PERSONNEL PLANNING FOR CPA FIRMS

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ABSTRACT

This paper describes two approaches to personnel planning for CPA firms. The problem faced by such firms is to maintain a reasonable distribution of ranks, to establish equitable promotion policies, and to have staff available to meet workloads. The approaches described are based on (1) tracing the cohort of existing employees forward in time in a simulation and (2) an aggregated Markov model. Detailed descriptions of the model are presented and preliminary results of applying the models are discussed.

INTRODUCTION

In spite of the frequent attention given to the formulation of accounting standards and to the adoption of appropriate auditing procedures the accounting profession and academia have given little study to the ways professional firms are operated and professional quality controlled. SAS #4 (AICPA, 1976) established general guidelines for quality control in a firm of independent auditors. Section 160.02 states that "complying with generally accepted auditing standards is a basic objective of every firm conducting an audit practice." To which section 160.03 adds

> "the considerations (that affect the quality of a firm's audit work) are interrelated. Thus, a firm's hiring practices affect its policies as to training. Training practices affect policies as to promotion. Practices in both categories affect policies as to the nature and extent of supervision. Practices as to supervision, in turn, affect policies as to training and promotion."

This paper deals with this thread of issues with emphasis on personnel planning and auditor career development.

A recent study (Vasarhelyi, 1978) surveyed the scheduling practices of large offices in CPA firms. It was found that career development and personnel planning are closely associated to staff scheduling. These issues, of significant importance to those interviewed, have received little if any attention in the accounting literature. All the firms surveyed (including 12 out of the 15 largest international CPA firms) had similar personnel career development paths. Four basic levels were found: staff assistants, seniors, managers and partners. A consistent shortage of seniors was identified with little formal attention given to the planning of staff level distribution.

This paper describes two analytic approaches to staff planning, one micro and one macro. In the micro approach individual staff members are traced through a simulated development process, whereas in the macro approach Markov chain methods are used to project long range staffing trends. The micro model (a cohort-based approach) is more appropriate for policy analyses relative to specific policy changes whereas the macro (Markov) approach is a better description of general trends.

The cohort and Markov approaches for manpower planning are not new. They have been used extensively in university faculty planning (see e.g. Grinold and Marshall (1976)). The specific models used here are based on the cohort model by Gray (1975) and the Markov models of Hopkins (1974) and Pittman and Gray (1974).

Of key importance in this paper is the concept of desired mix. CPA firms should, in terms of national policy, establish ratios of desired rank mix among their staff. This approach avoids the overstaffing (or understaffing) of jobs with overqualified or underqualified staff members and allows for optimal billing from both the firm's and the client's point of view. A firm too heavy with, say, partners will have either excessive unbillable partner time or unnecessary partner billing to particular clients. On the other hand senior understaffing implies less experienced and qualified auditors working at the client's location, with risk of losing the client.

The following sections of this paper present a detailed description of the two modeling approaches, a discussion of their application to accounting firms, and the key research steps necessary for empirical testing of the proposed models in CPA firms.

THE COHORT APPROACH

Next year's staff will differ from this year's. The larger the turnover in a CPA firm, the more considerable is this difference. Turnover usually has a very negative connotation and conventional cost-benefit analyses may well justify this feeling. On the other hand, it is these year-to-year differences in personnel that provide the opportunity for a firm to

- maintain organizational vitality and growth
- undertake new practice development initiatives
- maintain economic viability

in the face of

- changes in accounting and auditing standards
- inflation and the business cycle
- changing markets
- increasing competition
- changing nature of new staff

This section describes a policy-oriented personnel planning model that allows personnel managers to evaluate the effects of present and proposed polices on their firm's long-term future, and to select those policies that will result in shaping the composition of staff to meet the firm's objectives.

In brief, four interelated policy variables can be controlled directly:

- hiring, in terms of the rank, age, sex, race, and salary levels of new hirees
- promotion from one level to the next
- retirement, including the option of early or late retirement
- salary

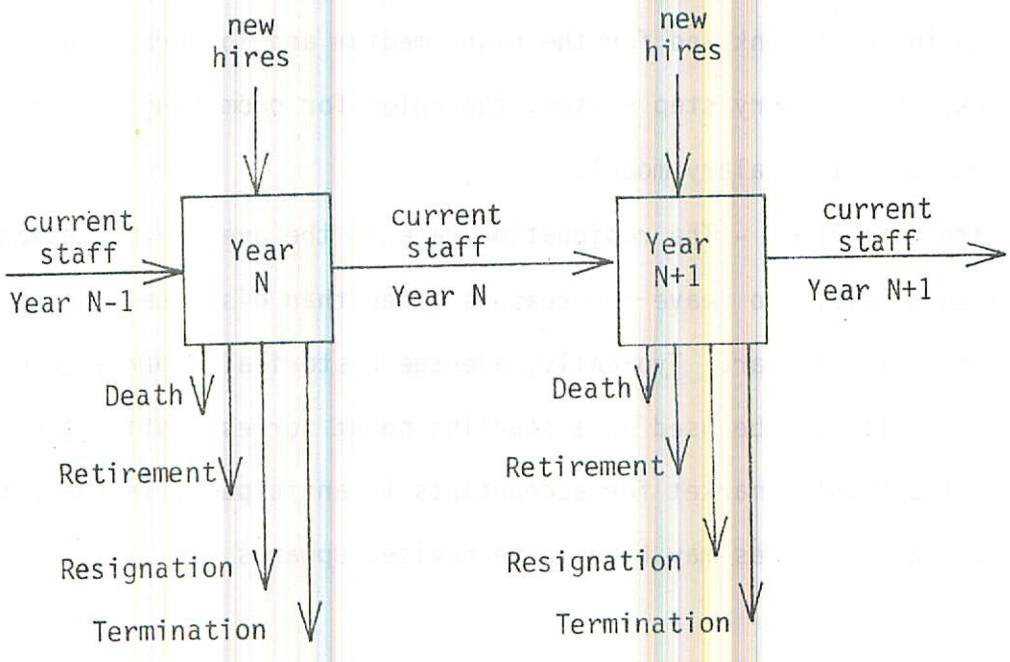
The model described here permits exploring the effects of these policy variables, individually or in combination, on the long term personnel structure of the firm. It begins with information about the characteristics (rank, age, salary, sex, race) of each staff member. It then traces these individuals forward in time, adding or dropping individuals according to policies set forth. The approach is that of a fixed-time interval simulation with a time interval such as one year (the choice of time interval depends on the frequency of turnover).

As shown in Figure 1, next year's staff is the same as this year's except for the addition of new hires and the losses through attrition and termination. Losses result from death, resignation (uncontrollable in the short term), retirement, and dismissal (controllable). In general:

next year's staff = continuing staff + hires - terminations

Figure 1

Staff Flow



As shown in Figure 2, the model requires two sets of inputs, one set representing the present and anticipated environment and the other the policies to be followed. The model traces the staff through the environment according to the policies specified and produces statistics on the implications of these policies over the time horizon.

Environmental Inputs

Staff Data Bank - The age, rank, salary level (see below), sex, over time worked, and department (division, area) is stored in a data file. For a large office, separate data files are provided for each of the major divisions (e.g. Audit, Small Business, Tax, MAS).

Mortality Tables - Mortality tables specify the probability of a male's dying this year given his current age. A factor of .58 corrects for the longer life expectancy of females.

Salary Structures - Several approaches are available for representing salary structure. In a merit system, regression lines are fitted to salaries as a function of age. Typically in this approach (Gray 1977) separate curves are fitted for each rank and for the high, medium and low groups within a given rank. In a salary step system, the rules for promoting from step to step are used in the salary model.

Resignation Rates - The resignation rate is the average percentage of staff at each level who leave for reasons other than dismissal, death or retirement during a year. Typically, average historical experience over a 5 or 10 year period can be used as a starting point for estimating these rates. However, if a tighter market for accountants is anticipated in the future, the historical estimates may have to be revised upwards.

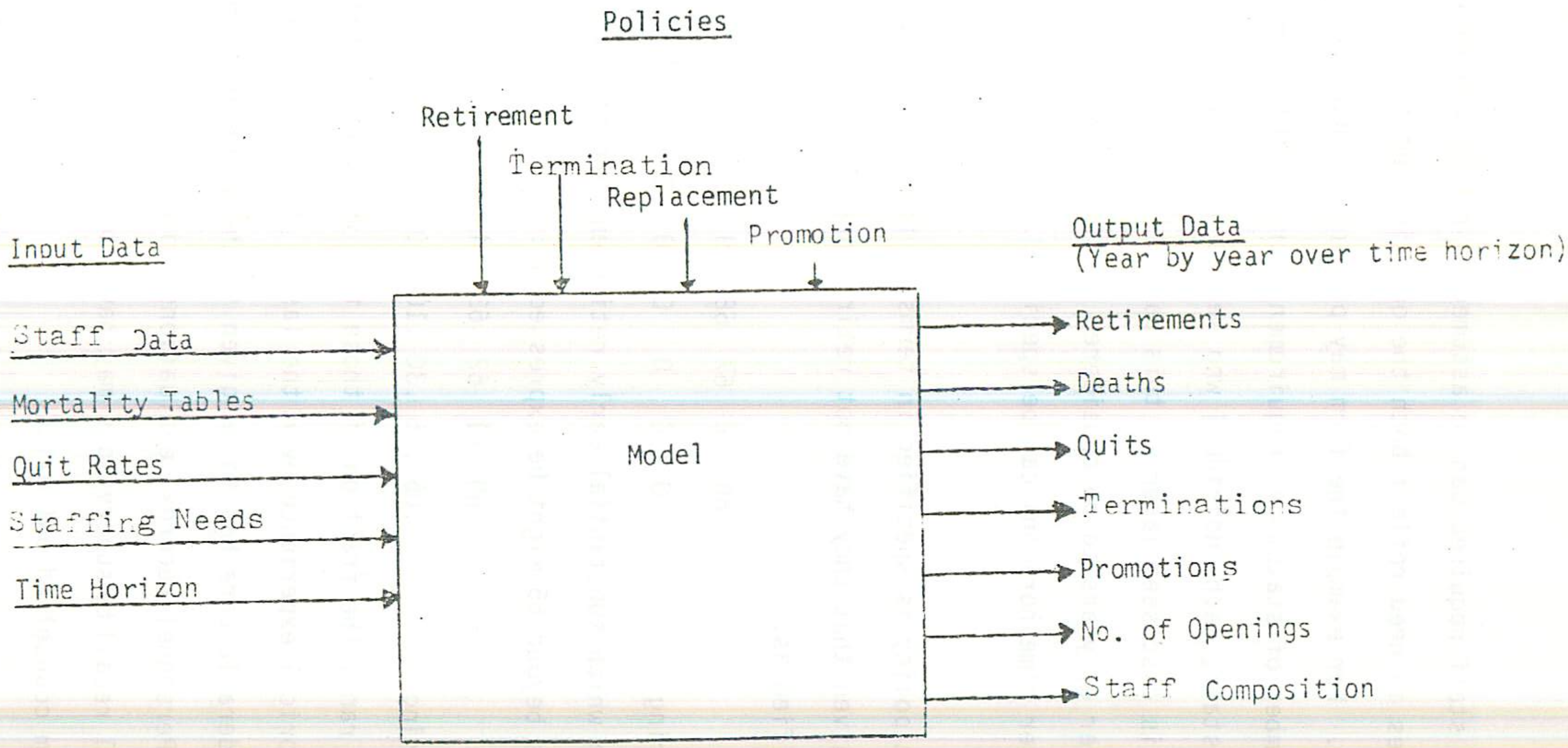


Figure 2 Basic Structure of the Cohort Model

Staff Needs - The total staff required can be assumed to remain constant over time or to vary. Changes in need reflect both the quantity and the types of work the firm anticipates. For example the firm may predict an increased client load, an increased number of statutory requirements or a combination of factors. For a constant staff, each individual who leaves is replaced. Modeling growth or decline, is discussed later in this paper.

Time horizon - the number of years to be considered is typically set at 10, however, shorter or longer time horizons can be specified.

Policy Decisions

Retirement - Retirement policy is specified in terms of the probability of an individual retiring, given that they have not retired previously. A retire at 70 policy is specified as:

Age:	65	66	67	68	69	70
Probability of Retiring	0	0	0	0	0	1

An analysis of a proposal in which substantial early retirement incentives are offered and no one stays beyond 65 might be expressed as:

Age:	60	61	62	63	64	65
Probability of Retiring	.05	.05	.30	.10	.10	1

Termination - For each rank, the fraction of those that were terminated is specified. Average historical experience over the last 5 years can be used as a starting point. Considerable care has to be given to the determination of termination fractions. Personnel records, evaluations prior to staff exit, exit interviews and personal recall by supervisors may have to be used to differentiate voluntary from counselled out exits.

Hires - As staff in a given rank leave, they are replaced by new staff whose rank follows a specified probability distribution. Firms tend to hire mostly at entry but hiring at higher levels is not unusual. A typical hire policy for seniors might be:

	Replace by			
Rank of leaving staff	Staff Assist.	Senior	Manager	Partner
Senior	.9	.07	.03	0

Promotion - Promotion is specified in terms of the probability of promotion in a given year. Limits on promotion can be imposed, including minimum and maximum years after reaching a grade and maximum age. Furthermore, a breakpoint can be specified; the promotion probability can be different before and after the breakpoint. (e.g. after 8 years as a manager the probability of promotion to partner may decrease in a particular firm.).

Output Statistics

The model provides data on the average number of:

- retirements
- quits
- dismissals
- promotions
- deaths
- positions available

in each year over the time horizon. It also provides data on the nature of the staff, including average age, salary (in constant dollars), and level distribution.

In addition to providing information about average outcomes, the model provides data on the maximum and minimum values observed at the end of the time horizon for:

- total number of positions available

- total costs
- average age

This information is designed to aid in understanding the range of outcomes that can be anticipated.

Model Organization

The model traces the current staff year by year, removing those that leave and adding those that are hired. A random number generator and input probabilities are used to make decision about each individual eacy year. Figure 3 shows the over-all structure of the model. The description that follows assumes no change in total staff required from one year to the next.

The program starts with the staff as it exists in the current year. It examines each staff member and performs a series of tests.

Retirement: Is the staff member old enough for retirement? If so, apply the retirement policy to determine retirement. If retiring, replace according to the replacement policy.

Death: Look up the probability of dying in the mortality table. Determine if he or she dies. If so, replace.

Resignation: Use probability of quitting for the rank to determine resignation. If so, replace. This probability may later be related to salary differential to opportunities in industry and hours of overtime required.

Termination: Is this the year where termination must be decided? Should termination be postponed due to staffing needs? If termination occurs, replace staff member.

Promotion: Is this the year where promotion must be decided? If promoted, adjust rank. If desired, postpone decision.

As a result of these tests, either the present staff member is retained for another year or a new staff member is hired according to the replacement policy.

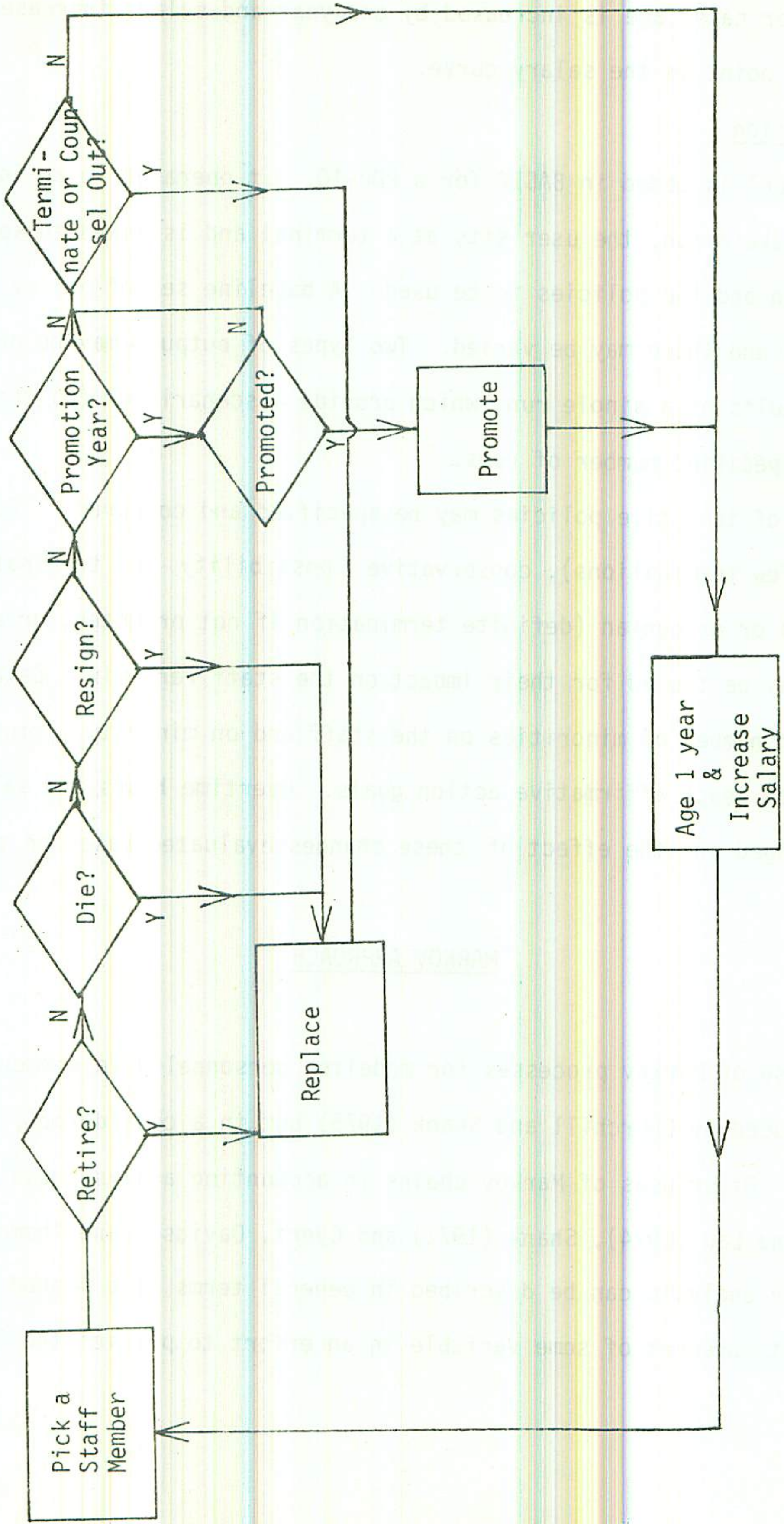


Figure 3 Model Organization

In the former case, age is increased by one year and salary increased to the appropriate point in the salary curve.

Model Operation

The model is coded in BASIC for a PDP-10. It operates in an interactive mode. To make a run, the user sits at a terminal and is asked to specify the time horizon and the policies to be used. A baseline set of policy variables is provided and these may be varied. Two types of outputs may be obtained: (1) the results of a single run, which provide a scenario or (2) the averages of a user-specified number of runs.

A set of tentative policies may be specified and compared. For example a benign (few terminations), conservative (possibility of termination at each level) or draconian (definite termination if not promoted, or earlier) policies may be tested for their impact on the staff rank mix. Data can be obtained on number of minorities on the staff and on minority hiring levels necessary to reach affirmative action goals. Overtime hours and salary levels may be changed and the effect of these changes evaluated based on the model.

MARKOV APPROACH

The use of Markov processes for modeling personnel developement in accounting was introduced by Churchill and Shank (1975) but in a considerably different framework. Other uses of Markov chains in accounting analyses can be found in Jaggi and Lau (1974), Shank (1971) and Cyert, Davidson and Thompson (1972).

Markov analysis can be described in general terms as a method of analyzing the current movement of some variable in an effort to predict the future movement of that variable. The basic assumption is that the probability of occurrence of an event this period depends only on the status of that variable in the immediately preceding period and is totally independent of other events or of the history of the variable in previous periods. Second, Markov models assume that the probabilities that determine changes in status of variables remain constant over time (see e.g. Kemeny and Snell, 1959).

To apply Markov analysis to the staff problem, we start with the assumption that there are four states corresponding to staff levels (staff assistant, senior, manager and partner) and one state which is absorbing that describes the firm's alumni.

Figure 4 shows the form of the transition matrix, S.

Figure 4
The Transition Matrix

From \ To	Staff Asst.	Senior	Manager	Partner	Alumnus
Staff Asst.	0.5	0.4	0	0	0.1
Senior	0	0.5	.35	0	0.15
Manager	0	0	0.6	0.08	0.32
Partner	0	0	0	0.95	0.05

The numbers in the transition matrix S indicate the probability that in a given year a staff member at level i is:

- promoted to level i+1
- remains at level i
- leaves the firm.

The numbers are those used in Appendix 1.

By multiplying the transition matrix, S, by the vector, V, of the number of people at each staff level, the distribution of continuing staff for next year is determined. To determine the total staff distribution next year, the vector, V , of the new hires must be added. If the policy is to hire only staff assistants, for example, then the number of new staff assistants would be equal to the difference between the continuing staff and the total staff required for the upcoming year. The mechanics of this process are analogous to that used in many applications of Markov chains (see, e.g., Cyert, Davidson, and Thompson (1962) and Cyert and Thompson (1962) for use in projecting bad debts).

The Markov model has been coded in APL. A very simple example is shown in Appendix 1. The example is based on the assumption that terminations are replaced after each period by hiring entry level accountants only. The total staff size is assumed constant. The output illustrates the staff distribution for five years if this policy is followed.

This type of model cannot respond the detailed questions to be answered by the cohort model. However, it can be used efficiently to answer questions related to:

- the effect of a particular hiring policy
- the long range rank mix at the firm
- the effects of termination or salary policies

In the cohort approach policies can be tested both by changing the data inputs to the system as well as the probabilities of particular events at a given rank. The Markov model does not have this flexibility. Its aggregate nature allows only manipulating the number or level of system entrants or changes in the transition matrix. To reflect changes in termination policies, the probability of becoming an alumnus is altered.

Model Inputs

The data to be gathered and analyzed to run the Markov model are the movements between levels by staff members. This data, which can be obtained by looking at aggregate personnel statistics over a 5 to 10 year period, is used to develop the transition matrix S.

Data concerning the sensitivity of the probability parameters in the matrix S can be changed as a policy variable to reflect promotion and termination but has to be estimated for the probability of quitting. Other data may encompass the development of supply and demand curves for the different level of accountants in relation to salaries and estimation of the "quitting threshold".

Output Statistics

The model can be used through as many periods as the user wishes and provides a trace of the staff composition by level, in each time period. The variation of assumptions allows for evaluation of alternative staff personnel policies.

COMPARISON OF APPROACHES

The cohort approach to staff development modeling (Gray 1977) differs from the two other principal approaches reported in the literature for the same problem applied in other areas (e.g. faculty modeling, military career development modeling), the Markov model approach of Hopkins (1974) and the goal programming approach of Schroeder (1974). The cohort-based simulation approach has several advantages over Markov models and goal programs:

1. It traces individuals so that it can present particular outcomes "scenarios" as well as average results under a specified policy.
2. It provides information not only on average outcomes but on the range of outcomes that can be anticipated.
3. It can provide a richer set of output information.
4. It (and the Markov model) can be used in an interactive mode. Policy makers can sit at a terminal and find out the implications of various alternatives being considered.

To achieve these advantages it presents some disadvantages over both the Markov and goal programming approaches:

1. It requires more input data, a more involved computer program, and longer running times than the Markov model (but less that the goal programming model).
2. It does not result in optimization as does the goal programming model.

The cohort approach seems to be most suitable for detailed policy planning for offices with between 40 and 200 staff members. Goal programming appears to be best for very small groups (say 5 to 30) while Markov models are best for staffs above 200. The Markov chain model is less costly to run if analyzing National Office staffs with large populations.

STATUS OF ANALYSIS

Both the Cohort and the Markov models have been tested with simulated data. Figure 6 shows the data gathered by Vasarhelyi (1978) on the audit staffs of the Los Angeles offices of 12 large CPA firms. By assuming a

Figure 6

CPA Firm Characteristics

A. Number of Staff

Rank \ Firm NB.	1	2	3	4	5	6	7	8	9	10	11	12	Mean
STAFF ACCOUNTANT	11	75	75	50	5	25	60	21	40	85	160	90	58.08
SENIOR	5	65	45	25	5	25	26	22	15	52	80	36	33.42
MANAGER	5	55	25	49	9	30	6	10	18	40	60	18	27.08
PARTNER	13	25	18	25	5	10	8	6	32	20	20	15	16.42

B. Average Stay at a Rank

Rank \ Firm NB	1	2	3	4	5	6	7	8	9	10	11	12	Mean
STAFF ACCOUNTANT	2	2.5	2	2	3	2	3	3	3	2.5	2.5	2	2.46
SENIOR	2	2.5	3	2	3	2	2	3	2	3	2.9	3	2.53
MANAGER	6	5	3.5	7	7	8	5	3	6	6	6.6	8	5.43
PARTNER													

reasonably constant inflow of new staff accountants over the last five years, a transition matrix was derived. This matrix with the initial probability based on the average number of years at a particular step was adjusted by the experience of one scheduler. This data served as input to the example in Appendix 1.

Figure 5 shows that the average large CPA firm office in Los Angeles has 58 Staff Assistants, 33 Seniors, 27 Managers and 16 Partners in the audit staff. It also shows that a staff accountant is promoted on the average in 2.46 years. This average does not include the staff that leaves the firm.

The next stage of this research involves runs of the model with additional simulated data and sensitivity analysis of the results.

A CPA firm is being sought that would be interested in providing the needed data, helping in the validation of the models, and using the results in its manpower planning.

The final stage of testing the model involves the following steps:

1. Agreement with the firm on the scope and objectives of the study.
2. Study of data avaliable and its format. The firm may decide to decide to provide the data only in aggregate or masked form to maintain confidentiality.
3. Data preparation and manipulation based on 7 years of personnel data, including 2 years for validation.
4. Interviews with the firm's personnel management to establish the firm's growth patterns, national policies and policy alternatives considered viable within the context of the firm.
5. Running both models with 5 years of data.

6. Validation based on the 6th and 7th year's data.

7. Adjustments on the models based on (6).

8. Analysis of results of potential policies.

CONCLUSIONS

The cohort and Markov approaches have been used in several different areas for personnel planning purposes. They seem to lend themselves well to the analysis of personnel patterns and personnel planning for typical sized CPA offices.

This paper is an initial attempt to the use of these two approaches in dealing with personnel planning in CPA firms. The next step will entail the cooperation of a CPA firm in the field testing of these models. Experience in other areas as faculty planning (Gray 1977)and military-civilian workforce analysis (Letsky et al., 1976) seems to support the desirability of the approach.

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APPENDIX I

This appendix presents the results of a series of experimental runs made with the Markov model. The runs represent the following alternatives:

1. Constant staff level
2. Staff size increases by 5 per year
3. Staff increases by 10 per year
4. Constant staff level; increased salary levels with resultant lowered termination probabilities than alternative 1.
5. Staff size increases by 5 per year, with increased salary levels and lower termination probabilities than alternative 2.

The following pages show the program used, the results of the five cases, and a summary comparison of these cases. Conclusions follow the summary comparison.

MARKOV_MODEL_RUNS: AN EXAMPLE

```
      ∇MARKOV[⎕]∇
      ∇ E←MARKOV;A;B;C;D;F;G;H;I;J;K;TT;N;W;X
      X 'Y'
      'ENTER INITIAL LEVELS.'
      TT←+/A←,⎕
      W←(ρA)ρ0
      'ENTER TRANSITION MATRIX'
      →((ρA)≠(ρB←⎕)[1])/ER1
      E←(0,(ρA)+1)ρT←F←0
      'ENTER AVERAGE SALARY LEVELS OR ZERO'
      SL←,⎕
      'DO YOU WANT A TRACE? (YES OR NO)'
      X←1↑⍞
      'DO YOU WANT TO SPECIFY ENTRANTS EACH PERIOD ?'
      '(YES OR NO)'
      'ALTERNATIVELY YOU WILL SPECIFY A RULE'
      →('Y'=1↑⍞)/L1
      'ENTER NUMBER OF PERIODS TO SPECIFY'
      T←1↑⎕
      'ENTER INCREMENT IN PERSONNEL PER YEAR'
      'A ZERO WOULD KEEP A CONSTANT STAFF LEVEL'
      I←(F←J←1)↑⎕
    L1:C←2 RND A MM B
      W←W+A×B[;(ρB)[2]]
      →('N'=X)/L6
      'END-OF-YEAR STAFF LEVELS ',(5 0 ⍕4↑C),' : ',(4 0 ⍕¯1↑C),' WILL LEAVE'
    L6:E←E,[1] C
      →(F=0)/L2
      D←0 RND(¯1↑C)+I
      →('N'=X)/L3
      →L3,ρ⎕←(⍕D),' NEW HIRES IN YEAR ',⍕J
    L2:'ENTER NUMBER OF NEW ENTRY LEVEL  HIREES'
      '(EXIT WITH 9999)'
      T←T+1
      →((9999=D←1↑⎕),1)/S1,L5
    L3:→(T<J←J+1)/S1
    L5:C[1]←C[1]+D
      →L1,A←¯1↓C
    ER1:→0,ρ⎕←'NON CORFORMABLE, TRY AGAIN'
    S1:→(0=+/SL)/0
      'TOTAL SALARY EXPEDITURES FOR THE ',⍕T
      'YEARS WERE ',2⍕+/SL×(¯1↓+/[1] E)+W
      ∇
```

```
      ALT1←MARKOV
ENTAR INITIAL LEVELS∘
⎕:
      V
ENTER TRANSITION MATRIX
⎕:
      S
ENTER AVERAGE SALARY LEVELS OR ZERO
⎕:
      SL
DO YOU WAJT TO SPECIFY ENTRANTS EACH PERIOD ?
(YES OR NO)
ALTERNATIVELY YOU WILL SPECIFY A RULE
N
ENTER NUMBER OF PERIODS TO SPECIFY
⎕:
      10
ENTAR INCREMENT IN PERSONNEL PER YEAR
A ZERO WOULD KEEP A CONSTANT STAFF LEVEL
⎕:
      0
END-OF-YEAR STAFF LEVELS      38    60    53    29  :     31 WILL LEAVE
31 NEW HIRES IN YEAR 1
END-OF-YEAR STAFF LEVELS      34    57    55    33  :     31 WILL LEAVE
31 NEW HIRES IN YEAR 2
END-OF-YEAR STAFF LEVELS      33    55    56    36  :     31 WILL LEAVE
31 NEW HIRES IN YEAR 3
END-OF-YEAR STAFF LEVELS      32    53    55    40  :     30 WILL LEAVE
30 NEW HIRES IN YEAR 4
END-OF-YEAR STAFF LEVELS      31    51    55    44  :     30 WILL LEAVE
37 NEW HIRES IN YEAR 5
END-OF-YEAM STAFF LEVELS      30    50    54    47  :     29 WILL LEAVE
29 NEW HIRES IN YEAR 6
END-OF-YEAR STAFF LEVELS      30    49    53    50  :     29 WILL LEAVE
29 NEW HIRES IN YEAR 7
END-OF-YEAR STAFF LEVELS      29    48    51    53  :     29 WILL LEAVE
29 NEW HIRES IN YEAM 8
END-OF-YEAR STAFF LEVELS      29    47    50    55  :     28 WILL LEAVE
28 NEW HIRES IN YEAR 9
END-OF-YEAR STAFF LEVELS      29    47    49    58  :     28 WILL LEAVE
28 NEW HIRES IN YEAR 10
TKTAL SALARY EXPEDITURES FOR THE 10
YEARS WERE  75590214.00

      V
75 60 50 21
      SL
10000 18000 27000 90000
      S
 0.5  0.4  0    0    0.1
 0    0.5  0.3  0    0.2
 0    0    0.7  0.1  0.2
 0    0    0    0.95 0.05
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```
      ALT2←MARKOV
ENTER INITIAL LEVELS∘
⎕:
      V
ENTER TRANSITION MATRIX
⎕:
      S
ENTER AVERAGE SALARY LEVELS OR ZERO
⎕:
      SL
DO YOU WANT TO SPECIFY ENTRANTS EACH PERIOD ?
(YES OR NO)
ALTERNATIVELY YOU WILL SPECIFY A RULE
N
ENTER NUMBER OF PERIODS TO SPECIFY
⎕:
      10
ENTAR INCREMENT IN PERSONNEL PER YEAR
A ZERO WOULD KEEP A CONSTANT STAFF LEVEL
⎕:
      5
END-OF-YEAR STAFF LEVELS     38   60   53   29 :    31 WILL LEAVE
36 NEW HIRES IN YEAR 1
END-OF-YEAR STAFF LEVELS     37   59   55   33 :    31 WILL LEAVE
36 NEW HIRES IN YEAR 2
END-OF-YEAR STAFF LEVELS     36   59   56   36 :    32 WILL LEAVE
37 NEW HIRES IN YEAR 3
END-OF-YEAR STAFF LEVELS     37   59   57   40 :    32 WILL LEAVE
37 NEW HIRES IN YEAR 4
END-OF-YEAR STAFF LEVELS     37   59   58   44 :    33 WILL LEAVE
38 NEW HIRES IN YEAR 5
END-OF-YEAR STAFF LEVELS     37   59   58   48 :    33 WILL LEAVE
38 NEW HIRES IN YEAR 6
END-OF-YEAR STAFF LEVELS     38   60   58   51 :    33 WILL LEAVE
38 NEW HIRES IN YEAR 7
END-OF-YEAR STAFF LEVELS     38   60   59   54 :    34 WILL LEAVE
39 NEW HIRES IN YEAR 8
END-OF-YEAR STAFF LEVELS     38   61   59   57 :    34 WILL LEAVE
39 NEW HIRES IN YEAR 9
END-OF-YEAR STAFF LEVELS     39   61   60   60 :    35 WILL LEAVE
40 NEW HIRES IN YEAR 10
TOTAL SALARY EXPEDITURES FOR THE 10
YEARS WERE  8[illegible]353652.00
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      ALT3←MARKOV
ENTER INITIAL LEVELS.
⎕:
      V
ENTER TRANSITION MATRIX
⎕:
      S
ENTER AVERAGE SALARY LEVELS OR ZERO
⎕:
      SL
DO YOU WANT A TRACE? (YES OR NO)
N
DO YOU WAJT TO SPECIFY ENTRANTS EACH PERIOD ?
(YES OR NO)
ALTERNATIVELY YOU WILL SPECIFY A RULE
N
ENTER NUMBER OF PERIODS TO SPECIFY
⎕:
      10
ENTER INCREMENT IN PERSONNEL PER YEAR
A ZERO WOULD KEEP A CONSTANT STAFF LEVEL
⎕:
      10
TOTAL SALARY EXPEDITURES FOR THE 10
YEARS WERE  85207963.00

      ALT3
 37.5  60    53    28.75 30.75
 39.25 61.4  55.1  32.61 31.89
 40.63 63.2  56.99 36.49 33.06
 41.82 65.05 58.85 40.36 34.23
 42.91 66.85 60.71 44.23 35.38
 43.96 68.59 62.55 48.09 36.51
 45.48 70.68 64.36 51.94 37.73
 46.74 72.73 66.26 55.78 38.95
 47.87 74.66 68.2  59.62 40.16
 48.94 76.48 70.14 63.46 41.34


      ⍝TEST OF EFFECTS OF NEW SALARY LEVELS

      ⍝SALARY VECTOR AND NEW TRANSITION MATRIX
      ⍝REFLECTING THE CHANGE


      SL1
14000 18000 25000 90000
      S1
 0.5  0.4  0    0    0.1
 0    0.5  0.35 0    0.15
 0    0    0.6  0.08 0.32
 0    0    0    0.95 0.05
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      ALT4←MARKOV
ENTER INITIAL LEVELS∘
⎕:
      V
ENTER TRANSITION MATRIX
⎕:
      J2
ENTER AVERAGE SALARY LEVELS OR ZERO
⎕:
      SL1
DO YOU WANT A TRACE? (YES OR NO)
Y
DO YOU WANT TO SPECIFY ENTRANTS EACH PERIOD ?
(YES OR NO)
ALTERNATIVELY YOU WILL SPECIFY A RULE
N
ENTER NUMBER OF PERIODS TO SPECIFY
⎕:
      10
ENTER INCREMENT IN PERSONNEL PER YEAR
A ZERO WOULD KEEP A CONSTANT STAFF LEVEL
⎕:
      0
END-OF-YEAR STAFF LEVELS     38    60    51    28  :    34 WILL LEAVE
34 NEW HIRES IN YEAR 1
END-OF-YEAR STAFF LEVELS     36    59    52    30  :    34 WILL LEAVE
34 NEW HIRES IN YEAR 2
END-OF-YEAR STAFF LEVELS     35    57    51    33  :    34 WILL LEAVE
34 NEW HIRES IN YEAR 3
END-OF-YEAR STAFF LEVELS     34    56    51    36  :    34 WILL LEAVE
34 NEW HIRES IN YEAR 4
END-OF-YEAR STAFF LEVELS     34    55    50    38  :    33 WILL LEAVE
33 NEW HIRES IN YEAR 5
END-OF-YEAR STAFF LEVELS     34    55    50    40  :    33 WILL LEAVE
33 NEW HIRES IN YEAR 6
END-OF-YEAR STAFF LEVELS     33    54    49    42  :    33 WILL LEAVE
33 NEW HIRES IN YEAR 7
END-OF-YEAR STAFF LEVELS     33    54    48    44  :    32 WILL LEAVE
32 NEW HIRES IN YEAR 8
END-OF-YEAR STAFF LEVELS     33    53    48    45  :    32 WILL LEAVE
32 NEW HIRES IN YEAR 9
END-OF-YEAR STAFF LEVELS     32    52    47    47  :    32 WILL LEAVE
32 NEW HIRES IN YEAR 10
TOTAL SALARY EXPEDITURES FOR THE 10
YEARS WERE   69685554.00
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      ALT5←MARKOV
ENTER INITIAL LEVELS.
⎕:
      V
ENTER TRANSITION MATRIX
⎕:
      S2
ENTER AVERAGE SALARY LEVELS OR ZERO
⎕:
      SL1
DO YOU WANT A TRACE? (YES OR NO)
N
DO YOU WANT TO SPECIFY ENTRANTS EACH PERIOD ?
(YES OR NO)
ALTERNATIVELY YOU WILL SPECIFY A RULE
N
ENTER NUMBER OF PERIODS TO SPECIFY
⎕:
      10
ENTER INCREMENT IN PERSONNEL PER YEAR
A ZERO WOULD KEEP A CONSTANT STAFF LEVEL
⎕:
      5
TOTAL SALARY EXPEDITURES FOR THE 10
YEARS WERE  74172101.00


      ALT6←MARKOV
ENTER INITIAL LEVELS.
⎕:
      V
ENTER TRANSITION MATRIX
⎕:
      S2
ENTER AVERAGE SALARY LEVELS OR ZERO
⎕:
      SL1
DO YOU WANT A TRACE? (YES OR NO)
N
DO YOU WANT TO SPECIFY ENTRANTS EACH PERIOD ?
(YES OR NO)
ALTERNATIVELY YOU WILL SPECIFY A RULE
N
ENTAR NUMBER OF PERIODS TO SPECIFY
⎕:
      10
ENTER INCREMENT IN PERSONNEL PER YEAR
A ZERO WOULD KEEP A CONSTANT STAFF LEVEL
⎕:
      10
TOTAL SALARY EXPEDITURES FOR THE 10
YEARS WERE  78957648.00
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ACOMPARISON OF ALTERNATIVE COSTS

ALT1	75590214
ALT1	80353652
ALT3	85207963
ALT4	69685554
ALT5	74172101
ALT6	78957648

ALT1

S.A.	SEN.	MNGRS.	PTNER	OUT	YEAR
37.5	60	53	28.75	30.75	1
34.25	57.4	55.1	32.61	30.89	2
32.63	54.8	55.79	36.49	30.66	3
31.82	52.85	55.49	40.24	30.31	4
30.91	51.15	54.7	43.78	29.86	5
30.46	49.94	53.64	47.06	29.45	6
29.73	48.75	52.53	50.07	29.02	7
29.37	47.87	51.4	52.82	28.63	8
29.19	47.28	50.34	55.32	28.33	9
28.6	46.52	49.42	57.59	28.01	10

ALT2

S.A.	SEN.	MNGR.	PTNER	OUT	YEAR
37.5	60	53	28.75	30.75	1
36.75	59.4	55.1	32.61	31.39	2
36.38	58.8	56.39	36.49	31.81	3
36.69	58.75	57.11	40.3	32.2	4
36.85	58.85	57.6	44	32.56	5
37.43	59.37	57.98	47.56	32.98	6
37.72	59.86	58.4	50.98	33.39	7
37.86	60.22	58.84	54.27	33.77	8
38.43	60.85	59.25	57.44	34.21	9
38.72	61.4	59.73	60.49	34.64	10

COMMENTS_ON_RESULTS_OBTAINED

OBVIOUSLY, ALT3 AND ALT2 ARE MORE EXPENSIVE THAN ALT1 AS THE NUMBER OF STAFF KEPT INCRESES CONSIDERABLY. THE SAME IS TRUE FOR STAFF LEVELS OF ALT6 IN RELATION TO ALT5 AND ALT4.

IF THE ASSUMPTIONS MADE ON THE CHANGES OF SALARY LEVELS AND THEIR INFLUENCE OVER THE TRANSITION MATRIX ARE REALISTIC, IT CLEARLY PAYS TO DECREASE MANAGER SALARIES AND INCREASE SENIOR SALARIES. THESE CONCLUSIONS ARE CONTINGENT ON THE SPECIFIC STAFF LEVELS THAT THE SYSTEM WAS INITIATED AND ON THE NATURE OF THIS TRANSITION MATRIX WHICH LEADS TO A TOO HIGH RATIO OF PARTNERS IN RELATION TO TOTAL STAFF.

IN SPITE OF THE NUMBERS BEING UNREALISTIC, THIS ANALYSIS ILLUSTRATES THE TYPES OF 'WHAT IF ??' QUESTIONS THAT MAY BE TESTED WITH A MARKOV MODEL.