

## WORKSHOP ON ANALYTIC MARKETING: MODEL BUILDING WITH LOTUS 1-2-3

Gary L. Lilien  
Penn State University

### ABSTRACT

Marketing models are becoming pervasive both as operational tools and as aids in understanding the operations of the marketplace. Until recently, considerable background in mathematics was needed to understand or build marketing models. The advent of the microcomputer and the development of software like Lotus 1-2-3 has changed that situation.

I have developed and have used microcomputer/Lotus 1-2-3 based pedagogic tools that have proven successful in:

- a. Introducing modeling concepts and skills at the undergraduate and MBA level.
- b. Interesting and explaining modeling ideas to marketing executives.
- c. Helping PhD students deepen their understanding of how to build and use marketing models.

In this presentation, I will demonstrate some of the software that I have used for these different purposes and share my experiences in these different pedagogic situations.

### Introduction

Markets are becoming increasingly competitive, the amount of data that is available for marketing decisions is growing and product life cycles are shortening. Marketing managers (current and prospective) are increasingly called upon to make sound decisions in the face of these formidable and increasing challenges. They typically rely on four major modes of response to these challenges.

Experience. Marketing people often say that experience is the best teacher. It is clearly valuable, but is unique in each person, and there is no easy way to transfer the experience of one individual to another or to choose between two "experience based" recommendations.

Standards of Practice. Companies tend to evolve standard policies and procedures to guide decision makers. These standards are often in the form of guidelines (like standard advertising to sales ratios or case allowances on promotions). But such standards, while often quite good on average, are inflexible, not providing the guidance to respond or adapt in a market with changing conditions.

Data or Facts. We encourage managers to rely on data or facts in making decisions. A manager who can say that 72% of consumers prefer package A to package B seems to have a compelling argument in favor of package A. But that conclusion is based on a set of assumptions including: higher preference leads to higher purchase rates; the sample of respondents represents the target market; the package is a tangible factor in the purchase decision; and others. Thus managers have

a framework that they use when viewing data. Facts are useful but, to be useful, must be translated into actionable information through explicit or implicit models.

Models. Because marketing systems are too complex to manage in all their detail, people deal with models of them. A model is the specification of the set of variables, relationships between those variables and management's objectives. The modeling approach to decision making has the advantages of being systematic, explicit and repeatable. Because it requires explicit specification of relationships, the modeling approach incorporates experience but does not rely on it. Modeling permits an explicit evaluation of the costs and benefits of breaking with standard business practice. Finally, as a vehicle for interpreting data, a model helps specify what data should be collected and often allows for informed decisions with less data than would normally be collected.

### Model-Phobia: Cause and Cure

"Modeling is what those ivory tower guys at the university do; real marketing managers don't need or use models," think many marketing students and marketing managers, even if they don't admit it. They're wrong, and here's why.

Everyone builds models all the time. If you are married, you often use a model of your spouse's behavior to predict how he/she will react to something you are about to suggest. "I knew he (she) would react that way!" you might think, afterward. If you think this way, you are using a (mental) model of his or her behavior--otherwise, why weren't you surprised? Marketing managers use models all the time in the same way when they predict how consumers in the markets they manage are likely to react to their actions (advertising programs, price changes, new product offerings and the like). The only difference between those who say they use models and those who claim they do not is the degree of formality in their modeling process. But formal model building has traditionally required both clear, systematic thinking and considerable mathematical training to execute. These two formidable hurdles have limited formal model-building in marketing to a relatively small number of situations. Sound decision making will always require clear, systematic thinking. But the widespread availability of personal computers and software like Lotus 1-2-3 has considerably reduced the mathematical barriers to model building, increasing the potential for use considerably.

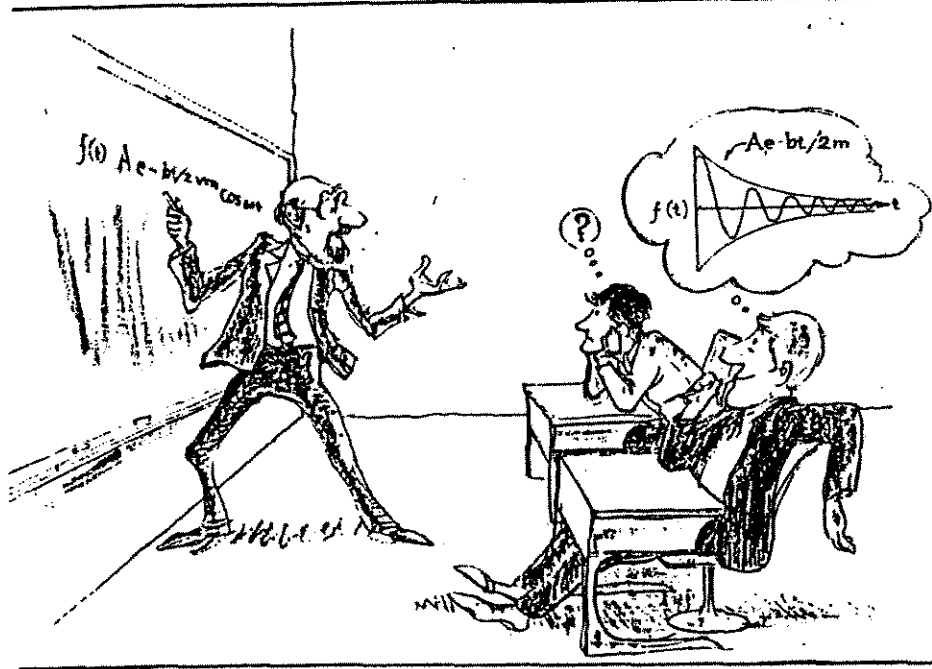
In the sections below I will outline the approach I have taken to address the needs of two different constituencies: the prospective model builder and the prospective model user. I will argue that rapid recalculation ("what-if?") capabilities combined with instant graphics promises to make formal modeling possible for those with very limited mathematical skills.

### For the Prospective Model Builder....

In the early 1980s, I was trying to teach the skills of model building in marketing to groups of PhD students in marketing and to some motivated MBAs. I had very little success, to my mind, because of a "language barrier"--ie, a lack of mathematical skill by the students as much as anything else.

Let me illustrate my predicament and "cure" with Figures 1 through 3. Figure 1 shows an Engineer and a Humanities Major listening to my lecture about damped harmonic oscillation. As you can see, I am using mathematics liberally, but the two listeners hear entirely different things. The Humanities Major sees a bunch of symbols that mean nothing to him.

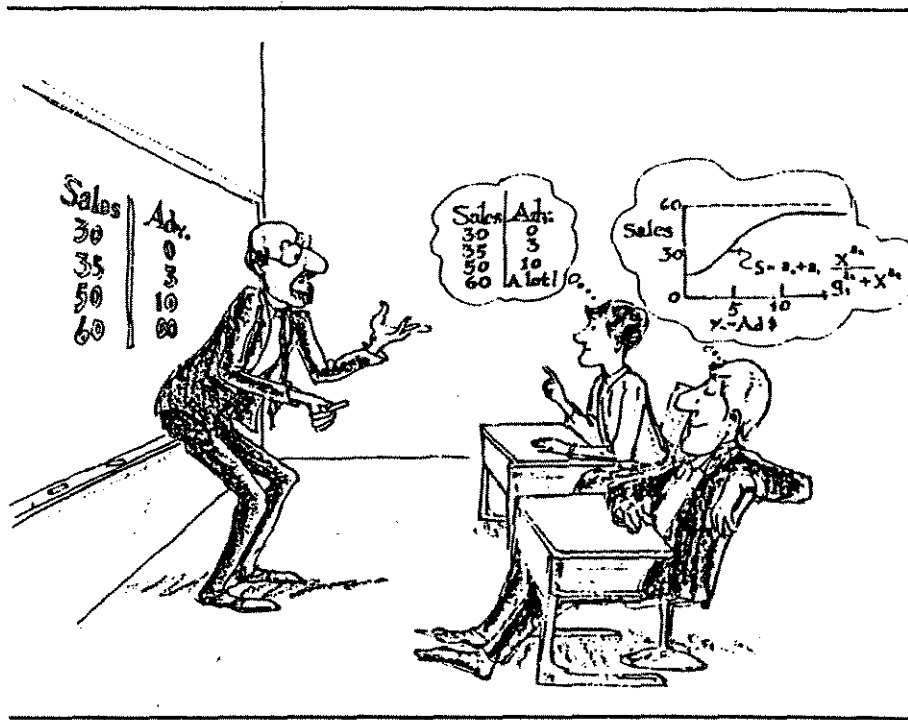
Figure 1  
The Engineer and the Humanities Major  
Differ in Their Abilities to Understand Mathematical Models



The Engineer, on the other hand, has the experience and practice of translating this equation into a picture. He probably has a mental library of such pictures that he has built up in a series of courses over the years and he mentally translates this equation into the appropriate picture. He knows what happens to the shape of the curve when  $a$ ,  $b$  or  $m$  change because he has worked with many such equations. In other words, he is an analytic expert.

Figure 2 puts this situation in a marketing framework. Both individuals are exposed to the same data. The Humanities Major, perking up a bit here, sees the numbers exactly as they are. The Engineer, an experienced modeler, sees a relationship in those data and plots them up as a graph in his mind. And he draws a mathematical form from his mental library of functions that can represent those data.

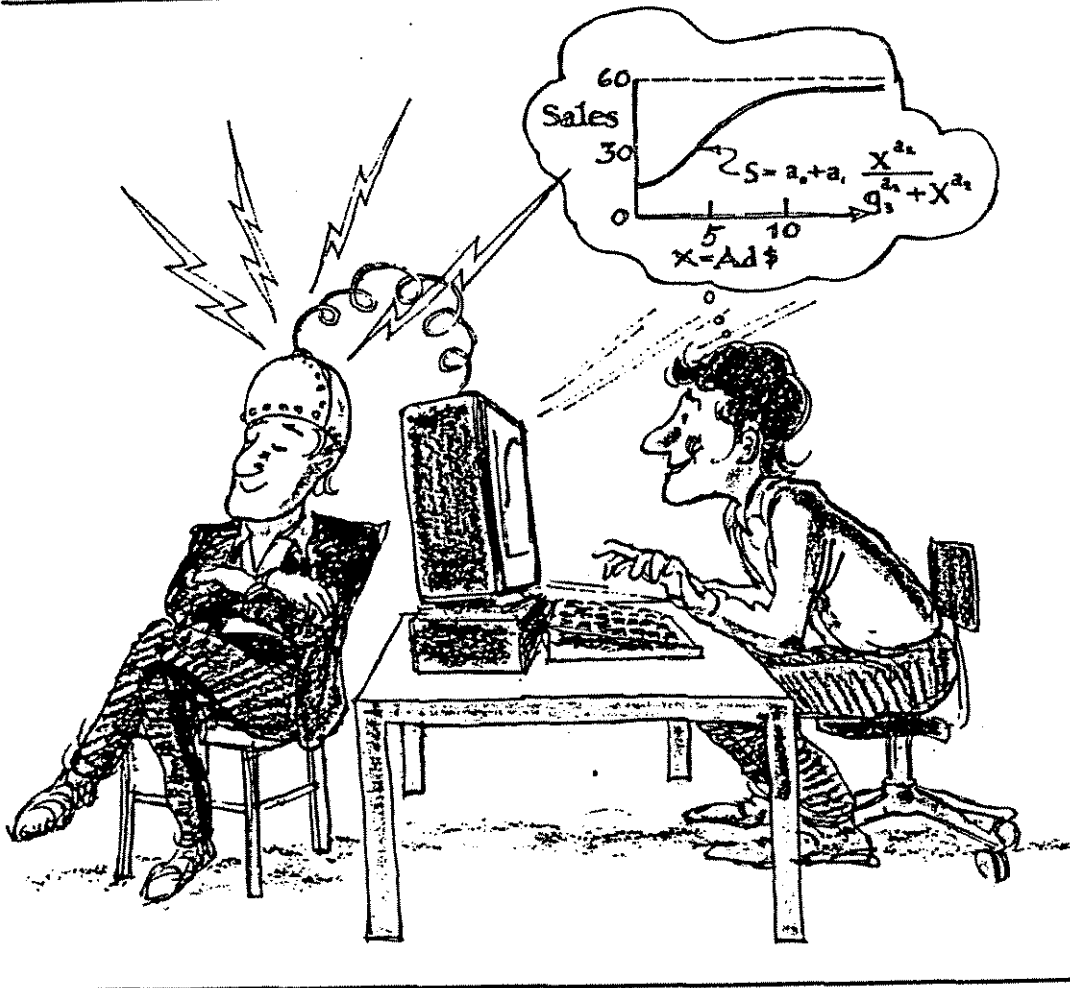
Figure 2  
 The Engineer Can Transfer  
 His Modeling Capabilities into a Marketing Context



The Engineer's perception--his mental model--is much more powerful than that of the Humanities Major because it is subject to possible manipulation. The Engineer can ask "What if?" questions (what if advertising is set at \$6 million?). He can link this advertising/sales relationship to a profit equation. And he can combine this information with other data about price response, competitive effects, sales carryover effects and so on to develop a quantitative, logically consistent understanding of how the market works.

Why can't the Humanities Major do this? It is probably a combination of lack of practice as well as a lack of potential for the skills involved. Some of us have more aptitude for language than others; some have more aptitude for mathematics than others. The point is that the Humanities Major does not have the analytic/model building skills that the Engineer has and that such skills are valuable in making marketing decisions. I developed the MARKET ANALYSIS system (Lilien, 1986) to allow the Humanities Majors among us to access and use the skills the Engineer has. (Figure 3).

Figure 3  
 The MARKET ANALYSIS System Gives the Humanities Major  
 Access to the Engineer's Modeling Skills



The programs in MARKET ANALYSIS allow the user to start with basic building blocks: the first program deals with (static) market response to a single marketing variable, and to investigate the behavior of various functional forms, experiment with different model-parameters, develop related profit functions and look at the results in graphical form. This program is called ONEVAR. There are four others:

**THREEVAR:** A multivariate extension of ONEVAR. It has three copies of the ONEVAR function library--one for each of up to three marketing mix variables--plus a set of multivariate response functions that can be used to combine the univariate response functions.

**COMP SHARE:** An extension of THREEVAR that incorporates the effect of competition. The basic building block in COMP SHARE is a market share response function.

**TIMESER:** An extension of **THREEVAR** that incorporates the dimension of time and the carryover effects of marketing activities.

**TIMESHAR:** A combination of **COMPCHAR** and **TIMESER** that incorporates both the effects of competition and of time.

All of the programs have a library of macros that can be used to automate many of the analyses (graphing the function, calculating profit, evaluating the fit of the model to data, etc). In addition each of the programs allows the user to build his own, customized function but still use the basic program structure.

Figure 4 shows a typical worksheet layout. Figure 5 shows the typical steps a user goes through in analyzing a function.

Figure 4  
Typical Worksheet Layout

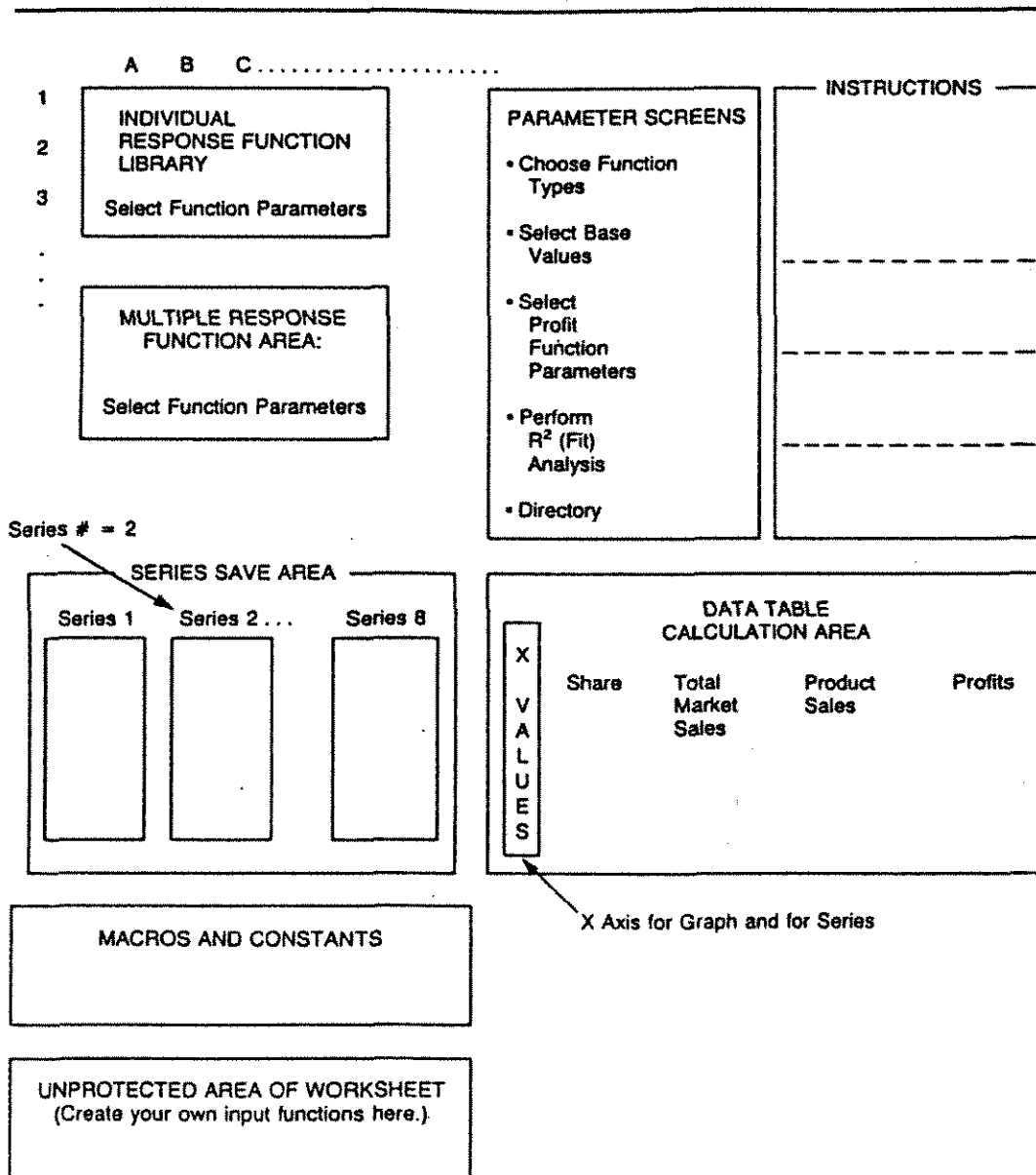


Figure 5  
Steps for Analyzing a Function

**Step 1:** You tell Lotus:

Give me the value of the function

$$\text{Sales} = a_0 + a_1 \frac{X^{a_2}}{a_3 X^{a_2} + X^{a_2}}$$

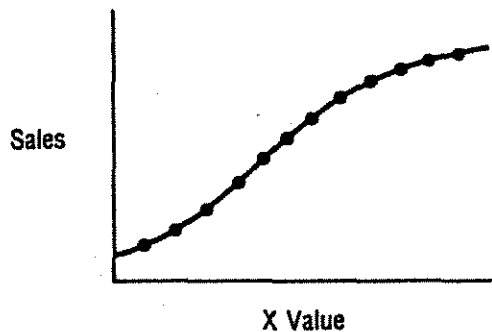
for  $X = 1, 2, \dots, 10$

**Step 2:** Lotus does that calculation as follows:

$X$	1	2	3	...	10
Sales	30	31	33		60

**Step 3:** Lotus asks you for "Series Number?" You respond: 2. It then places the sales row above in column 2 in the series save area of Exhibit A.4. The program asks you for the "Series Name?" You respond: Sales

**Step 4:** If you want to graph the function, the system will ask you to give the series name. (It will give you a list to choose from.) It will plot Sales versus  $X = 1, \dots, 10$  as:



I have used this system with a degree of success with PhD students in a Marketing Models course. The system has allowed students with limited mathematical training to build and explore various kinds of models that we commonly see in the marketing literature. The system has even proven useful for those students with strong mathematical background, as it has allowed them to quickly increase their modeling vocabulary (the functions they are familiar with and the shapes those functions have). I also have much success with it in introducing analytically oriented MBAs to how to build models for their own, future use.

However, MARKET ANALYSIS is too complex and sophisticated for most undergraduates, first level MBAs and executives. For that audience (of model users not model builders) I developed the MARKETING MANAGEMENT system (Lilien, 1988).

#### For the Prospective Model User...

When we teach the basics of marketing we often shy away from asking detailed, analytical questions ("How does optimal pricing under a 70% experience curve differ from that under an 80% experience curve in market X?", for example) because they require detailed calculations that distract the student's attention from fundamental, underlying concepts.

Yet, by doing so we leave students with fuzzy, undigested models in their heads about how these concepts really work. Indeed, almost every fundamental concept in marketing can be formalized as a model. I have tried to provide a series of model-based exercises that allow the student-user to absorb key marketing concepts.

The MARKETING MANAGEMENT system contains 30 exercises in Lotus 1-2-3 that only require the user to retrieve Lotus files and to enter numbers into cells in order to explore the concept. Little computer knowledge and virtually no mathematics are required to understand how to set prices and advertising levels when advertising affects price elasticity, to forecast sales in a new product diffusion environment, to see the impact of changing product positions on your product's sales or those of competitors and the like.

Figures 6a and b show what the student sees when he brings up the EXAMPLE spreadsheet. All the user needs to do to run these spreadsheets is to select options from a menu and to input values into an analysis page (Figure 7). Figures 8 and 9 give the numerical results of the analysis and an associated graph of the profit response to advertising, respectively.

Figure 6a  
EXAMPLE Instructions

```

A1: PR      Sample Exercise Spreadsheets (EXAMPLE)      Menu
1 Instructions 2 Input 3 GraphSales 4 GraphProfit 5 Quit
Go to Instructions Area
      A      B      C      D      E      F      G      H
1      Sample Exercise Spreadsheet (EXAMPLE)
2
3 This exercise is a sample of the Lotus spreadsheets found
4 throughout this book of exercises. When the spreadsheet is
5 "Retrieved," it starts out on this page, called the Instructions
6 page. The menu above is engaged whenever you go to this area, but
7 you may disengage it (freeing the cursor to move around the
8 spreadsheet) by selecting the "Quit" option.
9
10 The other key page in this and most other spreadsheets is the
11 "Input" page. You can get there by selecting "Input" from
12 the menu. Normally, you will wish to change some values on the
13 Input page, so when you select that option, you go to the Input page
14 but the menu is not engaged. You may engage the menu at any time by
15 selecting the [Alt]M command. This is done by depressing the
16 [Alt] key and, with that key held down, depressing the letter
17 "M." It will not matter if you use upper or lower case.
18
19 To see more instructions, select the "Quit" option before [PgDn].
20 ***** Select 5_Quit then hit [PgDn] for more Instructions *****
17-Jan-84 02:21 PM      CMD

```



Figure 6b  
Remainder of EXAMPLE Instructions

The other menu items will vary a bit from spreadsheet to spreadsheet. In the example here we will attempt to set an advertising budget that maximizes profit for the firm. We have available to us a relationship between advertising and sales that we can examine. We will wish to select certain values for such variables as price and unit cost as well as the level of advertising. These can all be found on the Input page.

You can run a sensitivity analysis in one of two ways:

1. One item at a time.
2. A range of items at a time.

To perform a sensitivity analysis as in option 1, you need only input the values you wish to study in the appropriate (unprotected) cells of the spreadsheet and the output values (sales and profit, in this case) are calculated for you immediately.

To perform a sensitivity analysis by option 2, you must select the range of values you wish to study before selecting the appropriate Graph menu option. To do this, choose a Lower Limit and an Increment. Most of the exercises will provide 10 values for the sensitivity analysis, so that if you select Lower Limit as \$4 million and Increment as \$1 million, you will get a sensitivity analysis from \$4 million to \$13 million.

Normally you will see a graph before being able to view the numerical values that were used in that graph. Hit any key to eliminate the graph and the associated values will be seen.

The best way to learn about these spreadsheets is to try some values and see what happens. If you wish to save your work, do not save it under the same name that you see at the top of the spreadsheet; if you do that, you will erase your master copy of the exercise. However, you are free to make as many copies of the exercise as you wish and you should certainly make a backup copy of this disk.

The Instructions area for each spreadsheet usually ends with the following reminder, repeated at the bottom of each analysis page:

-----  
The [Alt]I command returns you to this area and starts the menu as well; the [Alt]M command starts the menu at any time.  
-----

Now, try selecting [Alt]M and "Input" so that you can experiment with this exercise.

Figure 7  
EXAMPLE Input Screen

```

1      I      J      K      L      M      N      O      P
2
3      Input/Analysis Page
4
5      Advertising Level = $1.00 ***** Graphing Parameters *****
6      ($Millions)
7      Price/Unit = $1.00 Advertising Range to Graph
8      Unit Cost = $0.70 Lower Limit = $0.50
9      Increment = $0.25
10
11
12      *****
13      * Sales = 40.00 *
14      * (million of units) *
15      * Profit = $11.00 *
16      * ($Millions) *
17      *****
18
19 -----
20 Hit [Alt]I for Instructions; [Alt]M for Menu
21 17-Jan-84 02:21 PM

```

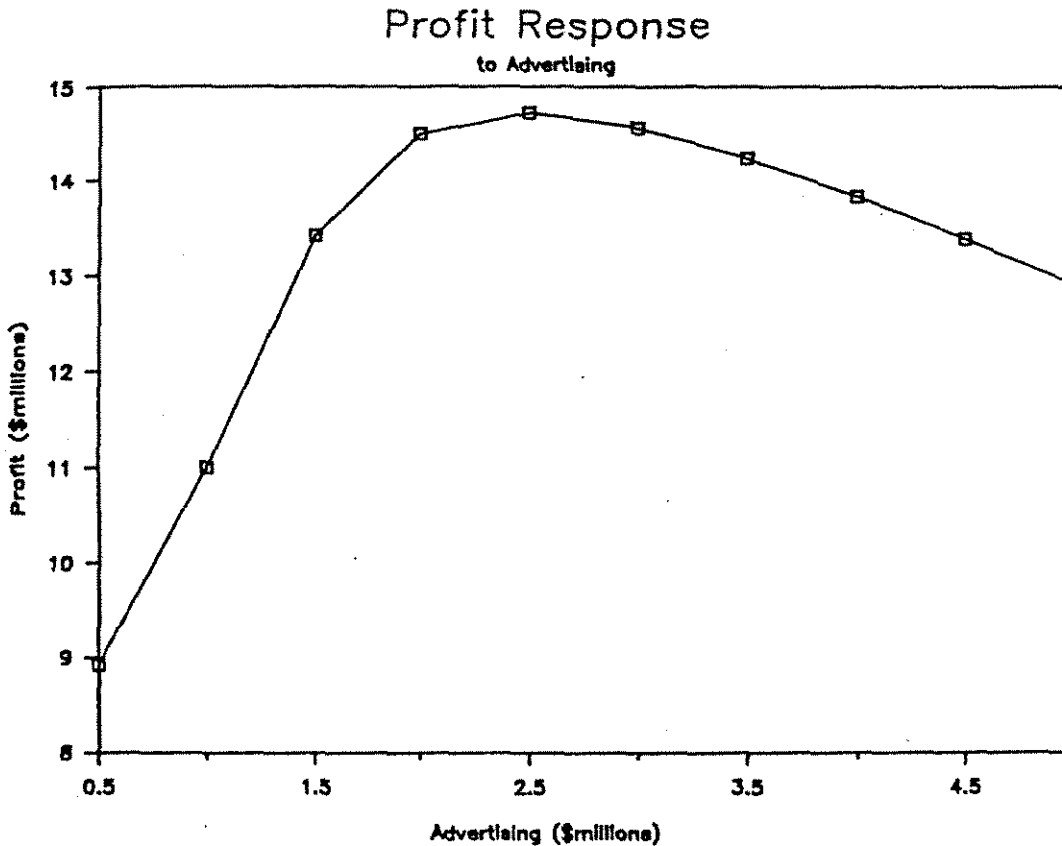
Figure 8  
EXAMPLE Data for Sales and Profit Response

```

21      I      J      K      L      M      N      O      P
22
23      Sensitivity Analysis Results
24
25      Advertising      Sales      Profit
26      (millions)      ($Millions)      ($Millions)
27
28      $0.50      31.43      $8.93
29      $1.00      40.00      $11.00
30      $1.50      49.73      $13.42
31      $2.00      54.99      $14.50
32      $2.50      57.39      $14.72
33      $3.00      58.51      $14.55
34      $3.50      59.09      $14.21
35      $4.00      59.41      $13.82
36      $4.50      59.60      $13.38
37      $5.00      59.72      $12.91
38
39 -----
40 Hit [Alt]I for Instructions; [Alt]M for Menu
41 17-Jan-84 02:21 PM      CMD

```

Figure 9  
EXAMPLE Profit Response Graph



### My Experiences and Recommendations

In using the **MARKETING MANAGEMENT** system with undergrads, grad students and executives, I have had excellent response. The process of doing the exercises provides the same kind of reinforcement of the basic model-concepts in marketing that comparable exercises do in mathematics, engineering and the applied sciences. In addition, as the spreadsheets are very easy to understand, unprotect and modify, many users have adapted the spreadsheet to their own business situations.

Students do have some difficulty in focusing on the marketing question (versus "getting the right answer to the problem"), especially at the beginning. The instructor has to help the students keep aware that the goal is to solve a marketing problem and that the model is only a means to that end.

In addition, the students often do get stuck with some problem related to the pc, to Lotus or to the spreadsheet exercise itself. I have found it best to have students work in pairs. This way one or the other is usually able to solve whatever technical problems they might have and they can focus on the exercise. More than two students on an exercise tends to result in two workers and one (or more) watcher(s) and is not pedagogically sound.

Little prior training is needed for the instructor with **MARKETING MANAGEMENT**; much more is needed with the far-more-sophisticated **MARKET ANALYSIS** system. In effect, the latter system can make the students quite dangerous and can allow them to build some very complex and sophisticated models. And it also allows them to make some very sophisticated blunders that can be time consuming for the instructor to identify. But such, I feel, is the price for the increasing power of the pedagogic tools we have available to us, and it is a price we must pay.

I have purposely restricted my developments to the those that would run on the widest range of hardware and software. At the time I wrote these systems (and still today), the IBM PC standard and Lotus 1-2-3 had the largest nationwide installed base at business schools. I intend to explore future developments that will enhance the interactive and the graphical capabilities of these systems. Those enhancements and future developments will streamline the systems but will not change the basic concept--to use the pc and spreadsheet software to put modeling capabilities in the hands of marketing students of all levels.

#### References

Lilien, Gary L. (1986) *Marketing Mix Analysis with Lotus 1-2-3*, The Scientific Press: South San Francisco.

Lilien, Gary L. (1988) *Marketing Management: Analytic Exercises with Lotus 1-2-3*, The Scientific Press: South San Francisco.