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Management Analysis: A Mathematical Model for Determining the Staffing Requirements of a Forensic Science Laboratory System

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ABSTRACT: A staffing model was developed for use by the U.S. Army Criminal Investigation Laboratory Command in determining the number of personnel required to staff the 15 technical divisions of its three forensic science laboratories adequately. Regression analysis was used to develop formulas for predicting the number of technical man-hours required to process a predicted evidence work load. Techniques were adopted for estimating the requirements for nontechnical man-hours. A forecasting system was designed to project future work load requirements. The model links these components to predict manpower requirements based upon year-to-year changes in case submissions.

KEYWORDS: forensic science, laboratories, management, linear regression, data collection, mathematical model, personnel requirements, personnel resources, productivity, regression analysis, reliability, staffing model, statistics, work load

Many difficult tasks of management involve personnel resources. Most of these tasks can be summarized as follows:

(*a*) determining the number of personnel required to accomplish the work load,
(*b*) obtaining the required personnel, or as many of them as possible, and
(*c*) using the personnel available in the most effective and efficient manner.

Government forensic science laboratories receive their authorizations for hiring personnel from higher levels. They compete with other agencies for the limited authorizations available. The distribution of these personnel authorizations is determined by a negotiation process following this general description:

(*a*) How many people do you need to do the job?
(*b*) That seems high—what is the basis for that estimate?
(*c*) If you don't get that many, what will happen?
(*d*) You can't have as many as you need—do the best you can with this smaller number.

The manager who can provide firm answers to the questions posed during this process is at a significant advantage over the competing manager who cannot. The manager who

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can provide firm answers also has learned a great deal about his or her organization and is more likely to be using the available personnel efficiently. Such a manager knows:

(*a*) how to measure the work load and how to forecast future work load demands,
(*b*) how to measure productivity, and
(*c*) how to estimate the number of man-hours required to achieve a certain level of productivity.

This knowledge can be obtained by data collection and mathematical modeling. In large businesses, this is the task of industrial engineers and operations research specialists. Although mathematical modeling is not new, there is a lack of literature on its application to the forensic science laboratory.

This paper describes the result of applying mathematical modeling to determine the staffing requirements of the technical divisions of the U.S. Army Criminal Investigation Laboratories (USACIL). The only reference available which describes the construction of staffing models has been Army Regulation 570-5. Army Regulation 570-5 is the basic reference document of the Army Manpower Staffing Standards System.

Throughout this paper, examples of the modeling process as it relates to the Firearms Division of the U.S. Army Criminal Investigation Laboratory at Fort Gillem, Georgia will be presented. This study resulted in a laboratory system model which consists of submodels for 15 divisions.

Management Environment

The USACIL is a subordinate unit of Headquarters, U.S. Army Criminal Investigation Command (HQUSACIDC), located in Washington, DC. The USACIL operates three forensic science laboratories: USACIL–CONUS at Fort Gillem, Georgia; USACIL–Europe in Frankfurt, West Germany; and USACIL–Pacific at Camp Zama, Japan. Each laboratory contains five technical divisions: Chemistry Division, Latent Prints Division, Questioned Documents Division, Firearms Division, and Photography Division. The Chemistry Division contains three branches: Trace Evidence, Drugs, and Serology.

The technical staff of the divisions consists of military personnel, who are special agents of the USACIDC, and civilian scientists and technicians. The staff of the Firearms Division of USACIL–CONUS is comprised of military personnel.

The civilian work forces of USACIL–Europe and USACIL–Pacific include citizens of the United States and local national personnel. United States citizens are employed through the federal civil service system. Local national personnel are employed under agreements between the United States government and the host governments. These agreements specify working hours, holidays, sick leave entitlements, and so forth. Military employees are subject to policies and guidelines of the U.S. Department of the Army and its chain of command. These policies include requirements for military-related training, such as weapons qualification, the military code of conduct, and physical fitness.

Data Collection

The Resource Management Division of HQUSACIDC designed and initiated a data collection program. Employees in the technical divisions completed a time sheet each day, recording the time spent in each of 16 categories. The division supervisors combined the data and reported them by four-week periods. Each report reflected the total number of hours spent by the employees in each of the 16 categories. The division chiefs reviewed the data recorded by the Resource Management Division twice during the data collection effort to verify their accuracy.

The division supervisors reported the number of actions completed and exhibits processed during every four-week period. An action was a case, or part of a case, completed in a division of the laboratory. Cases requiring work in several divisions were counted as an action in each division. An exhibit was generally defined as an item of evidence examined. The definition of an exhibit varied from one division to the next. Definitions were determined in advance to ensure that all related divisions counted exhibits, actions, and hours in the same fashion.

Model Concept

The measurable output of a crime laboratory consists of the number of actions completed and the number of exhibits processed. The cost of this output, in terms of personnel resources, is the number of man-hours required for evidence analysis. The number required varies with the amount of evidence submitted or the number of actions requested, or both. To find out what these hours are, we must determine the mathematical relationships between the exhibits processed, the actions completed, and the hours required.

The man-hours expended which are not required to analyze evidence fall into three general categories: fixed requirements, variable requirements, and nonavailable time.

The man-hours required by the physical plant of the laboratory are fixed requirements. Man-hours associated with programs that are not expected to change in the short term are also fixed requirements for modeling purposes.

There are two categories of variable man-hour costs: those man-hours which vary with the case-load and those which vary with the size of the division. For example, time spent on court preparation varies with the number of cases worked. Time spent on management and supervision varies with the number of people managed and supervised. These categories are variable case-related man-hours and variable overhead.

Nonavailable time is that portion of an employee's time that is not available for accomplishing work because of leave, holidays, illness, training, or other reasons.

Man-Hour Requirements Determination

Estimating Evidence Analysis Hours

The data pertaining to analysis hours, exhibits processed, and actions completed were analyzed using a computer statistical program. Each four-week period in each division was treated as a single data point, and the data of the related divisions were combined. For example, the combination of the 13 data points from each of the 3 chemistry divisions yielded 39 data points for analysis.

Regression analysis techniques and data smoothing routines were used to develop prediction equations. These equations predict the number of evidence analysis hours required to complete a given number of actions and exhibits in each division. The formulas vary in complexity from simple linear regression equations to equations derived from the multiple regression of power curves.

Multiple linear regression provided the best prediction equation for the Firearms Divisions. The equation developed from the regression analysis of the Firearms Divisions' data is

$$\text{EAH} = (7.73 \times \text{actions}) + (0.27 \times \text{exhibits}) + 18.48$$

where

EAH = evidence analysis hours required,
actions = actions completed,
exhibits = exhibits processed, and
18.48 = a constant.

The R-squared statistic for this equation is 0.888. The R-squared statistic is a measure of how well the prediction equation fits the actual data; an R-squared statistic of 1.0 is a perfect fit. R-squared statistics for these analyses ranged from 0.888 for the Firearms Divisions' equation to 0.976 for the Chemistry Division equation.

Figure 1 depicts the fit of the Firearms Divisions' equation to the actual data. One line on the chart represents the number of evidence analysis hours reported in each period. The second line represents the number of hours predicted by the equation based upon the number of actions completed and exhibits processed during the period. The standard error is 20.4 h.

Several guidelines were adopted for the development of the regression equations. Negative coefficients, or multipliers, for the variables in the equations were avoided. The use of negative coefficients requires a high constant in the equation. Hours are subtracted for each unit of output required. Although they may be mathematically valid within the range of the data, negative coefficients are not logical. They might reduce the reliability of the model when making predictions outside the range of the original data.

Where possible, one equation was developed for all related divisions in the laboratory system. Different equations for related divisions were adopted only if two conditions were met. First, there had to be significant differences between the divisions, such as differences in major items of equipment, which would affect the work product or productivity. Second, there had to be an improvement in the ability of the equation to predict man-hour requirements for all the divisions. For a linear function, this could be shown by an increase in the slope and a reduction in the constant.

Linear equations consist of a constant and a slope. The equations in the model should have small constants and steep slopes. Equations with large constants and flat slopes predict requirements for large numbers of man-hours regardless of the number of actions

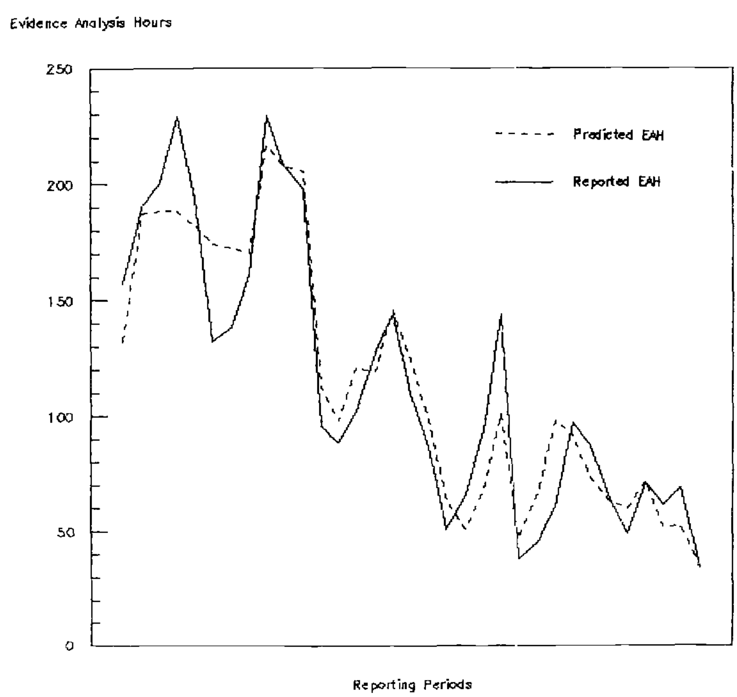

FIG. 1—*Fit of the regression equation for the Firearms Division of USACIL-CONUS.*

and exhibits to be worked. Ideally, the regression analysis will result in equations with positive coefficients, small constants, steep slopes, and high R-squared statistics.

Fixed Requirements Estimation

Fixed requirements will not vary significantly in the short term. Estimates of the fixed man-hour requirements per four-week period can be calculated as averages of the collected data. The hours reported in each of the categories were totaled and divided by 13, the number of reporting periods.

The USACIL–CONUS divisions provide initial certification training for all military personnel. The USACIL–CONUS Chemistry Division trains those civilians hired in the United States. The chemistry divisions of the overseas laboratories provide certification training for their local national employees and those U.S. civilians hired for overseas employment. The man-hours which must be available to provide this training were treated as a fixed requirement.

Certification training takes two years in most divisions. The number of people in training at any given time varies widely; therefore, the number of trainees in the laboratory during the data collection may not have represented the normal training situation. The average number of man-hours spent training new people, per trainee per four-week period, was calculated from the collected data. This was multiplied by the average number of trainees in the division for the previous five years. The result is the fixed requirement of having this training capability.

Table 1 depicts the result of these calculations for the USACIL–CONUS Firearms Division.

TABLE 1—*Results of fixed-requirements calculations for the USACIL–CONUS Firearms Division.*

Logistics and maintenance hours recorded	461.50
Field support training hours recorded	100.50
Crime scene response hours[a] recorded	56.00
Special projects hours recorded	440.00
Total hours recorded for fixed costs	1058.00
Divided by 13 periods	13.00
Average fixed man-hours per period	81.38
Total student training hours recorded	426.00
Divided by the number of student-periods[b] during the data collection effort	13.00
Average hours required per student period (A)	32.77
Number of student-periods in last 5 years	26.00
Divided by the number of periods in 5 years	65.00
Average number of students per period	0.04
Number of students the division must be able to train simultaneously (B)	1.00
Student training capability factor (A × B)	32.77

[a]Crime scene response hours were treated as a fixed requirement because of their small number. In laboratories with more crime scene responsibility, this category would be treated as a variable case-related cost.

[b]A student-period is when one student is trained for one four-week period. Two students present in the same period is counted as two student-periods.

Variable Requirements Estimation

Case-related man-hour costs, such as court time, vary with the number of actions processed. These costs are not always incurred in the same time period with the processing of the case. Evidence analysis man-hour costs also vary with the number of actions processed. Case-related man-hour requirements can be estimated as proportional to the evidence analysis man-hour requirements.

The hours reported for the year in the case-related categories were converted to percentages of the evidence analysis hours reported. These percentages were calculated separately for each division.

The variable overhead is estimated by a similar method. The number of man-hours reported in each time category was converted to a percentage of the total available hours reported. Table 2 gives the calculations for the USACIL–CONUS Firearms Division.

Work Load Forecasting

An estimate of staffing requirements obtained from collected data is an estimate of what the manpower should have been at the time the data were collected. To be useful, the model should estimate future, not past, staffing requirements.

The manpower model was developed using data collected during 1985 and 1986. Almost a year passed before the staffing model was completed. Man-hour data were not collected during the second year. However, data on the number of actions and exhibits received and processed were reported monthly.

A work load forecasting model was designed using exponential smoothing. An exponential forecasting model uses a multiplication factor, called alpha, which determines the responsiveness of the forecasting model to actual changes in work load from period to period. The alpha factor adopted for the USACILs is 0.5.

The alpha factor was selected based upon a computer simulation, which suggested that an alpha of 0.5 would be the best compromise between quick and slow responsiveness of the forecasts to changes in work load. Slow responsiveness to a change in work load will not allow changes in manpower requirements to be identified quickly enough for

TABLE 2—*Variable requirements estimation for the USACIL–CONUS Firearms Division.*

Variable case-related hours		
Total evidence analysis hours recorded	2374.00	
Quality assurance hours recorded	178.00	
As a percentage of the evidence analysis hours		7.5%
Court preparation hours recorded	187.50	
As a percentage of the evidence analysis hours		7.9%
Court appearance hours recorded	209.00	
As a percentage of the evidence analysis hours		8.8%
Variable overhead		
Total available hours recorded	8184.50	
Management and supervision hours recorded	710.50	
As a percentage of the total available hours		8.7%
Meetings and conference hours recorded	474.50	
As a percentage of the total available hours		5.8%

timely staffing adjustments to be made. This is important considering the bureaucratic process of bringing about such changes once the need has been identified. Too rapid responsiveness may cause unnecessary personnel turmoil since the model, and the personnel system, would respond to single-year quirks in the work load.

In the forecasting model, the data collection period is treated as the first year and as the forecast for the second year. The year following the data collection effort, Fiscal Year 1987 (FY87), is treated as the second year. The model multiplies the number of exhibits and actions received in the second year by 0.5. The model adds the result to the number obtained by multiplying (1 − 0.5) times the number of actions and exhibits forecast for the second year. The result is the work load forecast for the third year, Fiscal Year 1988. The forecasting calculations for the USACIL–CONUS Firearms Divisions are given in Table 3.

Total Man-Hour Requirements Calculation

An estimate of the total number of man-hours required for a division is obtained by completing the following six steps:

1. Obtain a work load forecast from the forecasting model.
2. Calculate an estimate of the evidence analysis hours requirement by plugging the work load forecast into the regression equation.
3. Calculate the case-related variable requirements by multiplying the proportions obtained from the collected data times the calculated evidence analysis hours requirement.
4. Add the previously calculated average fixed man-hour requirements, the case-related variable man-hour requirement from Step 3, and the evidence analysis hours requirement calculated in Step 2.
5. Add the variable overhead fractions calculated from the collected data. Then subtract this sum from 1 to obtain the fraction of the total man-hour requirements which is represented by all other categories of hours.
6. Calculate the total man-hour requirements, including the variable overhead, by dividing the sum from Step 4 by the fraction obtained in Step 5.

The man-hour requirements calculations for the USACIL–CONUS Firearms Division are presented in the worksheet in Table 4.

Figure 2 graphically depicts the man-hour requirements of the USACIL Firearms Divisions as a function of the average number of actions completed per four-week period. This graph is based upon the assumption that the completion of an action requires the processing of an average of 10.95 exhibits. This average is calculated by dividing the forecast number of exhibits (161.33) by the forecast number of actions (14.73).

TABLE 3—*Work load forecasting calculations for the USACIL–CONUS Firearms Division.*

	Actions	Exhibits
FY87 actual work load (A)	13.920	176.790
Alpha (0.5) × A = B	6.960	88.395
FY87 forecast work load (FY86 actual data) (C)	15.540	145.870
One minus alpha (1 − 0.5) × C = D	7.770	72.935
FY88 work load forecast (B + D)	14.730	161.330

TABLE 4—*Man-hour requirements calculations worksheet for the USACIL–CONUS Firearms Division.*

Constant		18.48
Actions to be processed per period	14.73	
Add actions multiplied by 7.73		113.86
Exhibits to be processed per period	161.33	
Add exhibits multiplied by 0.27		43.56
Total evidence analysis hours required (*A*)		175.90
Add fixed man-hour requirements per period		81.38
Add student training capability factor		32.77
Add quality assurance hours ($A \times 0.075$)		13.19
Add court preparation hours ($A \times 0.079$)		13.89
Add court appearance hours ($A \times 0.088$)		15.49
Total hours excluding variable overhead (*B*)		332.62
Proportion of total hours for		
Management and supervision	0.087	
Meetings and conferences	0.058	
Total variable overhead proportion	0.145	
One minus the variable overhead proportion (*C*)	0.855	
Total man-hour requirements ($B \div C$)		388.94

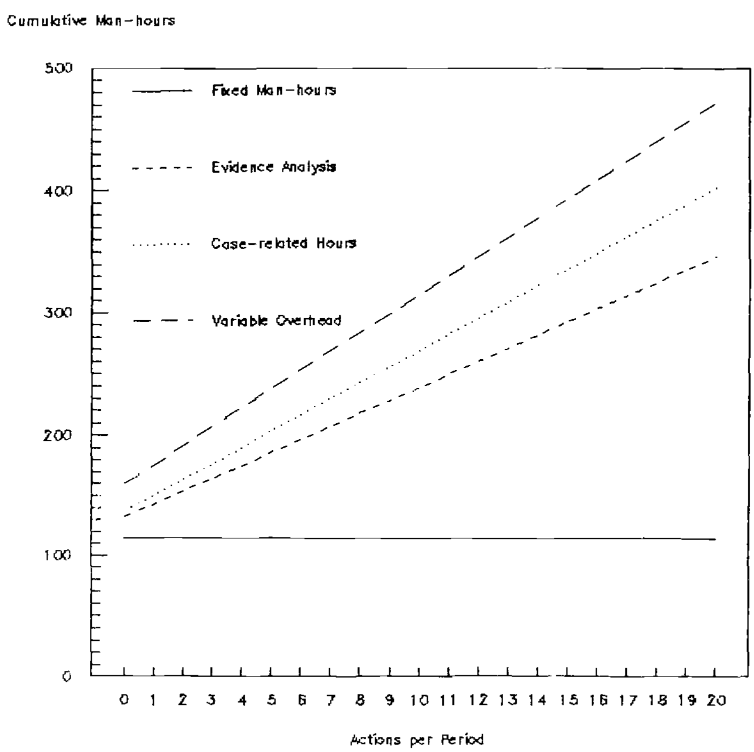

FIG. 2—*Man-hour requirements model for the USACIL–CONUS Firearms Division.*

Personnel Requirements Calculation

Personnel Availability Factors

The number of people required to staff a laboratory division is calculated by dividing the total man-hour requirements by the number of man-hours available per employee. If all employees have the same number of average hours available per period, this is easy. However, in the USACILs, particularly those overseas, this is sometimes complex.

The hours an employee is available to meet the calculated man-hour requirements of his division varies with the category of employment (for example, military, U.S. civilian working in the United States, U.S. civilian employed overseas, local national employee in West Germany, local national employee in Japan, and so forth).

Further classification of personnel as examiners and assistants and by divisions allows the use of management policies for training, research, and so on, which differ depending upon the degree of technical expertise of the employee and the division in which he or she works.

Man-hour availability factors were developed for each category and classification of employee. These factors include time for annual and sick leave, research, technical training, and nontechnical training. The development of these factors included historical data and standard availability factors for U.S. military and civilian personnel.

The staff of the USACIL–CONUS Firearms Division is military. There are no technical assistants or administrative personnel. The calculations for the availability factor applied to this division are given in Table 5.

TABLE 5—*Calculation of the availability factor for the USACIL–CONUS Firearms Division.*

Congressionally mandated work-year in hours		2087.00
Number of legal holidays	10.00	
Multiplied by the hours in a workday	8.00	
Holiday hours per year		80.00
Hours in a work-year after legal holidays		2007.00
Divided by the number of months in a year		12.00
Hours in a work-month after legal holidays		167.25
Nonavailable time (standard for Army manpower studies)		
Leave (nonmedical)	9.71	
Medical absence	3.61	
Ancillary training	3.64	
Organizational duties	3.36	
Miscellaneous	0.67	
Change of station-related hours	1.26	
Total nonavailable hours per month		22.25
Hours in a work-month less nonavailable hours		145.00
Multiplied by the number of months in a year		12.00
Total available hours in a work-year		1740.00
Divided by the number of reporting periods		13.00
Basis available hours in a reporting period (A)		133.85
Allocation of hours to research (B)	5.0%	
Hours allocated for research ($B \times A$)		6.69
Available hours after research allocation		127.15
Allocation of hours to technical training (C)	5.0%	
Hours allocated to technical training ($C \times A$)		6.69
Availability factor for the Firearms Division		120.46

The availability factor for military personnel is the same as that for U.S. civilians assigned to any division in USACIL–CONUS except the Chemistry Division. Military personnel are required to devote a portion of their duty time to physical fitness training. A personnel requirement add-on was developed to account for this. For each soldier assigned to a division, 0.09 personnel requirements are added to the calculation.

Personnel Requirements Calculation

Personnel requirements are calculated using the availability factor or factors which apply to the personnel in each division. Some divisions require the application of two or more factors. When more than one factor is used, personnel requirements can be calculated by one of several methods, such as the following:

1. Experiment with combinations of the factors to minimize personnel costs. For example, where there are two categories of employees in a division, estimate the smallest number of the most costly employees required to do the work. Subtract the total available hours for those employees from the total man-hour requirements. Divide the remaining hours by the availability factor of the less costly employee category to obtain the number of these employees required to do the remaining work.
2. As a more sophisticated version of Method 1, use the data obtained from the regression analysis in combination with availability factors, total man-hour requirements, and hourly pay charts for the employee categories to perform linear programming and constrained optimization calculations.
3. Subtract the total available hours of those employees whose employment can be considered "fixed" by virtue of contracts or other factors. Divide the remainder by the availability factor of the category of employees which are not "fixed" in numbers. This was the method used in the USACIL model.

Most methods of calculation result in fractional numbers. In the USACIL model, the fractions are rounded in compliance with the Fractional Manpower Break-Point Table required for Army manpower studies. This table allows an easy rounding of fractional personnel requirements. It does not, however, take into account the effect on the time it takes the average case to process through the laboratory by rounding down instead of up. Rounding down a fractional personnel requirement may have a significant impact on the average case processing time, especially in small work groups. Queueing equations or computer simulation techniques can be employed to estimate the effect of rounding before a final whole number of personnel requirements is determined.

As an alternative to rounding, the fractional personnel requirements can be adopted as calculated. An employee can work part-time in two divisions to meet the fractional personnel requirements in both. This is especially attractive when the employee concerned is a technical or administrative assistant whose duties do not require him or her to be expert in a forensic science specialty.

The staffing requirement calculations for the USACIL–CONUS Firearms Division are given in Table 6.

Assumptions

Four-week periods of data collection were used as data points in the development of the model. The man-hour requirements calculated from the model are for the average four-week period. This implies that, when staffed with the required number of personnel, actions submitted to the laboratory will be completed in an average of four weeks.

The model will respond to changes in man-hour requirements because of changes in

TABLE 6—*Staffing requirements calculations for the USACIL–CONUS Firearms Division.*

Total man-hour requirements (from Table 4)		388.94
Divided by the availability factor (from Table 5)		120.46
Personnel staffing requirements (A)		3.23
Physical training add-on factor per person (B)	0.09	
Physical training factor ($A \times B$)		0.29
Total U.S. military personnel requirements		3.52
Rounded per the Fractional Manpower Break Point Table		4.00

work load. It will not respond to changes in requirements because of changes in processing techniques or capabilities. The model should be revalidated periodically. To extend the use of the model pending revalidation, the management team can make interim adjustments to the model based upon estimates of the impact on the model of changes in the laboratory itself.

The use of standard availability factors and the use of combined data from related, but different, divisions make two important assumptions. They assume the work groups in the divisions are capable of working at the same average rate and that the work groups do the same work. A performance standard is established and applied equally to all the work groups.

Problems may arise if one group works at rate that is below average. This may occur where one group has a below-average experience level, if the analytical equipment of one division is different from that of the others, or if one division uses analytical techniques which are not used elsewhere. In these cases, variations on the regression equation can be created to account for institutional differences. This was required in the analysis of the USACIL Photography and Latent Prints Divisions.

Benefits of Modeling

A staffing model enables the laboratory manager to accomplish tasks which were previously difficult or impossible. These tasks include

(*a*) making reliable predictions of future demands for services;
(*b*) obtaining accurate estimates of current and future personnel requirements;
(*c*) distributing available personnel among the divisions for the following purposes:
   1. improving productivity,
   2. improving efficiency.
   3. meeting productivity priorities, and
   4. ensuring equity of work load and personnel distribution; and
(*d*) achieving cost savings by altering the "mix" of employee skill levels.

A staffing model is useful in making management policy decisions. Impact estimates for each of the alternatives can be developed by altering components of the model and recalculating the results.

The statistics and data which result from the modeling process can be used to develop add-on models. These may include the following:

(*a*) a queueing equation model to estimate the average time an action will wait to be worked depending on the number of people available;
(*b*) a computer simulation model connecting divisional models together to identify bottlenecks in the processing of multidivisional cases (simulation may also be used

to estimate the average processing time for multidivisional cases based upon the number of people available in each division); and

(*c*) linear programming and constrained optimization techniques to identify the best allocation of available personnel among the divisions.

Cyclical variations in work load can be studied using the data collected to develop the staffing model. Models of the work load cycles can be used in designing programs for cross-training personnel to ensure that work load peaks are met and nonproductive time is minimized.

The mathematical model establishes a performance standard for a division work group and defines the resources required to meet the standard. The actual performance of a work group can be judged against the standard and in consideration of the resources available. Exceptional performance can be detected and rewarded; below-standard performance can be investigated to determine the cause. Man-hour resources may not be allocated properly. The work group may not be adequately trained, equipped, or motivated to do the job.

Lessons Learned

Familiarity with both the techniques of modeling and the organization being studied is crucial. The detection of anomalies in data requires knowledge of the organization and its work. The development of methods to resolve the analytical problems produced by these anomalies requires knowledge of a variety of mathematical analysis techniques.

Mathematical modeling should not be attempted without a computer and the software capable of sophisticated statistical analysis. The software must be able to do a variety of regression analyses. It must allow for the internal transformation of the data with user-defined data smoothing and splicing routines or be able to access a spreadsheet program where these tasks can be done. The ability of the statistical software to present results in the form of graphs is very beneficial to the analyst.

Actions, exhibits, and all categories of time must be defined before any data are collected. Lack of coordination in the data-collection effort will cost many hours in producing a satisfactory model. Failure to coordinate the data collection can prevent the construction of a reliable model.

The completion of a complex action often requires the expenditure of evidence analysis hours over two or more four-week periods. The expenditure of these hours was reported as they were expended. The completion of the action was reported only once, in the period it was completed. This resulted in a mismatching of man-hour costs and productivity in the reported data. Evidence analysis hours reported in Period 1 may be inordinately high because many of the hours were spent on a complex action not completed until Period 2. Mathematical smoothing was used to minimize the effect of this mismatching. The data were smoothed using three-period moving averages or three-period weighted moving averages before regression analysis.

The model is most useful in day-to-day laboratory operations when it is built into computer spreadsheets. Rapid modification and recalculation of the model allows experimentation with the potential impact of policy decisions or work load changes.

Conclusions

The USACIL forecasting and staffing model has become one of the basic references for management policy and planning. Since it was adopted, it has been used regularly in management decision-making and in several special projects. The special projects included the following:

(*a*) development of an estimate of the impact on the laboratory system staffing requirements of a policy decision to remove certain categories of cases from the work load;
(*b*) development of an estimate of the impact on the laboratory system staffing requirements of the addition of DNA analysis capability,
(*c*) development of a contingency staffing plan for the reorganization of the laboratories if the United States becomes involved in an armed conflict, and
(*d*) development of an estimate of the impact on the staffing requirements of each division of a policy decision to increase the participation of the laboratories in the processing of certain types of crime scenes.

The model enabled the laboratory system commander to obtain an increase of almost 10% in the number of personnel requirements recognized by higher headquarters. The USACIL is the only organization within the U.S. Army Criminal Investigation Command with a reliable staffing model. The laboratory system enjoys a significant advantage in obtaining personnel authorizations to meet its requirements.

The usefulness of the model as a management tool has proven that it was worth the effort required for its development. Because of its success, plans for laboratory automation include specifications for routine data collection which make possible regular revalidation and continued use of the model.

Since the data used to develop the model are unique to the organization, the USACIL model cannot be applied directly to any other laboratory system. The same process, however, can be applied to the creation of models applicable to almost any organization, civilian or military.

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