THE USE OF SPREADSHEETS IN FINITE MATHEMATICS

Stephen D. Comer
Department of Mathematics and Computer Science
The Citadel, Charleston, SC 29409

This paper is a preliminary report on an experiment concerning the use of Lotus^{TM} 1–2–3^{TM} in a finite mathematics course for freshmen non–mathematics majors. The structure and purpose of the course and the rationale for using Lotus to do the modelling and calculations are described. In addition, the way in which Lotus is used in the course and the topics treated with the spreadsheet are discussed.

THE NATURE OF THE COURSE

A typical section of Finite Mathematics at The Citadel has approximately 30 students, mainly freshmen. They are mostly Business Administration or Political Science majors but the course is open to all non–mathematics majors. The course is used to partly satisfy the college's mathematics requirement. The purpose of the course is to increase a student's understanding of the value of mathematics through an exposure to different types of elementary mathematical models and to improve analytical skills by having a student solve problems using the various models. The course covers a standard set of finite mathematics topics: linear equations, matrices, geometric linear programming, quadratic functions, finite probability, and statistics. For the last several years a Finite Mathematics software package has been used with the course to assist students perform some of the tedious calculations, especially the computation of matrix inverses.

In at least one regard the past course has been a disappointment. Typically when ideas discussed in the Finite Mathematics course are encountered later in courses in other disciplines, a student exhibits total ignorance. We would like to overcome the attitude that mathematics is a sterile subject, only done in a mathematics class. One reason for introducing a spreadsheet as the vehicle for carrying out mathematical calculations is to improve student motivation for the course by increasing its impact on a student's career. The goal is to present the models used in the Finite Mathematics course in such a way that students will be able to build on these ideas when they are encountered in courses in their major.

WHY USE A SPREADSHEET?

Given the many software packages that are available to perform the calculations that are encountered in a Finite Mathematics course, why use a spreadsheet? There are two strong reasons – the wide availability of spreadsheets and their power. To some extent the "educational" software, geared to this particular course and useful for no other, contributes to a narrow view of mathematics' applicability. On the other hand, spreadsheets are widely available. Every computer in our PC lab is equipped with Lotus 1–2–3. Spreadsheet applications have become commonplace in businesses. It is felt that students, even those not majoring in business, will have many opportunities to build on the mathematical skills they acquires using a spreadsheet. Books by Deane Arganbright [1] and by Michael Kilpatrick [2] show how to implement a wide variety of common algorithms using a spreadsheet. A spreadsheet can be used to carry out every calculation needed in a standard Finite Mathematics course. Lotus 1–2–3 was the spreadsheet of choice because of the large number of built–in functions and operations available with version 2.0. Moreover, a student can begin to handle more complicated features after becoming proficient with the simple commands and functions. Those that master the use of macros can perform many sophisticated calculations. Lotus is a powerful calculating tool; however, it also should be emphasized that Lotus does not solve problems for students by magic. When using a spreadsheet to solve a problem or implement an algorithm, a student generally performs the same steps as if the problem were being solved by hand.

INSTRUCTIONAL USE OF LOTUS

To prevent the course from becoming preoccupied with computer skills, the spreedsheet topics to be introduced were carefully selected. For various reasons the topics were restricted to graphing, solving matrix equations with a non–singular coefficient matrix, and elementary statistics. These topics will be described in more detail below. Lotus 1–2–3 (version 2.0 or higher) provides an ample collection of @functions (not only statistical and financial, but also all of the standard trigonometric and logarithmic functions), the operations of matrix multiplication, matrix inversion, frequency distribution tabulation, and regression in addition to graphing. The one disadvantage of Lotus is the awkward procedure for printing out a graph. However, it was felt that the availability of so many built–in operations was worth the additional hassle with graphing. Lotus is used in the course in two ways.

1. It is used by the instructor to perform classroom calculations and to conduct classroom demonstrations.

2. It is used by students outside of class to complete assignments. To facilitate assignments that involve considerable data, Lotus worksheet files that contain the problem and data are stored on a hard disk for students to copy. This was done, for example, with a problem involving a Leontief model of the economy and problems involving the computation of probabilities using normal distributions.

Since it was assumed that a student in this course would have no previous experience with a computer, a certain amount of instruction in the use of a computer and the Lotus program was necessary. The discussion of basic computer operations included: how to format a diskette, how to create subdirectories, how to move between subdirectories, and how to copy and erase files. The first spreedsheet operations discussed were how to start Lotus, how to move around a worksheet, the types of data and how to enter data, how to save and retrieve files, and how to use the on–line help. The Command Menu was briefly explored. This introductory phase took approximately three hours of class, half of which was spent in a hands–on lab session.

During the course students are given hand–outs which, in a step–by–step manner, guide them through a "Lotus" solution to various mathematical problems and provide exercises. These exercises are coordinated with the classroom topics and discussions. Students are requested to turn in screen prints or the graph printouts of appropriate exercises. At mid–term each student was given a hands–on computer quiz.

As mentioned above three topics were chosen for spreedsheet implementation: graphing, solving matrix equations, and elementary statistics. Each of these topics will be discussed briefly.

GRAPHS

Ordinary XY graphs (as a set of ordered pairs) can be easily constructed using the Lotus 1–2–3 operations of /Data Fill, /Copy, and a formula for the function. Since functions such as @SIN, @LN, @EXP, and @ATAN are standard Lotus functions, students can quickly generate a large variety of graphs. The /Graph command is used to plot the ordered pairs on an XY axis for viewing. Up to 6 functions can be plotted at one time. After mastering the basic construction of a graph, a student was asked to recalculate a graph over various intervals. Once a graph has been created, if its domain is modified, the revised plot can be viewed with a single keystroke using the F10 key. Students were asked to examine various portions of a graph in order to identify the domain of a function, approximate zeros, and approximate relative maximum and minimums. For simple

functions (eg., quadratic functions) students were asked to compare the approximate values they obtained with values obtained by hand calculations.

MATRICES

The algorithm for matrix addition is easily implemented using the /Copy command. Lotus contains commands for multiplying two matrices and for computing the inverse of a matrix. Students are still required to learn how to perform these operations by hand, but with problems that do not involve an excess of arithmetic. Using Lotus, students were asked to solve various matrix equations of the form $AXB + C = D$ where A and B are nonsingular. The use of Lotus makes it reasonable to experiment with various open Leontief models for an n–industry economy.

ELEMENTARY STATISTICS

For a given collection of data the Lotus /Data Distribution command allows one to construct a frequency distribution. Students can display the data as a bar graph (to approximate a histogram) or a frequency polygon by means of the /Graph command. To measure the central tendency and dispersion of data a student first learns to use the @AVG, @VAR and @STD functions from the library of Lotus statistical functions. For frequency distributions of grouped and ungrouped data the student is required to implement the standard formulas for the mean and standard deviation. When considering problems involving a normal distribution Lotus can be used as a substitute for looking up areas under the standard normal curve. A template worksheet that contains the cumulative normal probabilities is available for students to copy. With this worksheet problems involving normal probabilities can be worked using the @VLOOKUP function.

Topics, other than those mentioned above, could be incorporated in the course. For example, Lotus can be used to obtain binomial probabilities. Also, finite probabilities could have been treated, but this would have involved having students write macros. At present only one example, a macro for factorial, is included as a exercise.

REFERENCES

1. Arganbright, Deane E. Mathematical Applications of Electronic Spreadsheets. McGraw–Hill, New York, 1985.
2. Kilpatrick, Michael. Business Statistics Using Lotus™1–2–3™. John Wiley & Sons, New York, 1987.