Developments in Business Simulation & Experiential Exercises, Volume 10, 1983

COMPSIM
A COMPUTER CENTER MANAGEMENT SIMULATION

Donald Burlingame, Rochester Institute of Technology
Thomas Pray, Rochester Institute of Technology

ABSTRACT

This paper describes a computer center management simulation entitled COMPSIM. This simulation deals with the operations and the management of a hypothetical computer center.

The simulation is designed to teach management decision-making skills that are pertinent to the data processing industry, such as computer equipment selection, data processing personnel decisions, and marketing of computer services.

The paper presents: (i) the purpose of the simulation, (ii) the simulation environment, (iii) the requisite skills of the participants, (iv) the major decisions, and (v) the computer center's objectives.

INTRODUCTION

COMPSIM is a computerized simulation designed to introduce students to the computer, to simulation using the computer, and to the dynamics of decision-making under uncertainty. Just as students of biology. chemistry, and physics have experimental laboratories in which they make their own discoveries that reinforce classroom lectures, COMPSIM permits students of different majors and diverse backgrounds to experiment, discover and reinforce their acquired learning.

BACKGROUND, ENVIRONMENT AND OBJECTIVES OF COMPSIM

COMPSIM was first implemented at the State University College of New York at Potsdam in the computer and data processing curriculum. The simulation not only introduced students to the computer and the simulation process, but also illustrated the dynamics of work groups and the decision-making process.

COMPSIM illustrates the need for an integrated approach to decision-making. It demonstrates the need for recognizing an interdependence of decisions in a fashion that students find both stimulating and enjoyable. The student participants quickly learn the importance of viewing decisions from Ha systems viewpoint" and this learning is reinforced by their experience.

COMPSIM permits students to investigate various approaches or strategies of managing a hypothetical computer center in a simulated competitive environment This is accomplished by dividing the data processing class into small groups or teams. Each team represents the manager or administrators of a computer center which offers computing services as its product. These services consist of selling computer time and programming time. Each center (team) competes with other centers in a competitive and open market. The "new" managers of the center assume the role of executive administrators for an ongoing and successful computer center.

Typically, the number of competing centers varies between three and nine. A competitive market with such a limited number of firms (centers) is referred to as an oligopoly. Some contemporary examples of oligopolies include producers of electronic components, manufacturers of microcomputers, aluminum and steel producers, as well as the automotive industry. As the participants will discover, the existence of the oligopoly environment will influence the activities and behavior of the centers. Because of the oligopoly structure, the major decisions that the computer teams make will not go unnoticed by their competitors. Thus, COMPSIM introduces students to the challenge of effective (management) decision-making when confronted with the uncertainties of the actions of their competitors.

The center managers are subjected to additional uncertainties due to uncontrollable events in the operation of their firm. Even if all teams in the market made identical decisions, their results would not be the same. As in the real world, COMPSIM'S uncertainty influences the reliability of forecasts and the efficiency of operating a computer center. The centers which are ultimately successful in COMPSIM must effectively cope with this uncertainty.

Many times "real world" managers must make difficult decisions when faced with limited funds. Some examples might be (i) whether to change the emphasis of their operations in one direction or another, (ii) whether to place additional funds in advertising or into quality development; (iii) whether to buy or lease equipment. Such real world decisions often involve trade-offs. Analysis of these trade-offs is needed to arrive at the best decision. In COMPSIM effective decisions require the analysis of such trade-offs.

COMPSIM allows the students to investigate various strategies of managing their hypothetical computer center. Undoubtedly, centers following some strategies will prosper, while other strategies will fail and the center may falter. What is important, however, is what students gain from the experience. The real "gains and rewards" from COMPSIM are not measured in dollars or financial type statements, but rather in knowledge acquired.

REQUISITE SKILLS

While COMPSIM is a FORTRAN program which uses a mainframe computer and is designed to be used in a batch-oriented or interactive node, participants need not have prior knowledge of computer programming.

New students of computer science, business, mathematics, science, humanities, or liberal arts may participate effectively in COMPSIM. In fact, COMPSIM has been used most effectively in classes (both large and small) where the background of students is extremely diverse.

It has been noticed, however, that some students without formal training in economics, business, and finance may feel somewhat overwhelmed during the first few decision periods. This is to be expected, for normally it takes two to three periods of play to be acquainted with the financial aspects of the simulation.

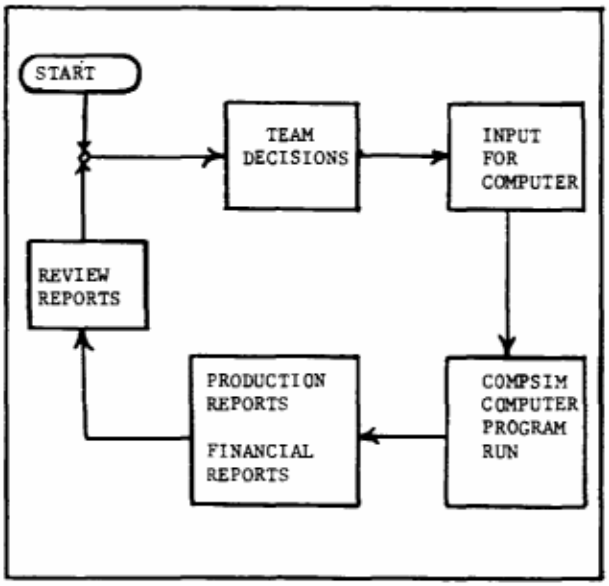
THE SIMULATION PROCESS

The administrator will divide the class into different teams or center managers, and assign a center number (i.e. 1 through 9). During allotted time, either within the class or outside, the team members are required to make approximately eleven major center management decisions. These decisions serve as the inputs for the computer algorithm. They may be entered on cards or from terminals. The COMPSIM program will then simulate the computer center market and print out financial and operational statements for each center. These statements summarize the effectiveness of centers' decisions and provide a basis for future decisions. For each period, the following procedural steps should be adhered to:

1. Each team reviews reports from previous period or periods.
2. Agreement is reached by the center's management team on the decisions.
3. The decisions are recorded on the decision sheet provided.
4. The decisions for each center are entered into the computer by computer cards or through a terminal.
5. The computerized results for the period are returned and the cycle is ready to be repeated.

This stepwise procedure is illustrated in Figure B-l.

FIGURE B-l
PROCEDURAL PROCESS IN COMPSIM



Each simulation period represents a fiscal quarter and the simulation is designed for any number of periods up to twenty. At the beginning play all centers start from the same position, each having the same amount of cash assets.

There are many different strategies and philosophies that the centers may undertake in COMPSIM. Each will be ranked relative to its competitors (i.e. other centers in the same market). Thus each center has inherently the same objective- to maximize the value of the center.

THE CENTER'S OBJECTIVE MAXIMUM NET WORTH

As noted, each computer center offers computing services as its product. These services consist of selling computer and programming time to outside users. Each center is in a competitive environment and they are required to make a set of decisions which determine how well a center performs as compared to its competition. These decisions include factors such as acquiring new equipment, selling or releasing unused equipment, hiring, promoting and/or releasing computer programmers, advertising their services, and pricing their services, computer and programming time. The overall effectiveness of the decisions are gauged by the value of the organization - NET WORTH. The NET WORTH, which is composed of the value of the equipment and cash assets minus debt, is intrinsically a cumulative measure of performance.

There are many secondary goals and objectives that the center might pursue such as maintaining positive cash balances and flows, having a high quality rated operation, consistent pattern of programmer promotions, largest dollar value of equipment, etc. These secondary objectives are left to the discretion of the individual centers. It is important, however, to view the operations of the center and the entire decision- making process from the point of view of the total system. No one of these objectives should dominate the primary objective of the company which is to main- tam its viability and increase its NET WORTH.

DECISIONS AND STARTING VALUES

Each center is responsible for making up to twelve decisions per period. These are as follows:

	Decision Variables	Decision Units
1	PRICE Per Hour	dollars
2	Payment on DEBT	dollars
3	ADVERTISING Expenditure	dollars
4	Research and Development	dollars
5	Equipment to Release	Computer type and memory
6	Equipment to Acquire	Computer type and memory
7	Programmer Acquisition	Number, grade, salary
8	Programmer Promotion	Number, grade, dollars
9	Programmer Release	Number, grade
10	Maximum Hours for Sale	hours
11	Priority for Application	rank order
12	Bids on CONTRACTS	dollar

After the decisions are made, turned into the administrator, and the computer run is completed, the following operations and financial statements are printed out and distributed to each center:

1. Beginning of Period Summary
   This section reviews financial status prior to the period including debt, cash balance and summary of contract jobs. It also reports on decisions made for that period and summarizes the status of equipment and programmers available for use in that period.
2. Results of the Period's Activities This report summarizes the outcome of the decisions. It includes both a market and individual center s sales summary center programmer usage analysis, and calculations of NET WORTH.

Typical decisions and output are presented in Figures B-2 through B-4,

THE FIRST PERIOD OF PLAY

At the Start of the simulation, each center has 300,000 dollars in cash. This cash serves as the basis for purchasing or leasing equipment, and hiring programmers. The centers have no debt or liabilities.

The remaining section describes the decisions and results that take place in COMPSIM

FIGURE B-2
DECISIONS AND DECISION VALUES

```
                CENTER NO. 2     PERIOD 1

BEGINNING OF PERIOD VALUES

  DEBT   $       0.00

  CASH   $  300000.00

  QUALITY   1.00

DECISIONS FOR PERIOD

  AMT. TO ADVER.  $ 1000.00

  AMT. TO DEVELOP.$ 8000.00

  PRICE PER HR.   $  200.00

  MAX HRS. FOR SALE  200.00

  EQUIPMENT AQUIRED-BOUGHT

    700K OF THE ADEX

  PAYMENT ON DEBT $100000.00

  PROGRAMMERS HIRED

    PROGRAMMER 1  ADDED, SALARY  $  2500
    PROGRAMMER 2  ADDED, SALARY  $  2500
    PROGRAMMER 3  ADDED, SALARY  $  2500

CENTER RESOURCE SUMMARY

    SUMMARY OF EQUIPMENT

    700K OF THE ADEX OWNED

    SUMMARY OF PROGRAMMERS

    PROGRAMMER NO. 1 GRADE 1 SALARY  $  2500.
    PROGRAMMER NO. 2 GRADE 1 SALARY  $  2500.
    PROGRAMMER NO. 3 GRADE 1 SALARY  $  2500.
```

FIGURE B-3
RESULTS OF DECISIONS
PERIOD 1

```
CENTER  2     PERIOD 1
RESULTS

QUALITY              1.55

SHARE OF MARKET      0.066

COMP HRS AVAILABLE       412.0
COMP HRS USED            412.0

COMP HRS DEMANDED        180.6
COMP HRS SOLD            180.6

UNSATISFIED DEMAND HRS     0.0

PROGRAMMER HRS AVAILABLE  343.4
PROGRAMMER HRS USED       343.4

CONTRACT PYMTS   $        0.00
VALUE OF EQUIP   $   526904.00
GROSS SALES      $    36129.17
USAGE COST       $        0.00
OVERHEAD COST    $    10638.75
WAGES PAID       $     7500.00
PENALTY COST     $        0.00
RENT PAID        $        0.00
INTEREST COST    $        0.00
CASH             $  208790.42
DEBT             $  467500.00
NET WORTH        $  268194.42

CONTRACT JOBS REMAINING

JOB NO. 12  AWARD DATE  1  DUE DATE  2
COMP HRS LEFT   348.63  PROG HRS LEFT    31.90
BID VALUE  $  39372.00  PENALTY 8%
```

FIGURE B-4
TOTALS FOR THE MARKET

```
TOTALS AND STATISTICS PERIOD 1

TOTAL HRS DEMANDED     2293.6
TOTAL HRS SOLD         2915.0
AVERAGE QUALITY          1.66
AVERAGE ADVERT.     $  3833.33
AVERAGE PRICE       $   145.56

PRICES
     CENTER 1  $   180.00
     CENTER 2  $   200.00
     CENTER 3  $   120.00
     CENTER 4  $   135.00
     CENTER 5  $   150.00
     CENTER 6  $   135.00
     CENTER 7  $   125.00
     CENTER 8  $   140.00
     CENTER 9  $   125.00
NET WORTH
     CENTER 1  $   279947.66
     CENTER 2  $   268194.42
     CENTER 3  $   272896.47
     CENTER 4  $   263278.92
     CENTER 5  $   273179.58
     CENTER 6  $   279475.39
     CENTER 7  $   276012.00
     CENTER 8  $   267671.82
     CENTER 9  $   310362.47
```

ACQUIRING EQUIPMENT

To begin the first period and for subsequent periods, each center must (i) select the type of equipment, (ii) decide whether to purchase or lease the equipment, and (iii) determine the computer size or desired memory size. These equipment decisions may be altered, either expanded or decreased, in sub- sequent periods. Each center may select its equipment from brands of super minicomputers available. Equipment data showing purchase cost, lease cost, and efficiency ratings for each computer are given to each center.

RELEASE OF EQUIPMENT

As the simulation progresses, centers may opt to release or sell some of the owned equipment. They may also decide to return leased equipment, in favor of purchasing or reducing their own capacity. The following two guidelines describe the charges associated with return or release of equipment:

(i) leased equipment may be returned at the beginning of any period without incurring a usage or lease charge for that period.

(ii) owned equipment may be sold at the beginning of any period. The sale price is computer's present value minus the depreciation. All sales are for cash.

ACQUISITION OF PROGRAMMERS

Each center must maintain a staff or professional programmers.

There are three grades (skill levels) of programmers Trainee, Junior, and Senior available to each center, with varying salary ranges and ranges for expected programmer production in hours per period.

A programmer may be hired at any grade level and paid any salary within the relevant salary range level. The actual productivity of a programmer is a function of the grade, the salary and some uncertainty.

Promotion of Programmers

Promotion of a computer programmer (and thus increase of the individual's productivity) is accomplished in COMPSIM by increasing the programmer's salary. When the salary increases paid to either TRAINEE or JUNIOR programmers make their new salary more than their upper limit of that grade. SENIOR programmer productivity may also be increased through salary increases.

Release of Programmers

If a center decides to reduce its workforce, it may do so by releasing the programmer at the beginning of that period. There is, however, a fixed charge for dismissal of programmers. This charge is equal to one- half of the programmer's salary for the dismissal period.

The Demand For Programming Hours

The total programmer hours available for each period may be obtained by summing the expected programmer production hours for all grades of programmers The programming hours are used (demanded) in three areas of COMPSIM:

(i) participants in short term - (one-time) CONTRACT jobs

(ii) improving the QUALITY of the computer services through research and development CR & D) commitments

(iii) meeting the regular DEMAND for computer work by their clients.

CONTRACT JOBS

At various periods during the simulation, there will be a number of one-time contract jobs that are awarded.
The information about the contract will, come from the simulation administrator. An example of a contract job is displayed in Figure B-S. The AMOUNT OF BID is a decision made by the center.

Figure B-5
TYPICAL CONTRACT JOB

CONTRACT JOB NO.	11
AWARD DATE	PERIOD 3
DUE DATE	PERIOD S
MAXIMUM ACCEPTABLE BID	$45,000
PENALTY FOR LATE DELIVERY	10% of BID
COMPUTER HOURS REQUIRED	100
PROGRAMMER HOURS REQUIRED	250
CENTER NO.	5
AMOUNT OF BID	$36,000

QUALITY

In COMPSIM, there is a quality of service rating for each firm. At the outset of the simulation, each center begins with a QUALITY rating of 1.00.

Centers may increase their quality rating by expanding their research and development efforts. This is done in three ways (i) dollar outlays for research and development (R&D) , (ii) allocation of programmer time to R&D, and (iii) allocation of computing time to R&D.

Quality improvements are dependent on the amount of the R&D expenditure, and some randomness that simulates results of research and development.

Centers who successfully increase their quality index also further reduce their actual programming time needed to perform a task.

THE MARKET DEMAND

In COMPSIM all of the centers comprise the total supply for computing services. The total demand by client users is determined by a number of interrelated factors. These factors include:
(i) total hours sold last period
(ii) the change in average PRICE from last period (iii) the change in average QUALITY from last period (iv) economic GROWTH factor
If the average PRICE for the market decreases, the overall market demand for services increases. Like-wise, increases in average quality ratings by computer center cause the market demand to increase.

INDIVIDUAL CENTER'S DEMAND

The individual centers receive a proportion or share of the total market demand. This share is influenced by (i) their price relative to market average price, (ii) their quality rating relative to average, (iii) hours sold during the last previous period, and (iv) additional hours obtained through effective advertisement.

FINANCIAL CONSIDERATIONS

Each center is evaluated on NET WORTH, where NET WORTH is defined as sum of the value of equipment plus CASH minus any debt. The following eight (8) financial considerations explain hay PROFIT and NET WORTH are calculated. Each center should estimate carefully their profit projects and NET WORTH for each period of play.

(1) CASH is the working capital that each team uses to buy equipment, pay lease charges and meet other cash expenses that occur each period. CASH never becomes negative. If at any time during the simulation play, there is insufficient CASH, then a QUICK LOAN is made automatically to pay the insufficient amount.
(2) QUICK LOAN occurs automatically when the CASH on hand is insufficient. All QUICK LOANS are discounted by 10%, and the total is added to the center's DEBT.
(3) DEBT occurs when a center opts to purchase equipment or when a team is forced to take a QUICK LOAN. In COMPSIM, at least 10% of DEBT must be paid each period. Interest charges are fixed at 1.5% per period.
(4) PRICE is the amount that a center charges per hour for its computing time. Each center sets its price each period. However, changes in PRICE are limited to 10% of the previous period's price. PRICE is a major factor used to determine the DEMAND for hours for each center. It is up to each center to determine the sensitivity of price on their individual DEMAND. Historically, the prices for computing time have ranged from $L00 to $200 per hour.
(5) HOURS SOLD occur in the form of CASH sales for that period. The actual hours sold is the minimum of (i) DEMAND, (ii) AVAILABLE Hours FOR SALE, or (iii) MAXIMUM Hours FOR SALE.
(6) REVENUE is the total income derived from sale of computer time and from contract jobs. REVENUE = (HOURS SOLD) X PRICE + (CONTRACT payment
(7) OVERHEAD includes the fixed and semi-fixed cost associated with the operations of the computer center. In COMPSIM, this cost is taken as a fixed 30% of actual REVENUE. OVERHEAD - . 3 X REVENUE
(8) PROFIT is defined as the difference between REVENUE AND EXPENSES. EXPENSES include CASH OUTLAYS for INTEREST, DEVELOPMENT, ADVERTISEMENT, LEASE, USAGE, ORDERING, OVERHEAD and LABOR. Expenses also include a non-cash expense - depreciation (i.e. 3% of value of equipment per period).

The ranking of standing of a center is its NET WORTH. In COMPSIM a simplified method for this calculation is used:
NET WORTH = value of EQUIPMENT + CASH - DEBT.

CASHFLOW

It is important that each center carefully watch its cash inflows and outflows. Large outflows may force firms to take unwanted loans which in turn lowers NET WORTH. The following two-stage process describes the inflow and outflow of CASH in COMPSIM.

Stage I - Cash Outflows

1.5 percent (one period's interest rate) of DEBT is added to DEBT..
The cost of newly purchased equipment and/or order cost for lease equipment is added to DEBT..

State I - Cash Inflow

If centers opt to sell Equipment, the selling price is added to their CASH.

Stage II - Cash Outflow

Payments for DEBT (if any), for ADVERTISING, for DEVELOPMENT, and for the period's base LEASE price (including newly LEASED equipment) are all subtracted from CASH.

Stage II - Cash Inflows

The revenues from actual hours sold and from completed CONTRACTS for that period are added to CASH.

Final Cash Outflow and Cash Balance Determined

Overhead, usage cost, cost for leased equipment and programmers' wages are deducted from CASH. This represents the cash balance.

Net Worth Determination

Equipment is depreciated by 3 percent of its value. NET WORTH is then the sum of the Final CASH balance and value of EQUIPMENT minus any DEBT.

SUMMARY

COMPSIM is a computerized simulation which allows the students to manage a hypothetical computer center. The simulation introduces the students to the concept of simulation and to the fundamentals of group decision making. Teams are confronted with decisions concerning: price per hour for computer services, payment on debt, expenditures on advertising and/or R&D, purchase and release of computer equipment, acquisition or release of computer programmers, and planning the distribution of computer hours among contracts, R&D hours, and customer demand.

The centers or teams are confronted with a competitive (i.e., oligopoly) environment. It is their task to maintain a financially viable center and attempt to maximize net worth.

Many different operational and managerial strategies may be investigated in COMPSIM.