NINE TOPIC ORIENTED MINI SIMULATIONS: DESCRIPTIONS, PURPOSES, AND OBSERVATIONS

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ABSTRACT

The authors have developed and used extensively a variety of computer based mini simulations as pedagogical tools in the teaching of topics within the functional areas of business. Specifically, the simulations are used in courses such as principles of management, personnel, production and operations management, manpower, statistics, forecasting and managerial economics. These topical simulations were developed to assist both undergraduate and graduate business students in understanding concepts, issues, and problems such as: (i) the inherent tradeoff in the classical E.O.Q. problem, (ii) robustness of inventory models when demand and leadtime are stochastic; (iii) non intuitiveness of queuing formulas; (iv) hiring, firing and training cost tradeoffs in the personnel area; (v) manpower planning via Markov analysis; (vi) optimal recruiting-selection strategy for minimizing total cost of recruiting, selecting, training, etc. (vii) use of simulated data to demonstrate modeling with regression analysis; (viii) and data for empirical demand and production analysis. This paper describes nine simulations which have been extensively employed by the authors. The purposes, underpinnings, and worked examples of each simulation are discussed. Some of the major benefits to both the student participants and the Instructor are highlighted.

INTRODUCTION

This paper describes nine simulations which the authors have developed and used in a variety of business courses. The simulations are all short, computer based and interactive. They were developed to be used primarily as pedagogical tools in the teaching of management decision making. The following topics are included in the simulations: inventory control, production scheduling, forecasting and demand analysis, recruitment and selection, queuing, and statistical data analysis.

The simulations have yielded benefits to both the instructor and students. Some of the student benefits include: (i) easy familiarization with the computer; (ii) an appreciation for trade off analysis in management decision making; (iii) importance of model building and scientific method, and (iv) awareness of the important role of simulation in situations with stochastic processes. Benefits accruing to the instructor include: (1) ability to easily generate individualized data sets; (ii) permits covering of sophisticated management decision making concepts with a minimum of class time; (iii) provides practical examples and applications of theoretical concepts and (iv) with a prior knowledge of the underlying function, ease in evaluation of the exercises.

DETERMINISTIC INVENTORY CONTROL

This simulation of the deterministic inventory model is used in undergraduate operations management classes to introduce students to the EOQ model. Students are given demand and cost data and are required to make weekly decisions on whether or not to place an order and the quantity to be ordered. Their goal is to minimize total costs without stocking out.

Once the students become familiar with the simulation, they may specify a fixed reorder point and a fixed order quantity. They are then provided with cost summaries for each decision set.

FIGURE 1

INVENTORY EOQ SIMULATION

```
DO YOU WANT TO SUPPRESS WEEKLY PRINTOUT  ?NO
REORDER POINT   ?300
QUANTITY  ?500

PERIOD  ENDING INVENTORY UNITS ORDERED

 1              400              500
 2              200              0
 3              100              0
ORDER RECEIVED   500 UNITS
 4              500              0
 5              400              0
 6              300              500
 7              200              0
 8              100              0
ORDER RECEIVED   500 UNITS
 9              500              0
 10             400              0
 11             300              500


ORDER RECEIVED   500 UNITS
 49             500              0
 50             400              0
 51             300              500
 52             200              0
TOTAL COST = ORDERING COST + CARRYING COST
 509.415  =    446   +    49.6154


DO YOU WANT TO SUPPRESS WEEKLY PRINTOUT  ?YES
REORDER POINT   ?300
QUANTITY  ?800

PERIOD  ENDING INVENTORY UNITS ORDERED

TOTAL COST = ORDERING COST + CARRYING COST
 370.462  =    280   +    90.4415


REORDER POINT   ?500
QUANTITY  ?800

PERIOD  ENDING INVENTORY UNITS ORDERED

TOTAL COST = ORDERING COST + CARRYING COST
 415.395  =    280   +    135.395


REORDER POINT   ?200
QUANTITY  ?1500

PERIOD  ENDING INVENTORY UNITS ORDERED

TOTAL COST = ORDERING COST + CARRYING COST
 308.462  =    160   +    148.462
```

By plotting the costs versus the order quantities, students may approximate the total inventory cost curve for this problem. After six trials the students are introduced to the EOQ model and encouraged to use the model to test its effectiveness.

Some of the benefits of this simulation include:

- The introduction of students to computer simulations
- Students learn to graphically represent the cost functions
- Students learn trial and error decision methods are time consuming
- The effectiveness of the deterministic model is demons t rated
- Students can easily see the advantage of standard operating procedures, e.g. fixed order point
- Independent data may be generated for each student or each problem

STOCHASTIC INVENTORY CONTROL

This Monte Carlo simulation is an extension of the deterministic model. The students are confronted with a stochastic inventory problem and must make weekly decisions on how much and how often they should occur. Cost information is given, as well as, detailed information about the nature of the demand probability function.

FIGURE II

Inventory Simulation

```
                         INSTRUCTIONS

     THIS PROGRAM SIMULATES AN INVENTORY SYSTEM. IT PROGRESSES ON A
WEEKLY CYCLE. VALUES FOR THE BEGINNING INVENTORY, THE DEMAND,
THE ENDING INVENTORY, AND THE NUMBER OF ORDERS RECEIVED FOR THE
CURRENT WEEK ARE DISPLAYED EACH WEEK. YOU MUST DECIDE WHETHER TO
ORDER MORE STOCK, AND IF SO, HOW MUCH.
     DEMAND IS SELECTED BY THE PROGRAM FOR EACH PERIOD (WEEK).
LEAD TIME, MEASURED IN WEEKS, IS SELECTED EVERY TIME YOU PLACE AN
ORDER. BEFORE THE SIMULATION STARTS YOU WILL CHOOSE WHETHER LEAD
TIME IS TO BE CONSTANT; IDENTICAL FOR EACH ORDER, OR VARIABLE;
RANDOMLY SELECTED FOR EACH ORDER.
     YOU'LL ALSO BE ASKED IF YOU WANT TO SEED THE RANDOM NUMBER
GENERATOR. THIS CAN PROVIDE A COMMON BASIS FOR COMPARING RESULTS.
ALTERING THE RANDOM LINK IN SUCH A MANNER AFFECTS SELECTION OF
DEMAND AND VARIABLE LEAD TIME.
     YOU MAY CHOOSE TO ORDER AT THE END OF ANY WEEK BY TYPING THE
AMOUNT YOU DECIDE UPON IN THE COLUMN MARKED 'AMOUNT ORDERED', THEN
HIT THE RETURN KEY. ORDERS ARE RECEIVED AT THE END OF A WEEK, THE
AMOUNT RECEIVED IS ADDED TO THE INVENTORY AT THE BEGINNING OF THE
FOLLOWING WEEK. IF YOU DECIDE NOT TO ORDER SIMPLY HIT THE RETURN
KEY. WHEN YOU WANT TO END THE PROGRAM TYPE STOP AND HIT THE RETURN
KEY. YOUR SUMMARY INFORMATION WILL THEN BE DISPLAYED.


                            VALUES

     KNOWING THE FOLLOWING VALUES MAY HELP YOU TO PLAN YOUR ORDERS.

DEMAND FREQUENCY DISTRIBUTION AND PROBABILITIES;
DIST.... 180 190 200 210 220
PROB.... 0.2 0.3 0.2 0.2 0.1
EXPECTED VALUE=197     STANDARD DEVIATION=12.68857754

LEAD TIME FREQUENCY DISTRIBUTION AND PROBABILITIES;
DIST.... 4.00   5.00   6.00   7.00   8.00
PROB....  .10    .35    .20    .20    .15
EXPECTED VALUE=5.95     STANDARD DEVIATION=1.24398553

UNIT COST CONSTANT IS         30 DOLLARS/UNIT
HOLDING COST CONSTANT IS       6 DOLLARS/UNIT/TIME PERIOD
ORDER COST CONSTANT IS       500 DOLLARS/ORDER
STOCKOUT COST CONSTANT IS     15 DOLLARS/UNIT/TIME PERIOD

THE BEGINNING INVENTORY IS 2000 UNITS.

HIT THE RETURN KEY ONCE WHEN YOU'RE READY TO CONTINUE.
```

As quoted in Figure II, stockouts may occur in this simulation, but they will all be backordered. Leadtime may be fixed or variable. This particular option is up to the instructor or to the student.

The simulation generates demand and maintains a perpetual inventory system. The students merely hit the carriage return or place an order of some desired quantity.

Typically the simulation is played for 100 periods at which time a summary of order, stockout, and holding cost is presented. Figure III notes a typical cost for 100 periods.

FIGURE III

```
                    [illegible]

  TOTAL      ENDING      TOTAL QTY     NUMBER OF        NUMBER OF
  DEMAND    INVENTORY    ORDERED     ORDERS PLACED   ORDERS RECEIVED

  19750     -1750        16500           9                8

   TOTAL          TOTAL            TOTAL          TOTAL
 UNIT COST    STOCKOUT COST    HOLDING COST    ORDER COST

  555000         333455           491053          4500

TOTAL INVENTORY COST IS:
TOTAL STOCKOUT COST + TOTAL HOLDING COST + TOTAL ORDER COST =        1029008

                  SIMULATION COMPLETE

   1) TO START AGAIN WITH IDENTICAL OPTIONS:
        TYPE  GO   THEN HIT RETURN.

   2) TO START AGAIN WITH NEW OPTIONS:
        TYPE  OPTIONS  THEN HIT RETURN.

   3) TO FINISH:
        TYPE  STOP   THEN HIT RETURN. THEN,
        TYPE  [OFF   AND HIT RETURN AGAIN.
```

The simulation has been utilized in a variety of business courses, including freshman level introduction to business, junior level management principles course and in a senior level capstone course for quantitative analysis majors. Interestingly, most students are not familiar with the classical E.O.Q. formulation utilize decision rules based on intuition whereby the stockouts are minimized. After covering the inventory models and noting the inherent tradeoff in the inventory modeling process, the students replay the simulation, and in most cases, reduce their total cost by factors ranging from 20 to 50 percent.

Some of the noted benefits of this simulation include:

•Students are introduced to a Monte Carlo simulation
•The tradeoff in inventory control becomes apparent after comparing team results
•To a certain extent there is a pre and post measure of learning (i.e.--changes in total inventory cost).
•Illustration of the robustness of deterministic inventory models when applied to stochastic environment
•The seed number for the random link may be fixed so as to ensure equity in terms of demand, and leadtime.
•Leadtime may be fixed or variable. This allows the instructor to utilize the game at low level or at a more sophisticated modeling level.

SCHEDULING

The simulation 'Scheduling" is used in operations management course to introduce students to Monte Carlo simulations and their uses. The students are given a repair facility scheduling problem with three unique service areas. Incoming repairs randomly enter the system in any of the three areas and are either completed there or are routed to another service area. Entry and routing probabilities are given, as are the service time distributions for each area. Students attempt to assess how long it will take to complete all repairs, given a finite number of customers.

Later variations limit resources in each service area and require students to allocate those resources among the areas in an attempt to decrease average customer (repair) time in the facility. The observed benefits of this simulation include:

•A unique problem result (solution) for each student
•Students see the benefits of Monte Carlo simulations

•Students develop a better understanding of truly stochastic processes and the difficulties associated with planning and scheduling for random events
•Gantt charting can be easily coupled with this simulation to help students with the allocation of resources
•Comparing individual results in class gives students a better feel for the statistical distributions and ranges of possible outcomes

FIGURE IV

```
[illegible]   [illegible]  NOW...
SIMULATED MOTORCYCLE REPAIR SHOP

A SET NUMBER OF MOTORCYCLES ARE DELIVERED TO THE SHOP AT ONE TIME.
ONCE AT THE SHOP, THEY PROCEED THROUGH THREE WORK CENTERS-
FRAME REPAIR, ENGINE WORK, AND PAINTING.  EACH CYCLE MAY BEGIN
IN ANY OF THE WORK CENTERS AND PROCEED TO ANY OTHER WORK CENTER
THE NUMBER OF HOURS SPENT IN ANY WORK CENTER VARIES FROM ONE TO THREE
ON A RANDOM BASIS.

HOW MANY MOTORCYCLES DO YOU WISH TO PROCESS   ?6

**********************

       CYCLE   1

**********************

ENGINE WORK
     2 HOURS
PAINT
     2 HOURS
              WORK FINISHED

CYCLE    1  COMPLETED IN   4  HOURS



 YES
HOW MANY MOTORCYCLES DO YOU WISH TO PROCESS   ?6

**********************

       CYCLE   1

**********************

FRAME REPAIR
     3 HOURS
PAINT
     3 HOURS
FRAME REPAIR
     2 HOURS
ENGINE WORK
     1 HOUR
PAINT
     1 HOUR
ENGINE WORK
     1 HOUR
PAINT
     2 HOURS
              WORK FINISHED

CYCLE    1  COMPLETED IN   13   HOURS
```

FIT - The Regression Analysis Case

In the second or intermediate course in statistics, the simulation "FIT" is employed. The fundamental purpose of this exercise is to give each student a unique set of data. It is then the student's task to develop a model that adequately describes the data over the factor space. The program keys on the social security number and generates twenty-five paired observations for dependent variable Y and independent variable X. Three different sets are illustrated below:

To ensure differences in data, "noise" is introduced via a rectangular probability function. The program has five different functional equations which generate the data.

FIGURE V FIT

Three Unique Sets of Data

	$Y = B_0 + B_1X$		$Y = B_0 + B_1X + B_2X^2$		$Y = B_0X^{B_1}$	
	Y	X	Y	X	Y	X
1	14.140	5.547	19.475	1.407	4.179	2.110
2	12.680	5.360	33.375	2.379	6.263	2.640
3	15.900	6.733	42.900	3.243	10.957	4.255
4	16.820	7.340	46.100	3.443	15.027	5.375
5	22.500	9.533	50.875	5.236	17.749	6.660
6	23.840	10.280	49.100	6.300	23.038	7.085
7	24.040	10.847	43.575	7.436	27.129	7.780
8	28.980	12.593	29.750	7.343	31.901	8.695
9	27.600	12.433	20.425	9.679	36.728	9.525
10	33.200	14.600	2.500	10.700	43.677	11.310
11	31.940	14.480	-20.850	11.314	48.335	11.850
12	35.980	16.127	-47.925	12.007	54.922	13.260
13	36.180	16.493	-77.300	13.186	61.089	14.370
14	41.700	18.633	-109.700	14.643	65.499	14.515
15	41.740	18.947	-149.175	15.221	73.564	16.405

FIGURE VI

Functional Forms

Last digit of SSN	Mathematical Model
0 - 1	$Y = 2 + 2X$
2 - 3	$Y = 1.5X^{1.4}$
4 - 5	$Y = 1.5X$
6 - 7	$Y = .05 + 20X - 2X^2$
8 - 9	$Y = 20X + X^2 - .01X^3$

The students are then asked through 'good" statistical procedures to develop a model which explains the twenty observations. The exercise includes a written report where the students report on: underlying assumptions of the regression model; possible violations of those assumptions; goodness of fit measures; level of significance, etc. The "noise" is kept limited so that misspecified models may appear to be significant statistically, when in fact residual analysis depicts assumption problems of misspecification. Figure VII notes the summary statistics for a bivariate linear model while the residuals indicate problem areas.

Some of the observed benefits from the regression case include:
• Different data sets for each student or groups of students
• Ease in grading because the "true' functional forms are known to the instructor.
• Instructor can increase the random component and still have a significant model
• Encourages the student to model in a logical statistical model
• Feedback to student as to the "true" model

FIGURE VII

Summary Statistics and Residual Analysis

```
Bivariate Linear Model
     Y = -9.66 + 4.[illegible]          R² = .[illegible]
  (S.E.)  (1.287)  (.125)          F = 1563

Residuals for the Model

WOULD YOU LIKE TO DISPLAY THE RESIDUALS
?YES
 OB        OBS Y        COMP Y        STANDARDIZED RESIDUALS
  1         4.18        [illegible]        [illegible]
  2         6.26        [illegible]        [illegible]
  3        10.96        [illegible]        [illegible]
  4        15.02        [illegible]        [illegible]
  5        17.75        [illegible]        [illegible]
  6        23.04        [illegible]        [illegible]
  7        27.13        [illegible]        [illegible]
  8        31.9         [illegible]        [illegible]
  9        36.73        [illegible]        [illegible]
 10        43.68        [illegible]        [illegible]
 11        48.34        [illegible]        [illegible]
 12        54.99        [illegible]        [illegible]
 13        61.09        [illegible]        [illegible]
 14        65.5         [illegible]        [illegible]
 15        73.56        [illegible]        [illegible]
```

QUEUING

"Queuing" is used in upper division undergraduate and MBA level operations courses as an introduction to common queuing formulas. The simulation generates random arrivals and service times in a one clerk store where average arrival and service times are known. The output shows the number of arrivals, the time of the arrivals (minutes) , the length of service, and the actual service times (cumulative minutes) in twelve minute segments over a four hour period.

FIGURE VIII

QUEUING SIMULATION

```
0 (TIME):  ARRIVALS = 1    ARRIVAL TIMES: 6
   SERVICE TIMES 10         ACTUAL 6- 16
12 (TIME): ARRIVALS = 3    ARRIVAL TIMES: 14   19   21
   SERVICE TIMES 9   10    .11 ACTUAL 16- 25  26- 32   33- 42
24 (TIME): ARRIVALS = 1    ARRIVAL TIMES: 30
   SERVICE TIMES 10         ACTUAL 42- 52
36 (TIME): ARRIVALS = 2    ARRIVAL TIMES: 38   [illegible]
   SERVICE TIMES 10  11       ACTUAL 52- 62  [illegible]
48 (TIME): ARRIVALS = 2    ARRIVAL TIMES: 52   [illegible]
   SERVICE TIMES [illegible]  ACTUAL 71- 80  [illegible]
```

The benefits of this simulation are:

•The simulation helps overcome the tendency on the part of many students to “intuitively reason” that a line should not form wherever average service time is less than average time between arrivals. This “intuitive reasoning”, if not dispelled, frequently causes students to distrust the answers they obtain using queuing formulas.

•The display allows students to see a queue forming in the facility

•Summaries allow students to compare actual arrival and service times with the expected times

•The simulation may be easily altered to change the queue length

EMPIRICAL DEMAND ESTIMATION

In junior and senior level managerial economics courses, one commonly covered topic is empirical estimation of demand. A simulation was developed which minimizes statistical complications such as multicollinearity, autocorrelation, and identification problems. This exercise gives each student a unique set of data from an apriori specified demand function. The students are given twenty-five observations on the following variables: period (time), quantity sold, price, substitution index, disposible income, advertising expenditures, unemployment data and a contrived taste index. An example is presented in Figure IX.

FIGURE IX

Empirical Demand Simulation

PERIOD	QUANTITY	PRICE	THREE	INCOME	ADVERTISING	UNEMPLOYMENT	TASTE
1	736	65.90	1.00	10.480	20	.03	8
2	1169	63.30	1.01	10.690	22	.04	16
3	877	70.40	1.03	11.000	24	.02	6
4	1088	72.80	1.06	11.600	26	.03	19
5	871	72.40	1.10	11.410	28	.05	3
6	728	71.20	1.08	11.450	20	.06	4
7	885	70.29	1.40	11.470	21	.07	9
8	1263	66.40	1.60	12.080	22	.06	14
9	1092	72.40	1.40	12.000	23	.05	16
10	1128	70.40	1.77	12.900	24	.06	12

The students are expected to thoroughly analyze the data and include both marketing and business policy implications, as well as the statistical significance of their model and various variables, in their report. The instructor has control over the variables via the elasticities. The functional form employed is a multiplicative demand function:

$$Q = B_0 X_1^{B_1} X_2^{B_2} X_3^{B_3} \cdots$$

where X_i is the value of the independent variable

B_i is the respective coefficient elasticity;

Three Different Models that have been commonly used are presented in Figure X.

FIGURE X

Three Functional Forms

$$Q = B_0 \cdot P^{B_1} \cdot Y^{B_2} \cdot I^{.05} \cdot A^{B_3}$$

where
B_0 = intercept
B_1 = price elasticity
B_2 = income elasticity
B_3 = advertising elasticity
P = price
Y = disposible income
I = substitution index
A = advertising expenditures
= unemployment rates

Model I	Model 2	Model 3
B_1 = -1.2	B_1 = 1.00	B_1 = -.87
B_2 = 2.0	B_2 =-1.00	B_2 = .9
B_2 = 1.	B_3 = .05	B_3 = .9

Some of the benefit derived from this empirical demand exercise include:

.Different exercises for each student or groups of students

•Minimizes student frustration by ensuring proper signs of coefficients and statistical significance

•Ease in grading--the functional forms are known to the instruct or

•Blends both economic theory and statistics with the managerial decision and policy making

•Allows for a diversity of products such as normal, inferior, superior price sensitive or elastic advertising elastic or inelastic, etc.

PERSONNEL

The “Personnel” simulation is used in junior-senior and graduate level personnel courses. This simulation provides the student with information on a sales office having levels of salespersons. Higher level sales- persons sell more and have lower turnover. Salespersons move to each succeeding level through training programs.

All entry level salespersons are hired into the lowest level; they begin with an orientation period and typically have lower sales and higher initial turnover. Students may select one of two selection procedures: the first is moderate in cost, but does not always make the best selection; the second provides better selection decisions, but is more expensive. Growth is limited to a fixed percent of the total salesforce each year. Students attempt to maximize profits over a five year period through optimal hiring and training decisions.

FIGURE XI

Personnel Simulation

```
DO YOU WISH TO USE REGULAR SELECTION TECHNIQUES
OR  EXPENSIVE SELECTION TECHNIQUES?  EXPENSIVE
TECHNIQUES WILL GET YOU BETTER PEOPLE AT A HIGHER COST.
ENTER REG OR EXP
?REG
YEAR  0:
   REGULAR        16.
.  ADVANCED       20.
   SENIORS        24.
     TOTAL        60.
   MAX SALESFORCE=      66.
   MAX  NEW HIRES=        18.

   NEW HIRES DESIRED?
?18
   ENTER NUMBER OF REGULARS TO BE TRAINED
?14
   ENTER NUMBER OF ADVANCED TO BE TRAINED
?15
   NEWHIRES=      18.      HIRING COST=      2225.00
   REG TRAINED=   14.      TRAINING COST=   16400.00
   ADV TRAINED=   15.      TRAINING COST=   28000.00
```

Observed advantages of the simulation include:
•The opportunity for students to develop a systematic approach to problem solving
•Given a systematic approach, students begin to develop an awareness for some of the cost functions involved in selection and training
•The simulation allows solutions (decisions to be interrelated, i.e. recruiting large numbers of sales-. persons increases costs, but allows economies of scale in later training programs

PRODUCTION THEORY - AN EMPIRICAL EXERCISE

An exercise similar to the empirical demand case is available for students of managerial economics. The students are given a simulated data on output and inputs (number of shifts or production lines). Each student gets a different set of data. Figure XII illustrates such a data set.

FIGURE XII

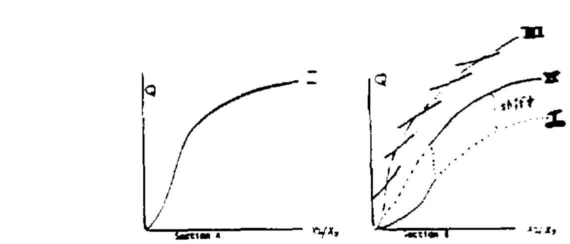
Production Exercise

PERIOD	QUANTITY PRODUCED	LABOR (MAN HOURS)	PRODUCTION LINES
1	498	275	2
2	221	163	1
3	668	349	3
4	721	392	3
5	504	331	2
6	467	280	2
7	432	232	2
8	253	167	1
9	200	121	1

The function is similar to curve I section A in Figure XIII. Some randomly selected students are confronted with changing technology during the time frame. This may occur as a shift as illustrated in section B, or as an increasing function over time as demonstrated by III in section B.

Figure XIII

Technological Consideration



It is the students, task with econometric analysis to describe the production process. In their analysis, they are to relate their findings to microeconomic theory such as elasticities of output, diminishing returns, changing technology, and returns to scale.

Some of the potential benefits of this exercise include:
.Gaining an appreciation for the practical components of microeconomic theory
Maining an appreciation for the sensitivity of econometric analysis particularly when dealing with changing technology

MANPOWER

This simulation is used in a graduate manpower forecasting seminar. Students are introduced to an organization with three levels of managerial positions and data on promotions, terminations, etc. From this data, they establish a matrix of transitional probabilities for personnel movement. They then enter being-ning staffing data and use the program to produce a Markov analysis of future staffing levels.

FIGURE XIV

Manpower Simulation - Hiring Decision

```
AFTER    3  PERIODS--
 34.3000        68.6000        221.200        275.900
DO YOU WISH TO DO FURTHER CALCULATIONS WITH THE SAME
TRANSITION MATRIX   ?NO
DO YOU WISH TO SIMULATE MANPOWER FLOWS
USING THE ABOVE DATA WITH HIRING ALLOWED  ?YES
HOW MANY PERIODS DO YOU WANT TO RUN   ?3
BEGINNING NUMBERS
 100            200            300            0
PERIODS    1  NUMBER OF NEW HIRES   ?100
PERIOD   1  END
 140.000        160.000        280.000        120.000
PERIODS    2  NUMBER OF NEW HIRES   ?50
PERIOD   2  END
 133.000        134.000        256.000        227.000
```

Once the students are familiar with the process, they are allowed to hire new managers into the lowest (entry) level on an annual basis. Their goal is to achieve desired staffing quotas for all three levels.

This simulation has produced the following observed benefits:
•Students may use this trail and error approach without large amounts of tedious calculations
•Problems can be assigned with infeasible goals to help demonstrate the need for planned personnel programs related to the transitional probabilities
•The long range effect of short-range hiring decisions are easily demonstrated

SUMMARY

Several mini simulations used by the authors have been described and the benefits of each listed. These simulations are diverse in nature and are used in a variety of courses, but the basic reason for their use and many of the benefits derived from them are similar. The simulations all appear to aid the learning process, no matter what the topic, by presenting the material in an interesting fashion with decision making as the common theme. Our observations, confirmed by numerous other authors, show that most students enjoy the simulations because they are participatory in nature. They also allow the students to focus on the decision making aspects of a problem without getting bogged down in tedious calculations and without the frequent calculation errors which lead to erroneous decisions and frustration, A secondary advantage of frequent use of computer based mini simulations is the familiarization of the student with the computer. Students exposed to a number of these simulations seem to experience a decrease in the “computer anxiety” one often finds among non-technical students.