

BUILDING MICROCOMPUTER BUSINESS SIMULATIONS

ABSTRACT

INTRODUCTION

Micros are not fast processors, especially for programs written in interpretative **BASIC** and the printers associated with micros are painfully slow when printing multiple copies of the pages of output for each team. When a microcomputer business simulation is developed, care must be taken to enhance the learning process by using those features for which micros can be used to their best advantage. Unlike a terminal attached to a mainframe, microcomputers are able to provide stand alone data analysis. large library of decision analysis programs exist and are in every day use. Spreadsheets, database management systems, word processors and statistical packages abound. While proprietary software packages dominate the market, there exists public domain software which can be used if the level of funding for the more popular software is unavailable. Therefore, business simulation authors should consider the peculiarities of microcomputers as well as the wide variety of software currently available for them when they design new versions of their existing games or when they design entirely new business simulations.

were run for a class, students frequently rekeyed the data from the output sheets into **SPSS** formats in order to do analysis. In a similar manner, as micros became commonplace on campus, the data were keyed into **VISICALC** and later into **LOTUS** models. Paper output from these games need to be abandoned, replaced by electronic output in a form readable by spreadsheets and data base management systems. Up to now these students were tacitly shown how to become expensive data entry clerks and by rewarding those students who were super data clerks, the faculty approved their poor allocation of time.

ELECTRONIC OUTPUT

It is amazingly easy to provide electronic output from even current microcomputer simulations, simple **ASCII** file, with each piece of data on a line by itself can be produced with a simple write statement. Exhibit I is an example from the business simulation Marketing in Action [Ness and Day 1984] and has the following few lines of code to write out part of the income statement:

EXHIBIT 1
INCOME STATEMENT PROGRAMMING CODE

```

40240      IF IP=1 THEN LPRINT:LPRINT:LPRINT:LPRINT *
*****INCOME STATEMENT*****":LPRINT "
REGION ":"II$:" COMPANY ":"IT:" PERIOD ":"IPEP
40241      IF IP=1 THEN LPRINT"-----:LPRINT:LPRINT
40250      LPRINT" >>>>>>>>MARGIN CONTRIBUTION
":POIS: "<<<<<<<<<":LPRINT:LPRINT
40260      NETSALES$="          "NET SALES . . . . .
                    $$$$$$$$$$$$"
40270      BEGININV$="    Beginning Inventory .
                    $$$$$$$$$$$$"
40280      VARIABLECOST$="    Variable Costs . .
                    $$$$$$$$$$$$"
40290      RETRNPKGDCOST$="    Returnable Pkg Cost$
                    $$$$$$$$$$$$"
40295      HOMEMPKGDCOST$="    Home Market Pkg Co
                    $$$$$$$$$$$$"
40300      OVERTIME$="          "Overtime . . . . .
                    $$$$$$$$$$$$"
40310      INVENTORYCHGS$="    Inventory Charges.
                    $$$$$$$$$$$$"
40320      GOODSAVAIL$="    Goods Available for Sale
                    $$$$$$$$$$$$"
40330      ENDINGINV$="    Ending Inventory . .
                    $$$$$$$$$$$$"
40340      GROSSMARGINCONT$="GROSS MARGIN CONTRI-
BUTION- \ \ . . . . . $$$$$$$$$$$$"
40350      GROSSMARGIN$="          "GROSS MARGIN . . .
                    $$$$$$$$$$$$"
40360      LPRINT USING NETSALES$(DS(IT,IP)
40365      LPRINT"COST OF GOODS SOLD:"
40370      LPRINT USING BEGININV$(BIV(IT,IP)

```

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```

40550  LPRINT "   Produced this Month:"
40560  LPRINT USING VARIABLECOST%; CPRR
40570  LPRINT USING RETRNPKGCGST%;RPKGC
40575  LPRINT USING HOMEMPKGCGST%;HPKGC
40580  LPRINT USING OVERTIME%;OTC
40590  LPRINT USING INVENTORYCHG%;CCI,GAS1
40600  LPRINT USING GOODSAYAIL%;GAS
40610  LPRINT USING ENDINGINV%;EIV(IT,IP),CGS
40620  LPRINT USING GROSSMARGINCONT%;POI%,
      GMRG

```

The above lines of code generate the gross margin part of an income statement for one out of a possible set of three products. The generated income statement is shown in Exhibit 2. [Ness and Day, 1984]

EXHIBIT 2 INCOME STATEMENT

```

*****INCOME STATEMENT*****
      REGION 1 COMPANY 1 PERIOD 1

```

```

>>>>>>MARGIN CONTRIBUTION COLA<<<<<<

```

```

NET SALES.....$2798572
COST OF GOODS SOLD:
  Beginning Inventory..... 0
  Produced this Month:
    Var.Costs.....$1250000
    Ret Pkg Costs    $0
    Home Mkt Pkg.   $153921
    Overtime.....    $0
    Inv. Charges.   $25051 $1428973
    Goods Available for Sale $1428973
    Ending Inventory.. $250510 $1178462
GROSS MARGIN CONTRIBUTION - COLA .. $1620109

```

The same numeric information can be put into a file that is readable by a Lotus or other spreadsheet program with a very simple one program line of code as follows:

```

40000 CLOSE:OPEN FILE1% FOR OUTPUT AS #1: FOR
1 = 1 TO NVAR : PRINT #1,O(1):NEXT 1:CLOSE

```

This line of code produces the same string of numerical values as produced above with each item being on its own line. This file can then be imported into a LOTUS or other spreadsheet directly using a ".prt" file. If one wished, a spreadsheet template could be supplied for the output, providing the students with an entire set of electronic statements. Not only would this make the game output more readily usable by the student Management teams but would make the Programming much easier considering a large part of any simulation is the coding for all the output statements. The only caution is that the format for each statement would need to be fixed. Data such as Marketing research results which may not be requested for every turn of the game would still have to be allocated space. If substantial redesign

were to be done, distributed processing could be added and great changes could be made in the learning experiences of the students.

A complete redesign of business simulations would allow for reformatting all inputs as well as direct outputs into 80 character by 24 line formats. Full screen editors would facilitate the data input process and simple screen prints would suffice for any hard copy output needed by the team. If each statement was confined to a single screen, the student management team could concentrate on the job of running the simulated company instead of being file and data entry clerks.

DEMAND GENERATION AND ALLOCATION

The demand equations used in most of the available simulations are not easily changed or altered by an instructor. Take for example, the following demand generation equation for a single product, single market segment game. It is a simple three-variable, nine-parameter model. (Gold and Pray, 1984) An instructor wishing to alter the parameters' would have difficulty in determining the affects of any changes in the parameters.

$$Q = g_1 * P^{-\frac{(g_2+g_3P)}{g_4*A}} * g_5 * S^{\frac{(g_6-g_7S)}{g_8*S}} \quad (1)$$

Where :

- Q = The total derived demand in the market place.
- P = The harmonic mean of prices across all firms.
- A = Exponentially smoothed total advertising expenditures.
- S = Exponentially smoothed number in the sales force summed across all firms.
- g_i = parameters set by the game administrator.

Care must be taken when establishing elasticity parameters, industry elasticities must be smaller than firm elasticities (**Sweezy Kinked Demand Theory for Oligopoly**) or that simulation does not perform in a rational manner. Frequently the ability to alter Parameters is not reported in the documentation and one must know how to read the programming code in order to make changes. Caution must be used in making changes because the translation between parameter values and elasticity coefficients is not obvious. Routines are needed to translate desired elasticity values to parameter values. Equations to accomplish this translation are not difficult. It is possible to state the conditions in such a way as to make Alterations and their affects easily understood.

Exhibit 3 show possible? screen formats of how parameter changes could be made without undue trial and error.

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EXHIBIT 3. CURRENT PARAMETERS

Your Present Set of Parameters
page 1

1-Ind. Price Elast. @	7.00	/ unit	.500
2-Firm Price Elast. @	7.00	/ unit	.300
3-Ind. Price Elast. @	14.00	/ unit	2.000
4-Firm Price Elast. @	14.00	/ unit	5.500
5-Ind. Adv. Elast. @	50000	/ period	2.055
6-Firm Adv. Elast. @	50000	/ period	4.000
7-Ind. Adv. Elast. @	150000	/ period	.400
8-Firm Adv. Elast. @	150000	/ period	.800
9-Ind. Sales F. Elast. @	4	salesmen	3.500
10-Firm Sales F. Elast. @	4	salesmen	4.000
11-Ind. Sales F. Elast. @	16	salesmen	.300
12-Firm Sales F. Elast. @	16	salesmen	.900
13-Additional influence of Price			1.000
14-Additional influence of Advertising			1.000
15-Add. influence of the Sales Force			1.000

Using the cursor, make desired changes.

Data from questions 1 thru 12 are used in equations (2) and (3) to determine parameters for the demand equation (1). Using information from line 1 and 3 in the screen print above let:

The price level value of \$7.00 = A;
The Industry price elasticity
at \$7.00 of .500 = B;
The price level value of \$14.00 = C;
The Industry price elast.
at \$14.00 of 2.000 = D

Then;

$$g_1 = (B-C)/((A*(1+\log A))-(C*(1+\log C))) \quad (2)$$

$$g_2 = B-(A*(1+\log A)) * g_1 \quad (3)$$

The additional influence parameters allow Additional cross elasticities to be incorporated into the simulation. Values from 13, 14 and 15 become parameter values for 9., 94, and 97. This completes all the needed parameter estimations necessary to calculate the? industry demand. The same process using the firm data from above the screen and equations (2) and (3) can be used to determine the parameters for the allocation of that demand to each of the firms.

COST GENERATION

The majority of games provide a fixed cost structure during their course of play, while in reality, costs consistently change at different rates for different items. Students should realize that costs do change over time and that they must tract the results of these changes. In addition they must plan for changes in cost structures of their businesses over time. Cost structures and differential inflation or deflation rates can be generated in a straight forward, question and answer session at the start of each game. Exhibit shows screen prints allowing changes to be made in the cost structure of the firms in the Simulated industry. This allows both flexibility

in the description of the industry and changing conditions over time to be incorporated into the game. This process would make it easy for a novice instructor to follow and would add substantially more realism to a simulation. Of course all current costs need to be reported to the student teams each period and some of the these costs could be forecast with error terms for future periods.

Exhibit 4. Cost Structures

Unit cost, capacity and ratios Page 1

			Step	Annual %inc.
1-Labor costs	\$/unit	1.50	4	11.0
2-Cost per salesman\$/person		5000.	4	9.5
3-Fixed admin. cost		45000.	1	8.3
4-Cost of raw mat. \$/unit		1.75	2	3.1
5-Raw mat. Inv costs\$/unit		.06	0	
6-Fin goods Inv costs\$/unit		.09	0	
7-Cost /machine	each	3000.	1	4.5
8-Machine maint. \$/unit prod		.005	0	
9-Machine cap./units/period		3900	4	-20.
10-Income tax rate	Percent	44.	0	
11-Int. rate emergency				
loans	Percent	24.	0	
12-Bank charge for emergency				
loan	Per loan	1000	0	

Using the cursor, make desired changes.

Exhibit 4. (cont)

Unit cost, capacity and ratios Page 2

			Step	Annual %inc.
13-Int. rate term loan				
Percent		15.	0	
14-Int. rate Investments				
Percent		12.	0	
15-Cost /sales manager		9000.	4	8.
16-# salesmen /manager		5	0	
17-Hiring cost /salesman		8000.	4	10.
18-Firing cost /salesman		3000.	0	
19-Dividends /period		100000.	0	
20-Accounts receivable				
% of sales		33.	0	
21-Bad debts % of receivables		3.	0	
22-Plant depreciation				
% of cost		3.75	0	
23-Accounts payable				
% of materials purchased		25.	0	

Using the cursor, make desired changes.

These two screens could provide controls fu the cost structures. Notice that each component is allowed to have different inflation rates. In the screens above, the cost of labor goes up once a year corresponding to union contracts while materials costs goes up every six months. When mainframes were used in business simulation, parameters were not easily changed, but microcomputers provide a vehicle to alter these values whenever the instructor wishes.

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DISTRIBUTED PROCESSING

If distributed processing was built into a Business game, then student teams could Perform simulations within the game simulation. The beauty of this concept is that a team could study what would have happened if their team had made a different set of decisions under the same set of conditions as occurred in any previous period. A team could change their decisions and watch what would have happened had they been able to second-guess their competitors, because their competitors would always make their decisions exactly the same. Studying the results under ceteris paribus conditions would expand the learning concepts available to the student management team members and would greatly enhance the learning that takes place in this environment. Students would be able to investigate the shapes of demand curves, check the market's response to advertising changes and to test new products without the noise of competition or changing conditions in the marketplace.

While this is not real world and could never be utilized in a working situation, it provides insight into understanding one's competitive advantage. Using these features, business concepts and principles can be studied in the same fashion as the principles of science and physics. The force of gravity affects both the feather and the cannon ball the same, but one never sees them both fall at the same rate. The Physicist does not teach gravitational concepts by observation under uncontrolled conditions. Sometimes the affect of gravity is demonstrated with the aid of a long vacuum tube in which both a small ball and a feather are dropped at the same moment in time. In a similar manner, business principles can be isolated, the learning experience expanded and the student's inquisitiveness and curiosity encouraged. The trick is not to produce a simulated industry and have it behave exactly as it would in real life, but to produce a simulated industry with enough face validity to satisfy the participants. Reality is much too complex to be studied in the whole.

The best learning processes take place when the conditions are controlled and principles can be explored without too many interactions. Thus, price elasticity curves can be determined under their true definition; **the relationship between price and demand at an instant in time**. In addition to price, the effect of advertising, sales force and product formulation on demand as well as their interactions with each other could be explored. In a distributed processing simulation, these theoretical concepts can then be compared to what occurs under competitive condition over time. As a result, students can compare theory with practice and better learn how to move from the theory taught in universities to the world of the practitioner.

STUDENT OUTPUTS

the start of a microcomputer game with a student team should be able to select a name for their company and from

that point on each team can be referred to by that name. All input and outputs should be labeled by the company names and not by a team and an industry number. Thus, a student's firm which may be known as the **Southwest Manufacturing and Sales Company** should have all its statements labeled by that name.

Given that output is provided in spreadsheet readable files, each team could receive a floppy disk with a LOTUS template. This template then can be divided into statement sections such as a **Balance Sheet, Income Statement, Cash Flow, Sales Report, Factory Report, Production Report, Marketing Research Information, and Cost Information**. Each section would be a detailed report using column for the labels and columns B and beyond for the results of the initial output or starting position. Columns could be labeled using period numbers. At the start both the row and column labels could be shown on the screen using the labels command in the LOTUS spreadsheet. Statements, such as the reports suggested here, may require as many 300 rows or more. This format could then provide each student team with the maximum flexibility in analyzing and displaying their data. They may massage it in any fashion they wished and graph whatever relationships they wanted to view.

Getting started using spreadsheets for initial financial statements is easy. The following example shows its simplicity. Assume each student team has been given a data disk with a spreadsheet templates as described above, on it. Assume a file on the disk handed out to the student team is labeled "Start.prd" which contains the results of the starting period. The students would be instructed to load LOTUS into a computer and place their template disk into drive B:, and load the template. They then would be told to remove the template disk and replace it with the data disk. Next they would be told to put the cursor at column B, row 5, (the position for the first data value in the file) and bring up the menus in LOTUS by hitting the "/" and select "File", "Import", "Numbers" and to type the file name "Start" when requested. This procedure loads the starting position data from the file beginning at the point of the cursor. At this point in time they would have both the statement labels and the data in the spreadsheet.

The teams should be instructed to follow this same procedure each period with the exception that the input file name would change each period. Convention using the name "Per#" where the # symbol is the number of the period being run could be developed. The only caution is to be sure that the starting position of the cursor is in the appropriate column before importing. After each play has been recorded in the spreadsheet, the data disk would be removed and a team storage disk inserted for backup. The spreadsheet may be saved using the / command to bring up the Lotus menus, then have the teams select file followed by save. The student should type the name under which the spreadsheet is to be saved and presto, the team has their

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electronic financial and other statements on disk. If new names are used (suggest using Per# convention) with each new period's data included in it, the teams have backup copies for every period. In this way the student has both the current results and a running history of each and every iteration of the simulation. Lotus has been used as an example but any spreadsheet program could have been used in its place. The instructions would differ, but the process would remain almost as simple.

STUDENT INPUTS

Interactive software for recording decisions needs to be designed for use after a team has analyzed their data and are ready to input their decisions for the next period of play. Most of the micro versions now have this feature built in. It seems to be the one major change in the shift from mainframe to micro versions of simulations.

An additional feature to reinforce the concept of budgeting could be incorporated in these input routines. If marketing research budgets were either fixed or requested prior to the selection of the options, then students would quickly learn that research is a constrained activity. It has been this authors observation that most students use one or two research strategies, that of buying too much data (more is better) or buying too little (It's too expensive). Pointing out the difficulties of the first strategy would be assisted by a budgeting process.

Building a budgeting process into the input routine could be accomplished as follows. Exhibit 5 is a screen of a hypothetical input routine. Note that a marketing research budget is requested. Only after this value has been entered will a sub-menu appear allowing the selection of specific marketing research information.

Exhibit 5.
Decision Form

```
*****
Your Present Decisions
1-Decisions for Period          1
2-Product Price                8.95 per unit
3-Advertising Budget           100000 Dollars
4-Sales Force                   8 Salesmen
5-Production Schedule          230000 Units
6-Raw Material Purchases       275000 Units
7-Purchase New Machines        2 Machines
8-Marketing Research Budget     25000 Dollars
9-Pay Back Emergency Loans     0 Dollars
10-New Term Loans              0 Dollars
11-Invest in Securities         0 Dollars
12-Sell Off Securities          0 Dollars
*****
Using the cursor, make desired changes.
```

If the team wished more marketing research information than they originally budgeting for, the program should require that they go back to the decision routine and increase

their budget before they were able to request the additional marketing research. While procedures like this were possible using time sharing routines on mainframes, they had to be developed by each instructor and for each resident computer. The standardization of microcomputers makes this interaction available to all users without the need for the instructor to be a computer whiz.

OPERATING PRACTICES

One of the major drawbacks to business simulations in general, both mainframe and microcomputer versions is the operating practices. Simply because students will be students, decision deadlines are missed. The excuses are endless but missed decision deadlines are a hassle to the instructor. Rules of thumb are used by the instructor to make current decisions for the erring team and fines or other punishments are imposed, but the problems of instructor involvement and time delays remains. Routines can be developed to detect missing or non-current decisions, algorithms can be written to provide decisions that will not cause economic ramifications to the competing teams, the term can be fined and the instructor notified, all without requiring operator intervention. Note that the statement is can, this author of no simulation with this feature.

In the same vane, the problem may not be a late or missed decision but the withdrawal of an entire team. The majority of the simulations do not have provisions for the disappearance of a firm. The number of firms or teams is usually fixed at the beginning. Very fundamental artificial intelligence concepts can be incorporated to derive substitute decisions for teams which drop out. The use of industry mean values for price, marketing, A & D, and sales force size works well and does not affect the other teams strategies. Production and materials purchase strategies could be determined on the basis of the game's parameters and costs.

CONCLUSIONS

More effective use of business simulations in the classroom can be obtained by the use of microcomputers. This, however, is not automatic. Substantial care must be taken to rewrite the simulation models in order to make use of those features that will enhance the learning process and take advantage of the special features of the microcomputer. Micros are much more than small desk top computers. The way in which one interacts with the machine and the software is different with this small machine than with a mainframe. The fact that in a very short time period the microcomputer has become a commonplace office work station, one in which business students need to become accustomed. The use of simulations designed to interact with existing graphics, analysis and statistical microcomputer programs can teach not only important business principals, and provide insight to business practices through the use of these business simulations but they also teach students how to effectively utilize microcomputers and currently used software as well.

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ENDNOTES

This demand formulation was suggested by Gold and Pray in 'Simulating Market and Firm Level Demand: A Robust Demand System' Developments in Business Simulation Experiential Exercises Vol 10, 1983: Lee Graf and David Currie editors pp 101-106.

Tom Ness and Ralph Day Marketing in Action 5th Ed Richard D. Irwin, 1904. Joseph Wolfe and Richard Teach 'Three Downloaded Mainframe Business Games: An Essay Review', paper in preparation. 1985