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SIMULATION WITH INTEGRATED SPREADSHEETS: THE DESIGN AND DEVELOPMENT OF A CONVERSATIONAL MARKETING CONCEPTS DECISION GAME

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ABSTRACT

Integrated spreadsheets aren't just for financial models. In fact, they can simulate many different types of dynamic processes. This paper attempts to outline some of the basic principles that could be applied in designing and developing a spreadsheet simulation. MARKETING CONCEPTS, a spreadsheet simulation developed by the author is used to illustrate program development and system utilization.

INTRODUCTION

Many marketing faculty find computer simulations lively and effective. In fact, many hook publishers are now offering as part of their principles of marketing textbook packages companion microcomputer software, including various simulation packages. Marketing decision games offer a unique means of teaching marketing concepts and developing strategic abilities. With hands-on decision-making through simulation, students wore fully appreciate the complexity of the interaction among marketing mix components. Opportunities emerge for employing previously studied marketing decision-making tools. Also, through computer feedback, students note applications and limitations of various concepts such as price elasticity, breakeven analysis, ratio analysis, price markups, and a myriad of other concepts applicable to marketing opportunities and problems. This paper reports an alternative form of decision game which the author believes has a number of unique advantages over the traditionally used programming language batch mode games - a conversational [5] spreadsheet simulation involving competition between one player and a programmed, synthetic environment.

There is little question that the first, and still the primary, use of an integrated spreadsheet Is for financial applications such as budgeting, cash planning, and forecasting. n fact, advanced generations of spreadsheet software have concentrated on improving such features as formatting, word-processing, and integration with data bases; that is, features whose primary beneficiaries are the financial modelers. However, less obvious to the casual observer is the fact that most spreadsheet software can be used to analyze problems in disciplines other than accounting and finance [3].

Why Use a Spreadsheet?

The speed and accuracy of the computer have great y changed the science of simulation modeling in recent years. It is now possible to build and use model of truly astounding complexity. However, to many faculty, the design of business simulations is a very complex aspect of programming that, while widely used,, is still regarded as a mysterious science. Simulations have been developed in all areas of science and technology [1] and there are specialized programming languages that can be used to write simulations [4]. Still, the process is not easily available to many nor-computer business faculty.

But instructors can build customized simulation lessons quickly when they use the model presented in this paper. An attempt has been made by this author to offer an alternative format -the use of a spreadsheet in creating a marketing simulation. Spreadsheets possess some inherent advantages which are not available utilizing the typical methodology of our writing a computer program for processing decisions and producing simulation results. Perhaps one of the major advantages of a spreadsheet is the ease of installation of the simulations functions. The simulation writer does not have to learn a complex computer language. Using a spreadsheet, the writer enters the formulas as they might see them in a book or on a chalkboard (of course, using the reference cell language of the spreadsheet).

Probably the biggest problem with using a general- purpose computer language for simulations is the complexity of the resulting software [6]. Like all programming tasks, writing a simulation is usually far more complex than it first appears and, sooner or later, most programmers feel the need for something easier. Spreadsheets, or. the other hand, provide the writer with a systematic approach in developing the simulation. Good worksheet structure conveys a sense of flow or progression. With a modular approach used in spreadsheet design, the writer can easily add functions and modify existing model assumptions.

Finally, spreadsheets are becoming standard tools on the desks of many executives in the business community. Therefore, the spreadsheet environment watches the reeds of a manager or decision maker. Data is placed in tables, very much like the tables a manager might write on a sheet of paper. The results of the analysis can be readily printed, and can appear in the form of a table suitable for insertion in a report. That is, the spreadsheet conforms to the way managers handle data and information. Thereby, using the spreadsheet for simulations, students may be provided positive experience with the same type of software they are likely to find in the workplace.

Simulation Worksheets by Design

To indicate the potential of a spreadsheet simulation methodology, a conversational marketing simulation entitled MARKETING CONCEPTS, has been developed by the author. It appears to be a workable, pedagogical tool. The specific model from which this simulation evolved is based on a commercially available computer game called Paintco [21. The Paintco computer program permits a set of marketing decisions for the paint market (e.g. price, distribution, promotion, product quality, seasonality, for both the company and the market to be entered for a period of play and the computer then calculate their results and shows a series of reports. Several features of Paintco have been retained in the development of MARKETING CONCEPTS. The use of numerical levels (i.e. , I through 9) for data entry have been retained as an easily understood way of choosing a decision variable for data input and the formulas have been modified to reflect the laptop computer marker. Added to the spreadsheet simulation, however, have been a series of analysis modules which enable a student to explore several marketing concepts (e.g. price elasticity of demand, breakeven analysis, price markups, and selected ratio analysis components).

The design and development of this spreadsheet decision game was primarily the result of finding simulation design fundamentals on a trail-and-error basis. Upon reflection on this simulation writing

experience, the author has been able to develop a generalized model for writing conversational spreadsheet simulations. There are a number of specific design principles which a simulation writer should address when specifically designing a spreadsheet simulation. While probably not exhaustive, they include the following:

Design Principle #1
Build a Simulation Worksheet Block by Block

After determining what your simulation will accomplish, follow the pattern laid out in Figure 1 and block out the worksheet's main sections in a vertical structure, from top to bottom: Data Input, Reference, Formulas, Results, Analysis, Menu Selection, and Macros. Figure 1 provides the blueprint for the MARKETING CONCEPTS simulation worksheet.

The data input block is were the player enters the data that the worksheet will digest and use for the simulations calculations. This block contains the marketing mix decision variables of price, promotion, product features, and distribution. An example of this input is shown in Figure 2. Think of the data input block as a control panel. The player can change the decision variables to test "what if" conditions such as a decrease in price or an increase in advertising. A changed variable in this block, and the whole worksheet changes.

Related to the data input block is a reference block which provides the user with a quick reference of the data input variables without having to go back to the instructions section of the simulation (See Figure 3). The formula block is entirely mechanical; the simulations formulas gather data from the input block and crunch away. The complexities of the equations and the interrelationships are illustrated in Figure 4. The results block is an abbreviated income statement which reports the bottom line of the students decisions. A complete illustration of the results is presented in Figure 5. It includes for the decision period in question, the units sold, the expenses incurred, the profit or loss, the total units sold in the market and the company's market share.

The analysis blocks permit the student to analyze in more detail their decisions. This block contains price elasticity of demand (See Figure 6 as an example), breakeven analysis, price markups, and selected ratio analysis techniques.

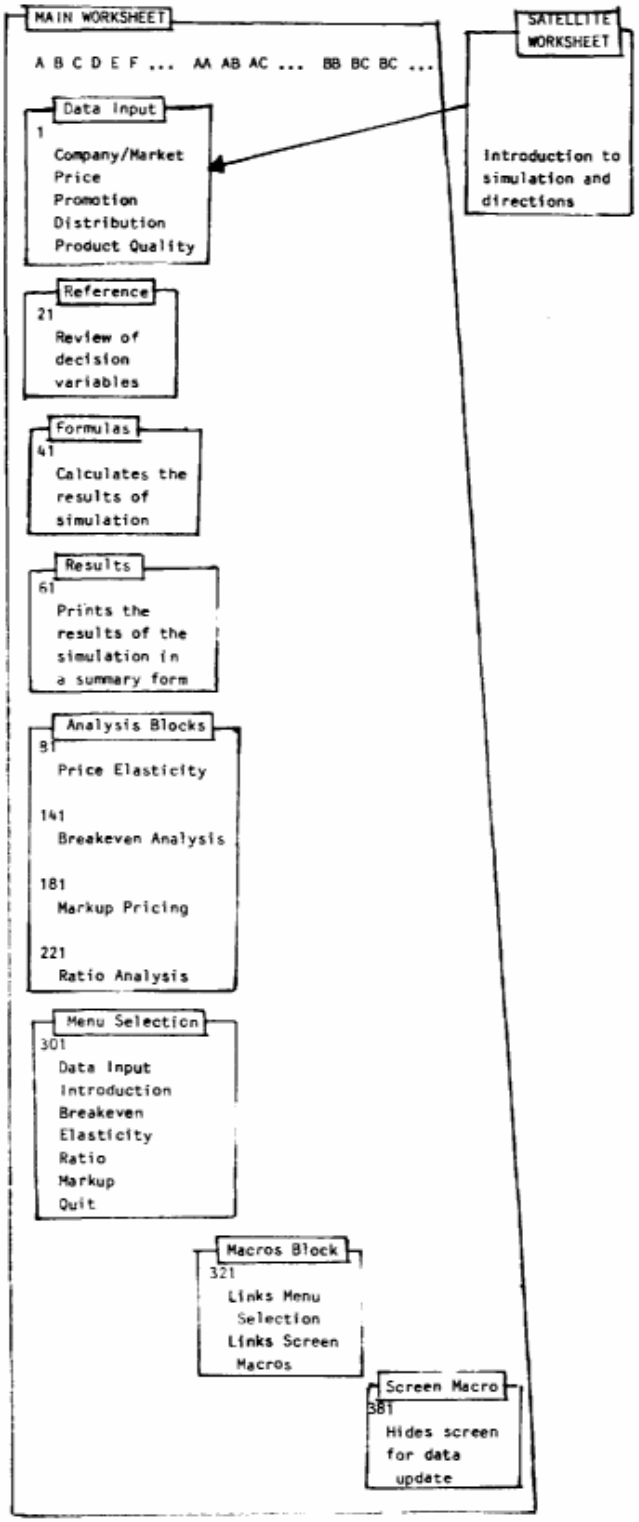
Figure 7 illustrates the menu selection block which offers a variety of commands for use in moving around the simulation worksheet easily. Commands for moving to another section of the spreadsheet can be selected by using the computer's right or left arrow keys which will move the cursor and highlight the desired command. Pressing the enter key at this time will move you to the desired section selected.

Figure 8 illustrates the Macros used in the worksheet. The macro blocks should always be below and off to the side of the worksheet's main activities. In Figure 1, for example, the macros for this simulation are fastened at row AA321 and 8B381.

By setting up a worksheet with the vertical block model approach, each step in the worksheet will be visible and will support the one that follows it. In the MARKETING CONCEPTS simulation, the seven major blocks are made up of smaller, structurally similar blocks, which make it easier to root out errors in procedures or logic.

This modular structure even makes it easier to print selected sections of the worksheet. Want a printout of the results section so that it can be compared with previous results, or you want a printout of one of the analysis sections? No problem; mark it and print it out.

Figure 1. Building a Simulation Worksheet Block by Block



Good vertical block structure also really pays off when you have to modify the simulation worksheet, because it's easier to recognize logically discrete elements, add new blocks, or reorder blocks. The

Figure 2. Data Input Table

```
      A       B       C       D       E       F       G       H
1                          DATA INPUT SECTION
2
3                                      MY COMPANY      MARKET
4                                      ----------      --------
5   PRODUCT QUALITY & FEATURES              1              5
6   DISTRIBUTION                            1              5
7   PROMOTION                               1              5
8   PRICE                                   1              5
9
10  ================================================================
11
12  After entering data, return cursor to Cell A1 by pressing the
     HOME key,
13  then press [Alt] R keys for the results of the simulation run
14
15  To review the input options available for your company or
16  market variable press the [Alt] A keys when the cursor is in
17  Cell A1.
17
18  For other options, press Alt M keys to go to the Menu Selection
    Table.
19
20
 A1

  1 help 2 edit 3 name 5 go to 6 window 7 data 8 table 9 recalcu-
    late 0graph
270K                              2:33                          READY
```

Figure 3. Reference Table

```
      A       B       C         D         E         F         G
21                                DATA INPUT REFERENCE
22  Product Quality & Features:
23          Ranges from a low quality and very few features repre-
24          senting a level of '1',to a very high quality and many
25          advanced features representing a level of '9'.
26  Distribution:
27          Ranges from a level of '1', representing exclusive dis-
28          tribution, to '5' representing selective distribution,
29          to a level of '9', representing intensive distribution.
30  Promotion:
31          Ranges from a level of '1' representing all personal
32          selling, to a '5' representing 1/2 personal selling and
33          1/2 advertising, to a level of '9', representing all
34          advertising.
35  Pricing:
36          Varies from a level of '1' = $560, to a'5' = $1120, to
37          a level of '9' = $1680.
38
39          Press [Alt] keys to return to the Data Input Table
40
 A21                          DATA INPUT REFERENCE
1help 2 edit 3 name 4 abs 5 goto 6 window 7 date 8table 9
 recalculate 0graph
279K                              2:54                          READY
```

Figure 4. Formulas

```
A41'Formulas                                                    B41
A41                                                             B42
A43 .25                                                         B43
A44 -1.4+((4+F8)/(6+(D8^1.5)))*4.4                              B44
A45 @ABS (D7-F7)+2*F7                                           B45 +A45/9.5
A46 (D5-1.5)/F5                                                 B46
A47 (D6+5)/(F6+5)                                               B47
A48 .3*PRICE+.27*PROMOTION+.2*QUALITY+.23*DISTRIBUTION
A49 420+$D$8*140
A50 @INT(SEASONALFACTOR*SALESFACTOR*20000)
A51 (F0)  +COMPANYSALES*PRICECONVERSION
A52 (D0)  +COMPANYSALES*(100+$D$5*50)
A53 (D0)  @IF($D$6<6,COMPANYSALES*20,COMPANYSALES*20+COMPANYSALES
    *($D$6-6)*3)
A54 (D0)  @INT((REVENUE*.07*($D$77-1)/8-.0000001)*100)/100
A55 (D0)  .1*REVENUE*(9-$D$7)/8+.001
A56 (F0)  2000000
A57 @IF($D$5<5,765000+283000*($D$5-5),280000+100000*$D$5)
A58 (F0)  +REVENUE-COSTOFGOODS-DISTRIBUTIONEXP-ADVERTISINGEXP-
    SALESCOMMISSION-ADMINISTRATIVE-QUALITYEXP
A59 (F0)  100000*($F$7+10)/15*((-$F$8+$F$5+20)/20)*(($F$6+24)/30)
    +COMPANYSALES-129
5
A60 @INT
((REVENUE/PRICECONVERSION*1000)/(MARKETSALES*SEASONALFACTOR))/10
```

Figure 5. Results

```
     A       B       C       D       E       F       G       H
61                RESULTS OF SIMULATION RUN
62                  PROFIT & LOSS SUMMARY
63                                      PREVIOUS        CURRENT
64                                      --------        ---------
65          UNITS SOLD                      4628           8962
66          @ PRICE                         1120            560
67  SALES REVENUE                     $ 5183360      $ 5020400
68  COST OF GOODS                     $ 1619800      $ 1344750
69            GROSS MARGIN              3563560      $ 3675650
70  LESS OPERATING EXPENSES:
71   DISTRIBUTION                     $   92560      $  179300
72   SALES COMMISSION                 $  259168      $  502040
73   ADVERTISING                      $  181418      $       0
74   ADMINISTRATIVE                   $ 2000000      $ 2000000
75   QUALITY CONTL & RES & DSGN       $  780000      $  380000
76         TOTAL OPERATING EXPENSES   $ 3313146        3061340
77  NET BEFORE TAX                    $  250414      $  614310
78  ANNUAL MARKET SALES Estimate WAS    100000, NOW  104337 UNITS
79  MARKET SHARE WAS ESTIMATED AT         18.5, NOW    34.3%
80            Press the [Alt]-M keys to go to Menu Selection Table
 A61
 1 help 2edit 3name 4abs 5goto 6window 7data 8table 9recalculate
   ograph
270K                              2:56                          READY
```

Figure 6. Example of Price Elasticity of Demand Analysis Module

```
        A      B      C      D      E      F      G      H

81
82  CONCEPT OF PRICE ELASTICITY OF DEMAND
83  ═══════════════════════════════════════════════════════
84      The PRICE ELASTICITY OF DEMAND defines the sensitivity of
85  buyers to price changes in terms of the quantities they will
86  purchase.  Price elasticity is computed by dividing the per-
87  centage change in quantity demanded by the percentage change in
88  price charged:
89      Initial quantity-New quantity/Initial quantity+ New
          quantity
90  E = ------------------------------------------------------------
91      Initial price - New price/Initial price + New price
92
93      This formula shows the percentage change in quantity de-
94  manded for each 1 percent change in price.  Because quantity 95
    demanded usually decreases as price increases, elasticity is a
96  negative number.
97      Price elasticity of demand usually assumes three forms:
98  ELASTIC DEMAND, INELASTIC DEMAND, AND UNITARY DEMAND.
99
100           Press the PgDn key to continue


        A      B      C      D      E      F      G      H
101
102 (leave the pointer in cell A61)
103
104 1.  ELASTIC DEMAND occurs if relatively small changes in
105     price result in large changes in quantity demanded.
106     Numerically, price elasticity is greater than 1.  With
107     elastic demand, total revenue goes up when prices are
108     decreased and goes down when prices rise.
109
110 2.  INELASTIC DEMAND takes place if price changes have little
111     impact on quantity demanded.  Price elasticity is less
112     than (<) 1.  With inelastic demand, total revenue goes up
113     when prices are raised and goes down when prices decline.
114
115 3.  UNITARY DEMAND exists if changes in price are exactly off-
116     set by changes in quantity demanded, so that total sales
117     revenue remains constant.  Price elasticity is 1.
118
119               Press the PgDn to continue
120
 A101


        A      B      C      D      E      F      G      H
121
122 WORKSHEET FOR DETERMINING PRICE ELASTICITY OF DEMAND
123 ═══════════════════════════════════════════════════
124
125
126 Initial quantity demanded:          4628
127 New quantity demanded:             8965
128 Initial price:                     1120
129 New price:                          560
130
131
132       Price Elasticity =     -.96
133
134
135
136      Press [Alt] M keys to return to the Menu Selection Table
137
138
139
140
 A121
```

worksheet will also make more sense from the start - both to you the author and to any one look over your shoulder - leaving you free to concentrate on the simulation objectives itself.

Design Principle #2 Developing Block Structure

Cast the worksheet's general shape by entering labels for each block (such as Data Input, Formulas, Results, etc.). This will permit the user to know which section they are viewing.

Also, for convenience' sake, anchor the different blocks in the worksheet to easy-to-remember rows as A21, A41, and A81.

Don't put blocks side by side, because if you later insert rows in one block, you 11 encroach on its neighbor.

Design Principle #3: Use Range Names to Minimize Reference Errors

Although the worksheet's formulas and micros can reference specific cells or labels, using range names simplifies matters. Range names should be applied to a cell, row, or entire block in a worksheet if it will minimize typing errors when creating formulas and macros. Most spreadsheet programs include a show function that lists all range names with their beginning and ending cells. Ranges should always be assigned to cells or rows that are used in calculations. Range names have been assigned to the equations in the formulas block.

Design Principle #4: Protect Key Cells of the Worksheet

When you create a worksheet simulation, all of the cells are unprotected; you can enter data in any of them. It's a good idea to protect the final version when you have unfinished building and modifying the simulation. This will prevent anyone from inadvertently modifying or erasing important cell contents. Most worksheet protection is global: it protects all the cells in the worksheet. Once global protection is enabled, you can then unprotect specific ranges or cells that you want to be able to access and change.

Design Principle 5: Use Macro's to Simplify Interaction with systems

Any task that a spreadsheet can perform, from the simplest to the most complex, can be automated with a macro facility. A macro is made up of a series of steps, each of which represents an instruction to the spreadsheet. Regardless of how many steps a macro includes, it can be invoked with only two activating keystrokes. In MARKETING CONCEPTS, macros are used to move the user to certain locations within the spreadsheet, in developing the menu selection table, and to create a message screen to hide a macro activity (See Figure 8).

Design Principle #6: Document, Document, Document!

Documentation takes two forms: one for the simulation participant and the other for faculty members who would like to see the model and the various elements making up the simulation itself.

You can display a description of the simulation scenario and the participant's instructions on how to run the simulation in a number of way so that they are easy to find. One of the simplest techniques is to assign them to a "satellite" worksheet -a separate worksheet that passes to the main worksheet after it is used. In MARKETING CONCEPTS, the satellite worksheet is automatically loaded without operator intervention. Every rime the spreadsheet (Lotus 1-2-3 or VP Planner) starts up, it searches the default disk drive for a file named AUTO123.WKS.

When the file is found, it is automatically retrieved and the simulation scenario and instructions are displayed on the screen. To make the reading of this material as easy as possible, you should assign material to a full-sized-screen area only and tell the viewer to leave the cursor in the Al cell and use the PgDn key to move to another window.

After reviewing the scenario and instructions the user can either recycle the scenario and instructions or pass to the data input section of the main worksheet to begin the simulation. In the satellite worksheet the user manual is completely written down as to all the fine points and details. An accurate and clear description must be made for all simulation data necessary to make appropriate decisions. Therefore, charts, tables, graphs, etc., would be helpful In presenting and understanding simulation data. An illustration of a typical table used throughout the introduction is shown in Figure 9. After the detailed explanation has been digested, the user can often refer to a summary table in the reference block. Also, make some room for documentation throughout

Figure 7. Menu Selection Table

```
          A      B      C      D      E      F      G      H
301
302                            MENU SELECTION TABLE
303
304
305 PUT THE CELL POINTER OVER:
306
307 Data         to update data and return to the DATA INPUT TABLE
308 Breakeven    to run BREAKEVEN ANALYSIS
309 Markup       to run MARK-UP ANALYSIS
310 Elasticity   to run ELASTICITY OF DEMAND ANALYSIS
311 Ratio        to run RATIO ANALYSIS
312 Intro        to return to the INTRODUCTION module
313 Quit         to quit the simulation at this time
314
315
316
317
318
319
320
 A301
```

Figure 8. Macros

```
       AA     AB     AC     AD     AE     AF     AG     AH
321 MACROS
322  m      /xmab332~                          Calls Menu Micro
323         /xmab325~                          Moves to commands
324
325    Data  Intro  Breakeven Elasticity  Ratio  Markup  Quit
326
327/xgab334~/xgab368~/xgab354~/xgab358~/gab370~/x
    gab356~/xgab360~
328
329
330
331
332          {goto}a301~/xr                   Moves to Menu
333
334   h      /xcHIDE~                         Updates the Data
335          /c$G$65..$G$79~$E$65..$E$79~
336          {goto}e61~{down}{down}{down}{down}
337          {edit}{calc}{down}{edit}{calc}{down}
338          {edit}{calc}{down}
339          {edit}{calc}{down}
340          {edit}{calc}{down}
AA321   'MACROS
```

Figure 8 (cont.)

```
       AA     AB     AC     AD     AE     AF     AG     AH
341          {edit}{calc}{down}
342          {edit}{calc}{down}
343          {edit}{calc}{down}
344          {edit}{calc}{down}
345          {edit}{calc}{down}
346          {edit}{calc}{down}
347          {edit}{calc}{down}
348          {edit}{calc}{down}
349          {edit}{calc}{down}
350          {edit}{calc}{down}{home}
351          /xcUNHIDE~
352          {goto}D5~/xq
353
354   b      {goto}a141~                Moves to Breakeven
355
356   u      {goto}a181~                Moves to Markup
357
358   e                                       Moves to Elasticity
359
360   q      /qy                                Quit
       AA     AB     AC     AD     AE     AF     AG     AH
361
362   r      {goto}a61~                 Moves to Results
363
364   a      {goto}a21~                 Moves to Reference
365
366   d      {goto}a1~                  Moves to Data Input
367
368   i      /frauto123~                  Moves to Introduction
369
370   f      {togo}a221~                Moves to Ratios
371
372 hide     {goto}TL~                  Hides Screen
373          {goto}BR~
374          /wwv/wwu
375          {windows} xr
376
377 unhide   /wwc/wws                     Unhides Screen
378          /xr
379
380
AA361
```

the worksheet. Just as an article summary helps to guide readers, worksheet documentation helps subsequent users find the information they need to add or modify the simulation model. For example, a "table of contents" that lists the function of each of the models formulas is a handy guide. It also makes sense to note macro key combinations and describe what each macro does.

Summary

MARKETING CONCEPTS is an integrated spreadsheet based simulation designed for the introductory marketing course. Its Intended role is as a complement to the typical course format of text assignments, lectures, discussions, cases, and so forth. As such, it embodies the major marketing concepts to familiarize students with basic decision alternatives, and the interaction among marketing mix variables vis-à-vis the marketing environment. The simulation Is still under development, and it is difficult to judge its effectiveness at this time. It is expected to require at least 6 months to test the game in the classroom and make appropriate modifications on it,

Design and development of a marketing simulation at best is a challenging and time-consuming task. However, an integrated spreadsheet provides some unique opportunities for simulations. The availability of

such simulations opens the door for many instructors to develop and use simulations as a pedagogical technique. One no longer needs to be an expert in computer programming to develop simulations. As an instructor becomes familiar with the principles presented in the paper, the time involved in creating models for conversational simulations can be greatly reduced.

There are many other dynamic systems, discrete and continuous, that one can simulate with a spreadsheet. I have tried to show how a spreadsheet can be used to model a marketing system, which demonstrates that a spreadsheet can be used for much more than financial analysis.

Overall, the implementation of a spreadsheet simulation is technically impressive and has the potential to be a valuable pedagogical tool when applied in the right situations.

Figure 9. Example of a Table in the Introduction Module

```
      A      B      C      D      E      F      G      H
421
422     4.  The DISTRIBUTION budget:  Your company has a broad
423         range of distribution alternatives available.
424         Distribution can vary from a level of 1 (exclusive
425         distribution) to 5 (selective distribution) to a
426         level of 9 (intensive distribution).  The input
427         variables for the distribution factor are:
428
429
430
431
432         ---------------------------------------------
433         1     2     3     4     5     6     7     8     9
434    Exclusive               Selective                Intensive
435    Specialty               Specialty                Specialty
436                          Computer Whirs            Cmptr Whirs
437                                                    Dept. Stores
438                                                    Disc. Stores
439 ---------------------------------------------------------
440
 A421
```

```
      A      B      C      D      E      F      G      H
441
442 Distribution Costs Per Unit at each Distribution Level
443
444
445         1     2     3     4     5     6     7     8     9
446       $20   $20   $20   $20   $20   $20   $23   $26   $29
447
448
449       Expanding the number of distribution outlets increases
450
451       both direct and fixed distribution costs.  This occurs
452
453       because increased distribution requires additional labels
454
455       packaging modifications, and delivery stops.
456
457
458
459 ---------------------------------------------------------
460                 (Press the PgDn key to continue)
 A441
  1 help 2edit 3name 4abs 5goto 6window 7data 8table 9recalculate
    ograph
                            3:15                          READY
```

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