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STUDIES OF OBLIGATION AND EXPENDITURE RATES
AT THE AIR FORCE HUMAN RESOURCES LABORATORY

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July 1988

Final Technical Paper for Period October 1986 - September 1987

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LABORATORY

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HERBERT J. CLARK, Director
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REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1a REPORT SECURITY CLASSIFICATION Unclassified			1b RESTRICTIVE MARKINGS		
2a SECURITY CLASSIFICATION AUTHORITY			3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b DECLASSIFICATION/DOWNGRADING SCHEDULE					
4 PERFORMING ORGANIZATION REPORT NUMBER(S) AFHRL-TP-88-26			5 MONITORING ORGANIZATION REPORT NUMBER(S)		
6a NAME OF PERFORMING ORGANIZATION Special Projects Office		6b OFFICE SYMBOL (if applicable) AFHRL/SA		7a NAME OF MONITORING ORGANIZATION	
6c ADDRESS (City, State, and ZIP Code) Air Force Human Resources Laboratory Brooks Air Force Base, Texas 78235-5601			7b ADDRESS (City, State, and ZIP Code)		
8a NAME OF FUNDING/SPONSORING ORGANIZATION Air Force Human Resources Laboratory		8b OFFICE SYMBOL (if applicable) HQ AFHRL		9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c ADDRESS (City, State, and ZIP Code) Brooks Air Force Base, Texas 78235-5601			10 SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO	PROJECT NO 9983	TASK NO 04
			WORK UNIT ACCESSION NO 51		
11 TITLE (Include Security Classification) Studies of Obligation and Expenditure Rates at the Air Force Human Resources Laboratory					
12 PERSONAL AUTHOR(S) Clark, H.J.; Koplyay, J.B.					
13a TYPE OF REPORT Final		13b TIME COVERED FROM Oct 86 TO Sep 87		14 DATE OF REPORT (Year, Month, Day) July 1988	
15 PAGE COUNT 14					
16 SUPPLEMENTARY NOTATION					
17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
05	01				
12	04				
19 ABSTRACT (Continue on reverse if necessary and identify by block number)					
This paper describes the development and application of a mathematical model used to forecast the monthly rates of obligating and expending funds at the Air Force Human Resources Laboratory during FY87. It also reports the effects of increased management attention on the rates of obligating and expending funds during FY87. Results indicate that obligations and expenditures can be accurately predicted using mathematical modeling based on historical data, and that management attention may have increased the rates of obligating and expending funds, but not the total obligations and expenditures for the year.					
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS			21 ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a NAME OF RESPONSIBLE INDIVIDUAL Nancy J. Allin, Chief, STINFO Office			22b TELEPHONE (Include Area Code) (512) 536-3877		22c OFFICE SYMBOL AFHRL/TSR

July 1988

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Distribution/	
Availability Codes	
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A-1	

Reviewed and submitted for publication by

Herbert J. Clark, Director
Special Projects Office

SUMMARY

This paper describes the development and application of a mathematical model used to forecast the monthly rates of obligating and expending funds at the Air Force Human Resources Laboratory during FY87. It also reports the effects of increased management attention on the rates of obligating and expending funds during FY87.

Results indicate that obligations and expenditures can be accurately predicted using mathematical modeling based on historical data, and that management attention may have increased the rates of obligating and expending funds, but not the total obligations and expenditures for the year.

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STUDIES OF OBLIGATION AND EXPENDITURE RATES
AT THE AIR FORCE HUMAN RESOURCES LABORATORY

STUDY 1. FORECASTING OBLIGATION AND EXPENDITURE RATES

Each fiscal year, the Air Force Human Resources Laboratory (AFHRL) is required to submit forecasts of obligations and expenditures to Headquarters, Air Force Systems Command (HQ AFSC). These forecasts are submitted by program element for each month of the fiscal year. Traditionally, the forecasts have been subjective estimates made by budget officers based on past experience and on information received from AFHRL divisions.

In early 1987, AFHRL developed an algorithm to estimate obligation and expenditure rates. The advantages of an algorithm compared to subjective estimates were assumed to be the following:

1. The algorithm can provide forecasts which are at least as accurate as those made by a budget analyst.
2. An experienced program analyst is not required in order to make the forecasts.
3. Computer-based data can be easily tracked and analyzed, and a mathematical model can be more easily modified during the fiscal year in response to budget perturbations.
4. Computer-based data can be accessed quickly by Laboratory personnel through the Human Resources Management Information System (HRMIS), a data base available to each Division and Staff Office of the Laboratory.

This paper describes the characteristics of the algorithm and provides an assessment of its accuracy in predicting obligation and expenditure rates for FY87.

Method

Data

The data consisted of obligation and expenditure data for each month of FY86 and the first four months of FY87 by program elements 61101F, 61102F, 62205F, 62703F, 63106F, 63227F, 63704F, and 63751F. Program element 63248F (\$500K) was included in total obligations and expenditures, but predictive equations were not developed for it, because the funds were spent at one point in time rather than over a period of time.

Approach

Using the obligation and expenditure data (in dollars) from October 1985 through January 1987, a proportional probabilistic mathematical model was developed to predict the FY87 obligation and expenditure rates. Separate analyses were performed for total obligations, for total expenditures, and for the obligations and expenditures of each program element listed above. The resulting third degree polynomials yielded the weights by which the remaining FY87 obligations and expenditures were predicted.

Results and Discussion

The correlation matrix at Table 1 shows that the equations provided highly accurate predictions for FY87. The Pearson Product Moment correlation coefficients between actual and predicted obligations for FY87 ranged from .940 to .997. The correlations between actual and predicted expenditures ranged from .947 to .989. The equations developed for each program element are shown in Table 2 and Table 3.

Table 1. Correlations: Actual versus Predicted
Obligations (OBL) and Expenditures (EXP)

Program element	BA ^a	OBL	EXP
61101F	938.0	.997	.976
61102F	1,030.0	.985	.959
62205F	23,244.0	.994	.989
62703F	8,019.0	.994	.982
63106F	11,392.0	.985	.988
63227F	4,041.0	.964	.953
63704F	1,431.0	.977	.989
63751F	1,809.0	.940	.947
63248F	500.0	N/A	N/A
OVERALL	52,404.0	.997	.995

^aBudget Authorization in \$K.

Table 2. Regression Equations for Predicting FY87 Obligations

Program element	Regression equation ^a
61101F	$22.984 - 22.826X + 5.184X^2 - 0.233X^3$
61102F	$- 8.704 + 18.839X - 1.283X^2 + 0.036X^3$
62205F	$-16.175 + 15.566X - 0.558X^2 + 0.001X^3$
62703F	$- 0.661 + 13.527X - 0.678X^2 + 0.019X^3$
63106F	$17.688 + 19.105X + 5.573X^2 - 0.287X^3$
63227F	$-30.504 - 19.126X + 0.011X^2 - 0.061X^3$
63704F	$3.939 - 10.480X + 4.137X^2 - 0.221X^3$
63751F	$-38.252 + 29.490X - 2.314X^2 + 0.067X^3$
OVERALL	$- 7.181 + 7.241X + 0.923X^2 - 0.070X^3$

^aAll coefficients are rounded to three decimal accuracy.

In Table 2 the predictor X is the number of the fiscal month; e.g., X = 1 for October 86, X = 6 for March 87, etc. The criterion or predicted value is the cumulative percent obligated by the end of a given fiscal month. For example, for X = 6 (March 87) the TOTAL percent obligation was $- 7.181 + 7.241(6) + 0.923(6)^2 - 0.070(6)^3 = 54.43\%$. Table 3 is interpreted in the same manner.

Table 3. Regression Equations for Predicting FY87 Expenditures

Program element	Regression equation^a
61101F	- 0.354 + 0.720X - 0.217X ² + 0.016X ³
61102F	- 1.585 - 3.747X - 1.072X ² - 0.038X ³
62205F	- 0.285 + 0.234X + 0.369X ² - 0.004X ³
62703F	- 0.743 + 3.625X - 0.107X ² + 0.023X ³
63106F	- 0.949 + 2.730X - 0.829X ² + 0.071X ³
63227F	- 0.818 - 2.388X + 0.733X ² - 0.024X ³
63704F	0.386 - 1.044X + 0.312X ² - 0.008X ³
63751F	- 0.230 + 0.208X + 0.074X ² + 0.028X ³
OVERALL	- 0.098 + 0.961X + 0.062X ² + 0.015X ³

^aAll coefficients are rounded to three decimal accuracy.

The results show that monthly obligations and expenditures can be accurately predicted using mathematical modeling based on historical data. The accuracy of the equations compared to budget analyst forecasts could not be assessed, however, because the budget analysts did not develop forecasts for FY87. It was also found that the computer-based data could be more easily tracked, and the equations could be more easily modified in response to budget perturbations. All laboratory divisions wanted access to the data through HRMIS.

As more historical data accumulate, more sophisticated analyses will be used to increase the accuracy and predictive stability of the equations. Some analyses yet to be explored include Box Jenkins Time Series Analysis, using autoregressive/moving average models to account for seasonal effects and the suspected periodic nature of the data; quadruple exponential smoothing; and various polynomial fittings. It is anticipated that given sufficient data points (50 or more), a highly reliable predictive algorithm can be developed and used as an important management tool in estimating fiscal obligations and expenditures.

STUDY 2. THE EFFECTS OF INCREASED MANAGEMENT ATTENTION ON OBLIGATION AND EXPENDITURE RATES

At the same time the algorithm was being developed, HQ AFSC placed increasing emphasis on obligating and expending funds as quickly as possible. The goals levied on all AFSC Laboratories were to obligate all funds, and to expend approximately 50% of all funds allocated to each program element, during the fiscal year in which the funds were appropriated.

To meet these goals, AFHRL took the following actions:

1. Purchase requests (PRs) submitted to Headquarters AFHRL were tracked on a daily basis, and the status of planned versus actual PR submissions was announced weekly at the Commander's Staff meeting. The increased management attention was intended to result in more timely PR submissions and subsequent faster rates of contract obligation and expenditure.

2. Division task scientists and program officers were directed to frequently track expenditures and ensure that contractors were billing promptly. This action was to be taken in coordination with the Aeronautical Systems Division (ASD) procurement office at Wright-Patterson AFB, Ohio, and was expected to increase the rate of contract expenditures.

3. At the Commander's direction, monthly teleconferences were held with all AFHRL Divisions and the ASD procurement office so that the obligation status could be reviewed for each AFHRL purchase request. Approximately three such meetings were held in 1987 and then discontinued. The teleconferences appeared to significantly improve communications between procurement and all AFHRL Divisions and Staff Offices.

4. The Plans and Operations Office at HQ AFHRL was directed to reduce the number of authorizations for forward financing and was also directed to reallocate funds which were not obligated as planned. This was often a difficult task to execute, since there was often no place to reallocate funds other than to task order contracts where the money would be obligated quickly, but not necessarily effectively. Consequently, some funds were returned to AFSC. In practice, funds reallocation and voluntary return of funds to AFSC occurred infrequently. Only \$250K was voluntarily returned to AFSC in 1986. Those funds were reprogrammed to AFHRL in 1987.

Results and Discussion

The effect of these management actions was examined by comparing the FY86 obligation and expenditure rates with the FY87 rates. Figures 1 and 2 show the results. Obligations and expenditures occurred earlier in FY87 than in FY86, and it appears that the increased management attention may have contributed to that effect. Total obligations and expenditures for FY86 and FY87 were essentially the same, however. FY86 obligations were 94.52% and FY87 obligations were 92.86%; FY86 expenditures were 40.60% and FY87 expenditures were 42.05%. The budget authorization for FY86 was \$50.054M, and for FY87 it was \$52.404M. Other factors which could have affected the rates of obligation and expenditure, and total obligations and expenditures, were: number of new start contracts versus incremental contracts; amount of money transferred to other organizations; and amount of money placed on task order contracts. Among those factors studied, early submission of PRs seemed to have had the greatest effect on increasing obligation and expenditure rates.

CONCLUSIONS

STUDY 1. Obligations and expenditures can be quite accurately predicted using mathematical modeling based on known past data points. Forecasting by mathematical model is less difficult, less time-consuming, and possibly more accurate than forecasting without the aid of a mathematical model. Refinements to the model are planned as additional data accumulate.

STUDY 2. Increased management attention on obligation and expenditure rates during FY87 appears to have increased the rate at which funds were obligated and expended during FY87 compared with FY86. However, total dollars obligated and expended at the end of FY87 were essentially the same as they were at the end of FY86. Although the management initiatives apparently did not increase total obligations and expenditures compared to FY86, they do demonstrate good business practice and, if continually applied, may eventually have a positive effect.

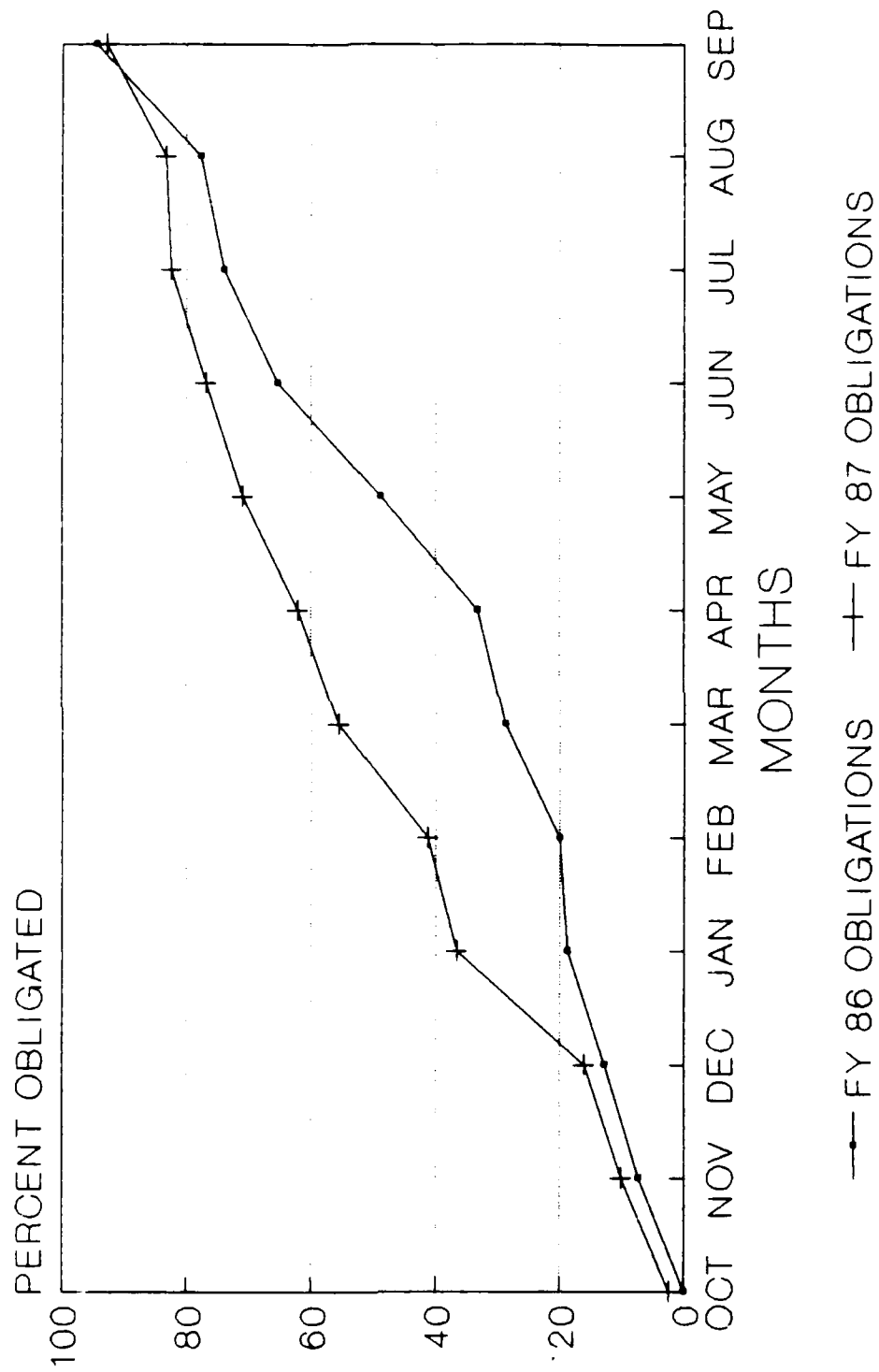


Figure 1. FY86-87 Obligations.

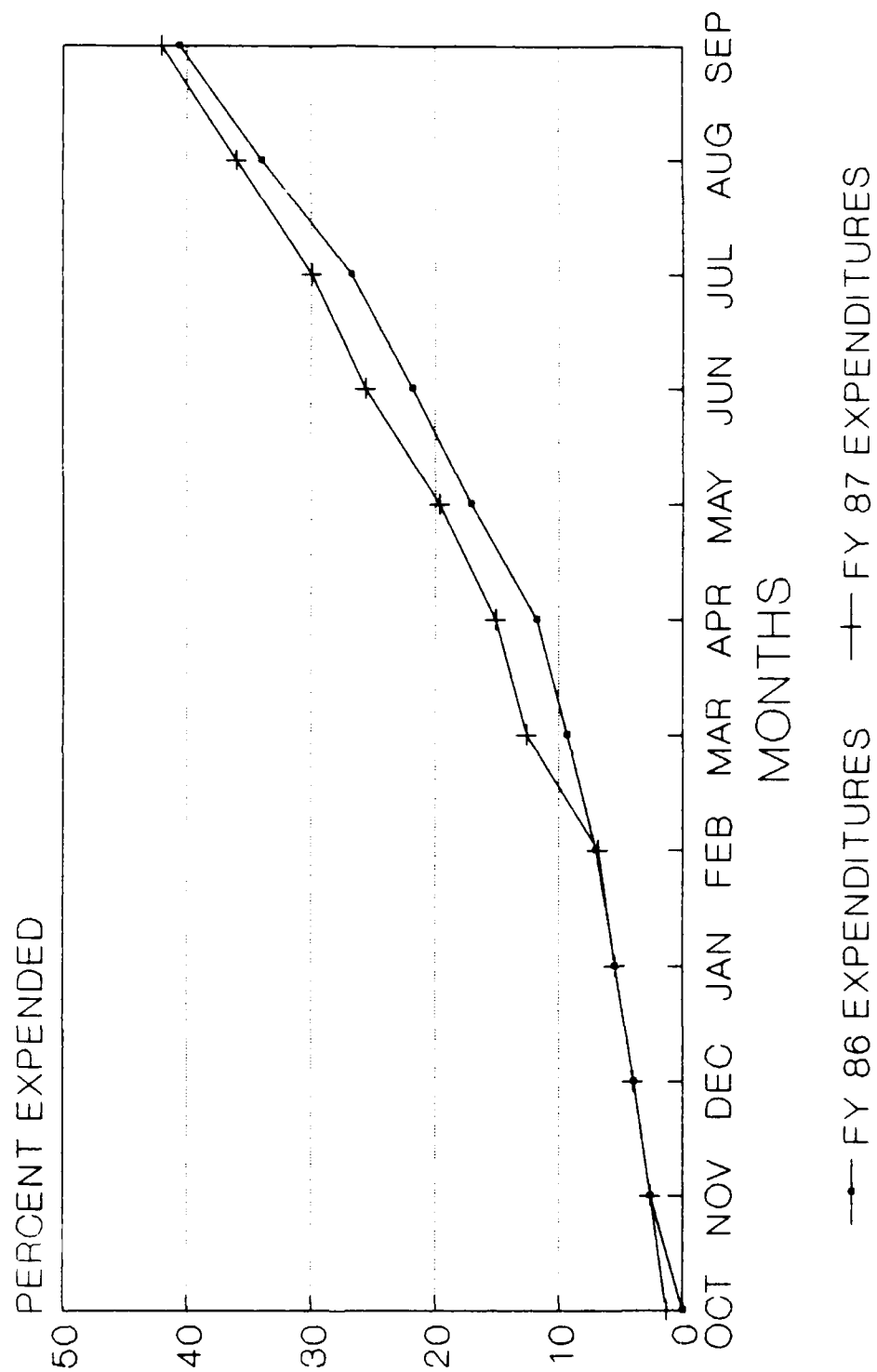


Figure 2. FY86-87 Expenditures.