People Staying in Civil Service by Grade Level and Alternative Retirement Plan

Grade Level	Plan				
	Grace Commission	Dottie	Private Sector	Stevens Bill	NAVMAT
GS-5	-1.4	-0.0	-1.4	2.7	-0.0
GS-7	-4.9	-0.0	-4.9	12.6	-0.1
GS-9	-6.9	-0.2	-7.1	14.3	-0.2
GS-11	-10.9	0.6	-12.1	5.3	-0.6
GS-12	-36.1	-3.5	-38.2	-46.2	-1.6
GS-13	-53.1	-5.8	-60.4	-84.4	-1.5
GS-14	-19.1	0.1	-22.6	-52.0	1.3
GS-15	-4.4	0.8	-2.0	-20.2	1.0
SES	-0.3	0.1	1.3	-1.5	0.2
Total change in number of people staying	-136.9	-7.9	-147.2	-169.5	-1.5
High Grade	-79.9	-4.8	-83.7	-158.1	1.0

Note. Negative (-) values indicate an increase in number of people leaving federal service.

CONCLUSIONS

A model has been developed that can be used to relate compensation issues, especially a wide range of alternative retirement plans, to retention of civilian engineers. In general, the model predicts only modest changes to retirement behavior under the various plans. This lack of sensitivity is due in part to the fact that COL only accounts for a small percentage of the variability in observed retention rates. Age and LOS are also included in the model and are probably more important than the COL (as defined in this model) in determining a person's stay/leave decision. However, predicted changes are in annual retention rates. If a decrease in retention is predicted, the cumulative effect over a number of years may be significant.

Although the model provides reasonable results; that is, changes are in the "right" direction, other issues, such as cost of the retirement system and the effect on recruitment are not addressed. Moreover, since limited time series (i.e., FY80 to FY82) data are used, the model cannot evaluate the effects of time-dependent variables such as inflation and unemployment rates. Furthermore, generalization of these results to other civil service occupations may not be valid because of the limited data base and the somewhat atypical nature of the engineering population. The methodology can be applied to other occupations, with additional data.

The COL values themselves can provide insight into the effects of changing the retirement system. For example, Figure 9 relates the average COL to LOS for three retirement systems; current, Grace Commission, and Stevens Bill. The COL for the Grace Commission is similar in shape to the present system and is uniformly inferior for those people who want to remain in civil service. The Stevens Bill system has higher COL values than the other plans until LOS 6. This would seem to provide more inducement than the current system to stay for at least the first 5 YOS.

The retention model has been installed on a computer system for interactive use. This implementation allows the user to define a retirement system and compare retention predictions between that retirement system and the present system. Users are also able to predict changes in retention based on changes in the government and private sector salary structure. However, after evaluating several scenarios generated by the model, OP-14 has decided against implementation.

There are a number of areas where improvement in the model could be pursued. These are the inclusion of more covariates in the regression model, refinement of the personnel flow rates, the addition of more historical data, further disaggregation of the data, and the use of alternative regression techniques. Civilian cohort files, recently developed by DMDC, could be used to extract personnel flow data.

The OSD has undertaken an extensive effort to build a COL model for Department of Defense personnel. This work is part of that effort. The results of the OSD effort should be evaluated to determine the validity of the overall approach in projecting civilian retention behavior.

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APPENDIX

COST OF LEAVING EQUATIONS AND MODEL RESULTS

COST OF LEAVING EQUATIONS

Let V, U, and G be defined as follows.
Then cost of leaving (COL) equals G - U.

V(i,j,l): present value of maximized lifetime earnings at grade i, age j, LOS l

i: GS-5, GS-7, GS-9, GS-11, GS-12, GM-13, GM-14, GM-15, SES
j: 22 - 64 years of age
l: 1 - 43 years

U(i,j,l): present value of lifetime private sector earnings if leave government at grade i, age j, LOS l

G(i,j,l): present value of lifetime earnings if stay in government one year and then make optimal stay/leave decision at grade i, age j, LOS l

$$V(i,j,l) = \text{MAX}\left[G(i,j,l),\ U(i,j,l)\right]$$

$$U(i,j,l) = \sum_{k=j+1}^{T} \left[e * s(j,k) * b^{k-j} * (w_2(k)) \right] + r_1(i,j,l) + r_2(i,j,l)$$

$$G(i,j,l) = b * s(j,j+1) * \sum_{k=1}^{9} \left\{ p(i,k) * \left[w_1(k,l,1) + v(k,j+1,l+1) \right] \right\} + p(i,10) * U(i,j,l)$$

$$COL(i,j,l) = G(i,j,l) - U(i,j,l)$$

e: risk factor, i.e. 1 - unemployment rate for engineers

S(j,k): probability of survival from age j to age k

b: 1 / (1 +RHO), where RHO is the discount factor

$w_1(i,l)$: average government wages at grade i and LOS l

$w_2(k)$: private sector wages at age k

$r_1(i,j,l)$: present value of government retirement if leave public service at grade i, age j, LOS l

$r_2(i,j,l)$: present value of private sector retirement if leave public service at grade i, age j, LOS l

p(i,k): transition probability from state i to state k
i: 1-9 corresponding to GS-11 level
k: 1 - 10 where state 10 is private sector
p(i,10) is the probability of involuntary separation

T: retirement age

Table A-1

Model Results Using FY82 Data and 10 Percent Discount Rate

LOS	AVERAGE STRENGTH	RETENTION RATE	PREDICTED RETENTION RATE	AVERAGE AGE	COL 10
1	1234.5	0.937	0.925	27.0	-4363
2	1002.5	0.928	0.934	28.3	-3817
3	768.0	0.932	0.941	29.5	-3643
4	749.5	0.960	0.949	31.2	-3896
5	741.5	0.941	0.956	32.5	-2548
6	617.0	0.971	0.960	33.8	-3436
7	679.0	0.946	0.961	33.8	-2347
8	847.0	0.976	0.963	34.3	-2155
9	790.5	0.975	0.966	35.3	-2492
10	723.0	0.972	0.971	36.6	-599
11	855.5	0.975	0.975	37.8	644
12	852.5	0.971	0.977	38.0	1740
13	862.5	0.980	0.978	38.3	3584
14	1033.0	0.981	0.979	39.0	5999
15	1041.0	0.985	0.981	40.2	9183
16	909.0	0.981	0.982	41.5	10267
17	858.5	0.988	0.983	43.1	11222
18	803.5	0.991	0.984	44.3	13277
19	799.0	0.985	0.986	44.7	18090
20	817.5	0.993	0.988	45.6	23354
21	746.5	0.980	0.987	46.5	19112
22	696.0	0.987	0.982	47.0	21979
23	639.5	0.970	0.981	47.6	24242
24	586.5	0.986	0.981	48.2	29340
25	535.5	0.993	0.981	48.8	34656
26	454.0	0.982	0.978	49.8	37142
27	400.5	0.983	0.974	51.0	40110
28	320.5	0.966	0.975	51.7	47777
29	254.5	0.983	0.974	52.6	52800
30	255.5	0.969	0.976	53.1	60367
31	208.5	0.914	0.910	53.4	5595
32	216.5	0.912	0.894	54.3	1644
33	167.0	0.886	0.862	55.1	-10742
34	146.5	0.809	0.857	55.7	-12352
35	100.5	0.841	0.845	56.8	-16014
36	51.5	0.864	0.836	57.6	-18931
37	32.5	0.840	0.827	57.6	-21679
38	29.0	0.931	0.834	58.7	-19706
39	26.0	0.885	0.823	59.6	-22713
40	22.5	0.867	0.825	60.2	-22229
41	16.5	0.818	0.823	61.1	-22766
42	6.5	0.692	0.821	62.7	-23473
43	3.0	0.667	0.815	63.3	-25045
	22960.0				

Table A-2

Model Results Using FY82 Data and 5 Percent Discount Rate

LOS	AVERAGE STRENGTH	RETENTION RATE	PREDICTED RETENTION RATE	AVERAGE AGE	COL 5*
1	1234.5	0.937	0.926	27.0	-4377
2	1002.5	0.928	0.934	28.3	-3223
3	768.0	0.932	0.940	29.5	-2404
4	749.5	0.960	0.949	31.2	-1846
5	741.5	0.941	0.957	32.5	2070
6	617.0	0.971	0.959	33.8	-605
7	679.0	0.946	0.961	33.8	1816
8	847.0	0.976	0.963	34.3	2646
9	790.5	0.975	0.966	35.3	2765
10	723.0	0.972	0.971	36.6	5595
11	855.5	0.975	0.975	37.8	8552
12	852.5	0.971	0.975	38.0	12015
13	862.5	0.980	0.976	38.3	16015
14	1033.0	0.981	0.980	39.0	22553
15	1041.0	0.985	0.982	40.2	27811
16	909.0	0.981	0.983	41.5	29089
17	858.5	0.988	0.983	43.1	31169
18	803.5	0.991	0.984	44.3	34043
19	799.0	0.985	0.987	44.7	43230
20	817.5	0.993	0.988	45.6	49081
21	746.5	0.980	0.985	46.5	40065
22	696.0	0.987	0.982	47.0	43855
23	639.5	0.979	0.981	47.6	45324
24	586.5	0.986	0.981	48.2	52667
25	535.5	0.993	0.982	48.8	58823
26	454.0	0.982	0.979	49.8	60519
27	400.5	0.983	0.975	51.0	60831
28	320.5	0.966	0.976	51.7	67953
29	254.5	0.968	0.974	52.6	72230
30	255.5	0.969	0.976	53.1	79563
31	268.5	0.914	0.936	53.4	8211
32	216.5	0.912	0.891	54.3	2022
33	167.0	0.886	0.854	55.1	-15033
34	146.5	0.809	0.856	55.7	-13937
35	100.5	0.841	0.846	56.8	-17326
36	51.5	0.864	0.840	57.6	-20431
37	32.5	0.846	0.829	57.6	-24623
38	29.0	0.931	0.844	58.7	-19056
39	26.0	0.865	0.835	59.6	-22287
40	22.5	0.867	0.840	60.2	-20672
41	16.5	0.818	0.838	61.1	-21224
42	6.5	0.692	0.836	62.7	-21991
43	3.0	0.667	0.831	63.3	-24132
	22960.0				

Table A-3

Model Results Using FY82 Data and 15 Percent Discount Rate

LOS	AVERAGE STRENGTH	RETENTION RATE	PREDICTED RETENTION RATE	AVERAGE AGE	COL 15%
1	1234.5	0.937	0.925	27.0	-4182
2	1002.5	0.928	0.935	28.3	-3692
3	768.0	0.932	0.941	29.5	-3563
4	749.5	0.960	0.949	31.2	-3878
5	741.5	0.941	0.956	32.5	-3230
6	617.0	0.971	0.960	33.8	-3711
7	679.0	0.946	0.961	33.8	-2983
8	847.0	0.976	0.963	34.3	-2936
9	790.5	0.975	0.966	35.3	-3289
10	723.0	0.972	0.971	36.6	-1785
11	855.5	0.975	0.974	37.8	-1157
12	852.5	0.971	0.977	38.0	-639
13	862.5	0.980	0.978	38.3	483
14	1033.0	0.981	0.979	39.0	1972
15	1041.0	0.985	0.981	40.2	4364
16	909.0	0.981	0.982	41.5	4910
17	858.5	0.988	0.983	43.1	5444
18	803.5	0.991	0.984	44.3	6727
19	799.0	0.985	0.986	44.7	9820
20	817.5	0.993	0.988	45.6	13729
21	746.5	0.980	0.987	46.5	11157
22	696.0	0.987	0.983	47.0	12735
23	639.5	0.970	0.981	47.6	13981
24	586.5	0.986	0.981	48.2	17492
25	535.5	0.993	0.980	48.8	21528
26	454.0	0.982	0.977	49.8	23726
27	400.5	0.983	0.973	51.0	27220
28	320.5	0.966	0.975	51.7	34435
29	254.5	0.988	0.973	52.6	39637
30	255.5	0.969	0.976	53.1	47074
31	268.5	0.914	0.913	53.4	3750
32	216.5	0.912	0.898	54.3	716
33	167.0	0.886	0.867	55.1	-9097
34	146.5	0.809	0.858	55.7	-11749
35	100.5	0.841	0.844	56.8	-15390
36	51.5	0.864	0.833	57.6	-16135
37	32.5	0.846	0.824	57.6	-20226
38	29.0	0.931	0.826	58.7	-19772
39	26.0	0.885	0.813	59.6	-22635
40	22.5	0.867	0.813	60.2	-22609
41	16.5	0.818	0.811	61.1	-23172
42	6.5	0.692	0.808	62.7	-23855
43	3.0	0.667	0.802	63.3	-25084
	22960.0				

Table A-4

FY82 Model Validation on FY81 Data

LOS	AVERAGE STRENGTH	RETENTION RATE	PREDICTED RETENTION RATE	AVERAGE AGE	CUL
1	958.5	0.900	0.935	27.9	-1860
2	739.5	0.915	0.939	28.4	-736
3	673.0	0.949	0.946	29.6	-293
4	682.0	0.956	0.953	31.3	-520
5	591.0	0.936	0.959	32.7	329
6	657.5	0.962	0.961	32.9	752
7	872.5	0.955	0.962	33.2	1295
8	803.0	0.953	0.966	34.4	1933
9	731.0	0.951	0.970	35.7	1634
10	866.5	0.963	0.974	36.7	4603
11	865.5	0.972	0.976	37.1	5265
12	880.5	0.981	0.97[illegible]	37.3	7440
13	1060.5	0.975	0.981	38.1	9984
14	1064.5	0.976	0.982	39.2	11911
15	913.5	0.987	0.984	40.6	15492
16	867.0	0.984	0.985	42.2	16159
17	821.0	0.983	0.986	43.3	17652
18	818.5	0.993	0.987	43.8	23027
19	839.0	0.983	0.989	44.8	26640
20	767.0	0.991	0.990	45.7	30837
21	718.5	0.978	0.989	46.1	27350
22	662.0	0.983	0.985	46.9	29149
23	603.5	0.982	0.985	47.4	33925
24	545.0	0.978	0.985	47.9	38137
25	463.5	0.981	0.983	49.1	40090
26	419.5	0.979	0.980	50.2	42122
27	340.0	0.971	0.980	50.9	49078
28	263.5	0.970	0.977	51.8	51123
29	263.5	0.976	0.977	52.5	56190
30	303.0	0.977	0.981	52.8	68136
31	240.5	0.825	0.912	53.5	7932
32	201.0	0.886	0.895	54.3	2006
33	189.0	0.735	0.868	55.1	-8772
34	123.0	0.707	0.864	56.1	-10181
35	71.0	0.718	0.851	56.6	-14516
36	44.0	0.614	0.851	57.0	-14555
37	39.5	0.620	0.842	57.6	-17124
38	33.5	0.493	0.835	58.7	-19224
39	28.0	0.750	0.831	59.5	-20596
40	22.5	0.778	0.830	60.4	-20710
41	11.0	0.818	0.827	61.8	-21735
42	3.5	1.000	0.826	62.4	-21879
43	1.0	1.000	0.823	63.0	-22895
	=======				
	22066.0				

Table A-5

FY82 Model Validation on FY80 Data

LOS	AVERAGE STRENGTH	RETENTION RATE	PREDICTED RETENTION RATE	AVERAGE AGE	COL
1	714.0	0.891	0.935	27.7	-965
2	660.0	0.913	0.940	28.3	520
3	602.0	0.920	0.948	29.8	560
4	533.5	0.931	0.955	31.5	752
5	659.0	0.941	0.958	31.9	2332
6	875.5	0.944	0.960	32.3	2405
7	842.5	0.957	0.964	33.3	2666
8	770.5	0.965	0.969	34.8	3351
9	923.5	0.977	0.972	35.7	4849
10	902.0	0.972	0.975	36.1	7725
11	922.5	0.970	0.977	36.2	9991
12	1118.5	0.979	0.982	37.0	12553
13	1106.0	0.971	0.983	38.3	14067
14	956.0	0.976	0.984	39.7	17327
15	902.5	0.982	0.986	41.3	20051
16	851.5	0.984	0.986	42.5	20990
17	851.0	0.982	0.988	42.9	26107
18	870.5	0.994	0.989	43.9	30066
19	793.5	0.992	0.990	44.9	33518
20	758.5	0.988	0.991	45.3	37513
21	694.5	0.977	0.991	45.9	34231
22	630.5	0.985	0.989	46.7	38515
23	579.5	0.981	0.989	47.1	42271
24	497.5	0.978	0.986	48.3	44194
25	449.0	0.976	0.984	49.4	46795
26	367.5	0.959	0.984	50.2	52312
27	289.0	0.976	0.982	51.0	54034
28	286.0	0.951	0.980	51.8	55892
29	327.0	0.972	0.984	52.1	68515
30	289.0	0.962	0.982	53.2	72391
31	246.0	0.743	0.911	53.8	9271
32	253.5	0.751	0.894	54.5	1597
33	182.0	0.588	0.875	55.6	-6175
34	108.0	0.417	0.871	56.1	-7714
35	75.5	0.417	0.864	56.5	-10102
36	70.0	0.286	0.860	56.8	-11399
37	64.5	0.480	0.845	57.8	-16275
38	53.0	0.208	0.834	58.8	-19674
39	42.5	0.082	0.835	59.9	-19353
40	21.0	.	.	60.6	-19983
41	7.5	.	.	61.7	-20355
42	3.0	.	.	62.5	-20474
43	1.5	.	.	62.0	-23653
	=======				
	22150.5				


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