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ABSTRACT

The computer packages of PLOTALL, SYMAP, SURFACE II, QUSMO, QUSMO2, QUCRS, and QUTAB are commercially available plotting programs that provide aids for visualizing spatial distributed data and concepts. The incremental drum and line printer plots communicate often vast and difficult-to-interpret tabular data with or without geographic coordinates. All the software packages are easy to understand and require no prior programming knowledge or skills. Due to the multi-discipline nature of graphic display, computer generated plots are an excellent tool for use in the classroom to illustrate sociological, geophysical, business, and mathematical concepts. Most of the plotting routines are, or can be made, available to educational practitioners. Each of the packages is described and eight figures which illustrate their applications complete the document. A short reference list is also provided. (Author/JB)

COMPUTER GRAPHICS FOR USE IN THE CLASSROOM TO ILLUSTRATE BASIC CONCEPTS AND SPATIAL DISTRIBUTIONS

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The computer packages of PLOTALL, SYMAP, SURFACE II, QUSMO, QUSMO2, and QUTAB are commerically available plotting programs that provide invaluable aids in visualizing spatial distributed data and concepts. The incremental drum and line printer plots communicate often vast and difficult-to-interpret tabular data with or without geographic coordinates. All the software packages are easy to understand and require no prior programming knowledge or skills. Due to the multi-discipline nature of graphical display, computer generated plots are an excellent tool for use in the classroom to illustrate sociological, geophysical, business, and mathematical concepts. Most of the plotting routines are or can be made available to educational practitioners.

INTRODUCTION

The expanding uses of computer graphics in all disciplines and its application to communicate often difficult-to-interpret data and concepts are rapidly becoming an essential tool for use in the classroom by educational practitioners. However, the usefulness of computer graphical systems must be based on its ability to communicate the results of data manipulation and ease of access. Thus, the purpose of this paper is to illustrate selected computer graphics techniques and socialogical, geophysical and mahematical applications for use in

simplifing complex concepts. The specific software used in the course of the study include PLOTALL, SYMAP, SURFACE II, QUSMO, QUSMO2, QUCRS, and QUTAB.

PLOTALL

PLOTALL is a language developed in an effort to make the graphic capabilities of the computer more readily available to a potential user (Klein, 1976, p. 5). The language is designed to consist of short, English-like statements that communicate the desired output from the incremental drum plotter.

The incremental drum plotter, which was the major device used to create the computer graphics in this study, refers to a type of plotter on which the paper is held by two rolls--a supply roll and a take-up roll--separated by a drum. The drum itself facilitates movement of the paper from the supply roll to take-up roll and provides a surface suitable for a pen. A pen holder is mounted on a bar above and parallel to the length of the drum. The pen is free to move along the length of bar or, in other words, across the width of the paper. Also, the pens can be raised or lowered in the holder to either make contact with the paper or not be in contact with the paper. Hence, a combination of paper and pen movements can produce lines in practically any direction resulting in a finished graph. The movement of the pen from point to point in a series of steps or increments can be as small as .0025 inch.

Via the incremental drum plotter and the use of the PLOTALL language as the communication medium between the potential user and the computer, five different types of plots can be produced; the type of plots are: scatter plots, line plots, pie plots, bar plots, and printer plots. Since each type of plot selected is dependent upon the nature

of the data and the intended use of the finished product, the investigator chose pie line, and bar plots. Pie plots are excellent to illustrate the overall change or percentage of change in a variety of situations, such questionnaire responses to sociological surveys and business analysis. Line plots can be used to illustrate trends over time and bar plots are used to display total numbers and percentages of a sample or pupulation for a relatively large number of variables. For a more detailed explanation on PLOTALL and its use, the investigator highly recommends the reader refer to Michael Klein's PLOTALL, printed and copyrighted by The University of Akron.

SYMAP

SYMAP is a computer package designed for the purpose of producing line printer maps to depict spatial distributed data. It is suited to a broad range of applications and has numberous options to fit a variety of needs. The SYMAP program is written in FORTRAN IV language and the source deck for the package is at The University of Akron, The University of Kentucky and others. Overall design and concept for the SYMAP program were developed by Northwestern Technological Institute. However, recent developments in the SYMAP program were completed by the Laboratory for Computer Graphics at Harvard University. The three types of two-dimensional, line printer maps produced by SYMAP are contour maps or isoline maps, and proximal maps.

The contour map consists of closed curves or contour lines that connect points having the same numeric value. Contour lines emerge from the datum plane in a series of levels which are determined from the scale of the map and the data range. The use of this type of mapping procedure should be restricted to the representation of continuous

information such as population distributions, lithographic changes, and any noncategorical data.

The conformant map hold data values within specific appointed areas. In other words, each data zone is enclosed by a boundary determined by a predefined spatial unit. The entire spatial unit is given the same value and symbolism is assigned according to its numeric class.

The proximal map is a hybrid of both the contour and conformant mapping procedures. It was the approach of the contour map, but functions as a conformant map. Spatial units are defined from point information. Each character location of the line printer map is assigned the value of the data point nearest to it. Boundaries are assumed along the line where the values change and the conformant mapping procedure is then applied (Torma & Nash, 1974, p. 1-2).

The author, for example, used the contour SYMAP procedure to display the distribution of students by county of residence attending a major University in Ohio. The result was a line printer map with contours. The author then used several electives available to the potential user of the program to create a data matrix on disk file to be used in the production of three-dimensional plots. This procedure is explained in more detail in the section concerning three-dimensional plots. The reader is encouraged to refer to Torma and Nash's publication entitled, SYMAP: User Manual, for more detail, or the standard SYMAP Manual printed by Harvard University and on file in most major computer centers, including University of Kentucky and Eastern Kentucky University (Dougenik & Sheehan, 1979).

THREE-DIMENSIONAL PLOTTING

The three-dimensional plotting programs can be used via the incremental drum plotter to produce statistical surfaces of geographic untis with assigned values of continuous data such as population denisty. There are a variety of options available to the user and these programs also produce their own diagnostic messages for common errors that the user may encounter. There are basically four programs under the three-dimensional plotting programs, each one designed to give either a completely different type of plot or flexibility in the presentation of its final form; these options are known as QUSMO, QUSMO2, QUCRS, and QUTAB.

QUSMO AND QUSMO2

Quick Smooth (QUSMO) produces a smoothed surface over an input data matrix and places the surface on a base or plane. This program performs a nine point quadratic interpolation between the input data points to give the plot a smooth appearance. QUSMO2 however, combines the features of QUSMO but allows for control over the size output, vertical scale, and read the data matrix from tape storage.

QUCRS

Quick Crosscut (QUCRS) also produces a smoothed surface over the input data as does QUSMO and QUSMO2. However, it does not put the interpolated surface on a plane. A base is drawn for the surface so that it can be visualized as if it was isolated in space.

QUTAB

Quick Tabular (QUTAB) produces a plot similiar to a three-dimensional histogram. Each data point of the data matrix is assumed to

be the center of a plotted cell and thus appears as many small squares at various levels. Since there is no interpolation between the input data points, the program produces a step-like surface. In addition, all four plotting routines have the option to view the surface from eight directions (i.e. north, south, east, west, northwest, northeast, southeast, southwest). The reader is recommended to review Sawan and Nash's Three-Dimensional Mapping Programs User Manual, which is available from The University of Akron for further detail.

APPLICATIONS

Figure 1 illustrates a line graph and Figure 2 represents a bar graph, produced bia PLOTALL, of college student mortality of a university in Ohio for a specified time period. Figure 3 displays a pie plot, generated through PLOTALL, of a questionnaire response from a sociological survey. Figures 4 through 8 represent three-dimensional plots using QUSMO, QUSMO2, and QUTAB. Figure 4 displays a population distribution of students who withdrew from an university; Figure 5 represents spatial distribution of deaths due to heart attacks; Figure 6 is a plot of depth to bedrock from selected boreholes as a result of a geophysical survey; and Figures 7 and 8 illustrate a structural joint diagram utilizing QUSMO and QUTAB, respectively.

CONCLUSION

Many educators of social and natural sciences, mathematics, and business disciplines collect and display data that are often difficult to explain, and even more difficult to visually model. The purpose of this paper was to illustrate examples of computer graphics to aid in the communication process of complex ideas in the classroom. The

programs that were discussed in this paper are readily available to most academic computer centers. Specifically in Kentucky, SYMAP and SURFACE II (Sampson, 1978), the counterpart of QUSMO2, are at a relatively low price for use in both the IBM-370 and PDP-11 computer systems. Educational personnel should take advantage of the available software in order to communicate classroom information in an effective manner.

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Dougenik, J. A. & Sheehan, D. E. SYMAP Users Reference Manual. Cambridge, Mass.: Laboratory for Computer GRaphics and Spatial Analysis, Harvard University, 1979.

Klein, M. PLOTALL. Akron, Ohio: The University of Akron, 1976.

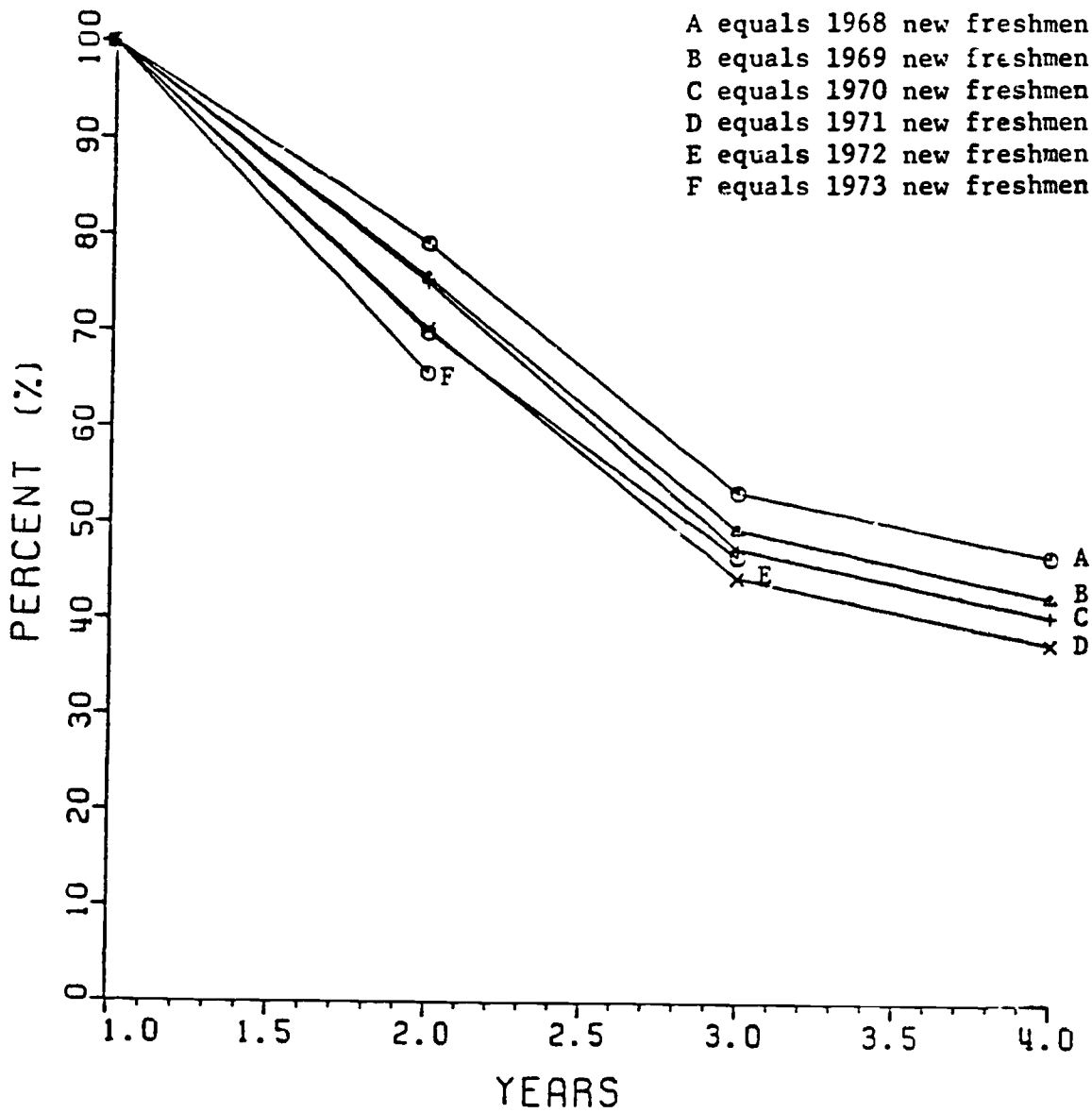
Sampson, R. J. Surface II Graphic System. Lawrence, Kansas: Kansas Geological Survey.

Sawan, S. P. & Nash, T. L. Three-Dimensional Mapping Programs User Manual. Akron, Ohio: Laboratory for Cartographic and Spatial Analysis at The University of Akron, 1974.

Torma, R. A. & Nash, T. L. SYMAP User Manual. Akron, Ohio: Laboratory for Cartographic and Spatial Analysis at The University of Akron, 1974.

FIGURE 1

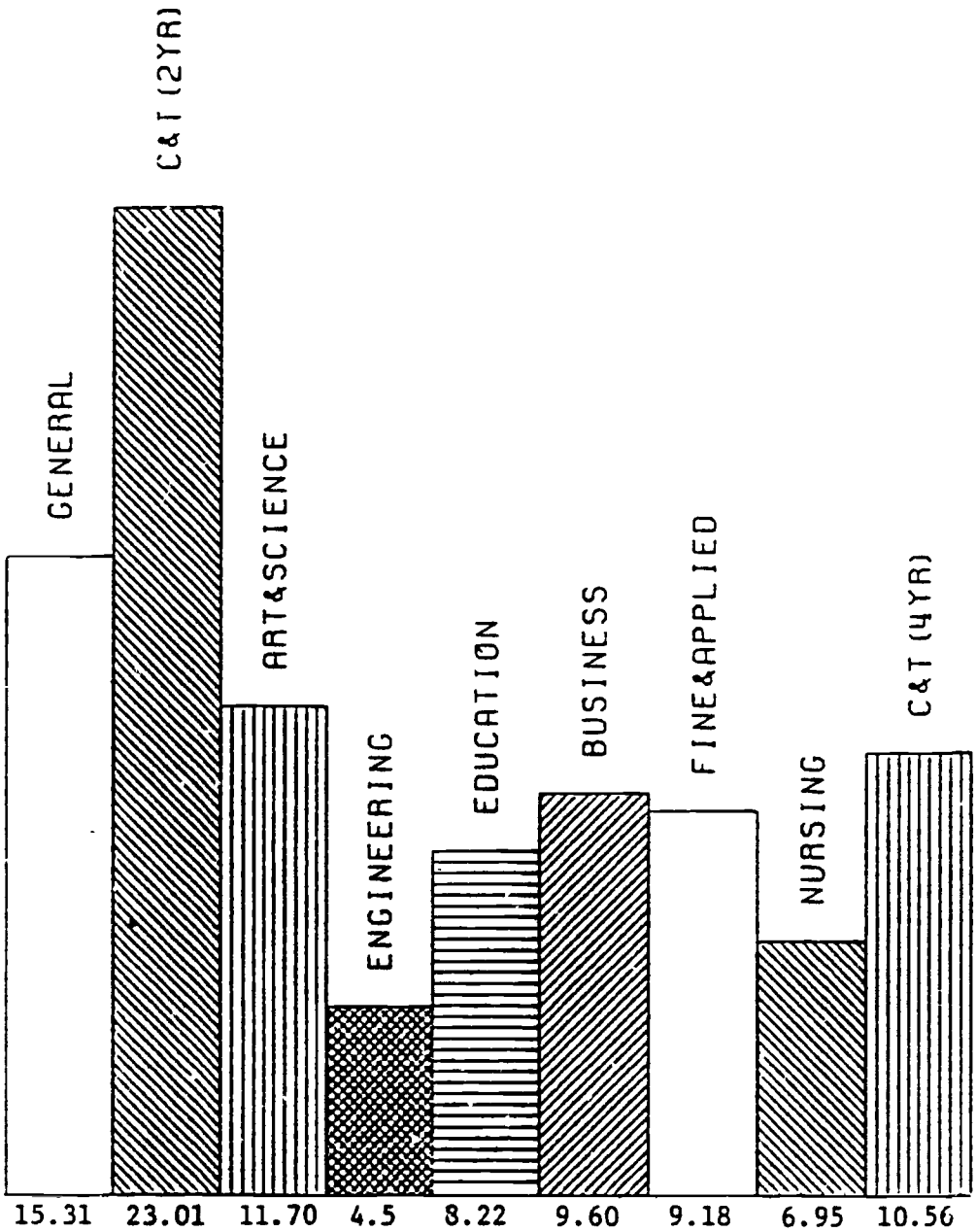
General College Mortality Study, Fall Freshmen, 1968-1974



Source. Data obtained from the Office of Institutional Research and Systems Development, The University of Akron.

FIGURE 2

Total Undergraduate Students Not Enrolled Spring 1979
Who Were Enrolled Fall 1978 and Did Not Graduate
Nor Were On Academic Probation By College



PERCENTAGE OF FALL ENROLLMENT IN
THE COLLEGE

Source. Data obtained from Office of the Assistant to the President
The University of Akron.

FIGURE 3

Distribution of Student Nonpersisters According to Their Response to the Question Describing Their Degree of Satisfaction with the University Concerning "Counseling & Advising" Variable

A denotes no satisfaction
B denotes littl satisfaction
C denotes moderate satisfaction
D denotes much satisfaction
E denotes factor does not apply

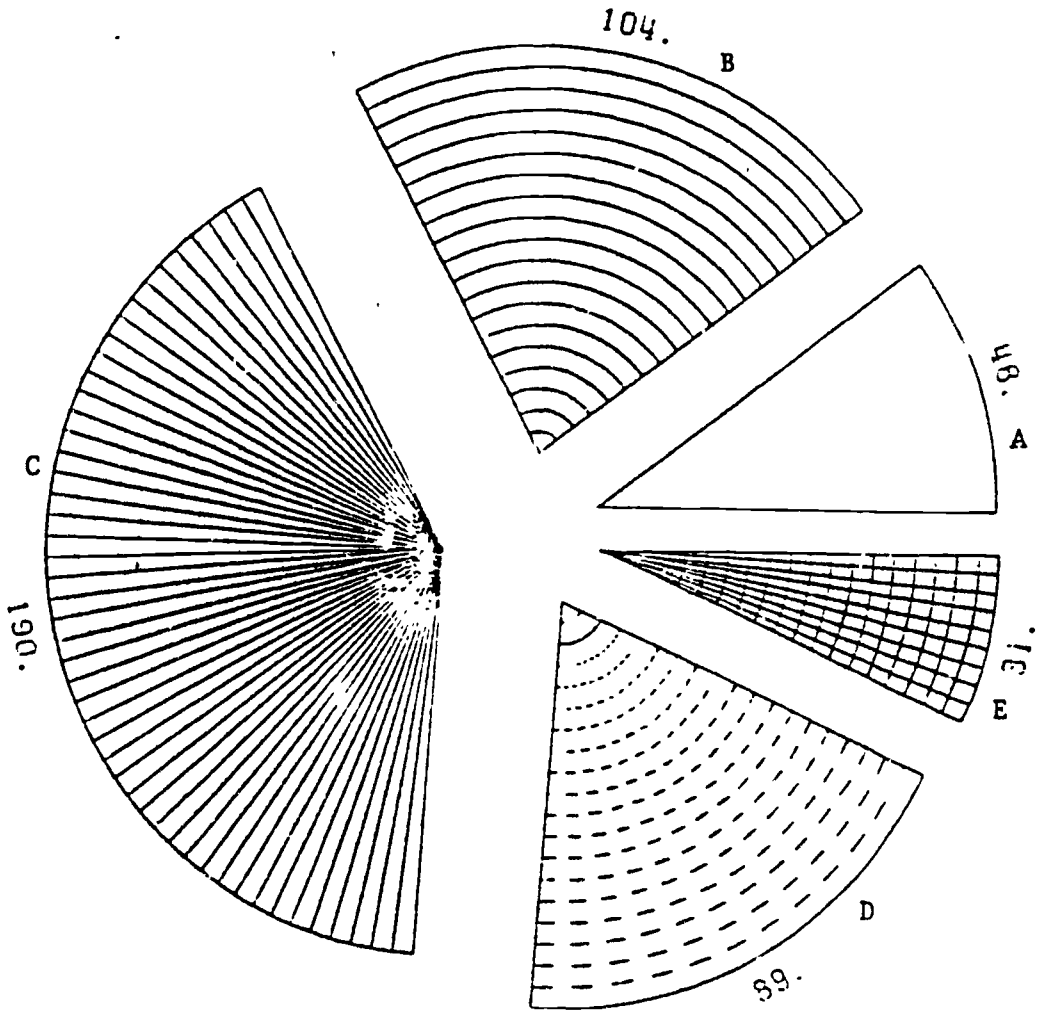


FIGURE 4

Spatial Distribution of Student Nonpersisters According to the Demographic Variable County for Ohio Residents as Viewed from the Northeast Direction

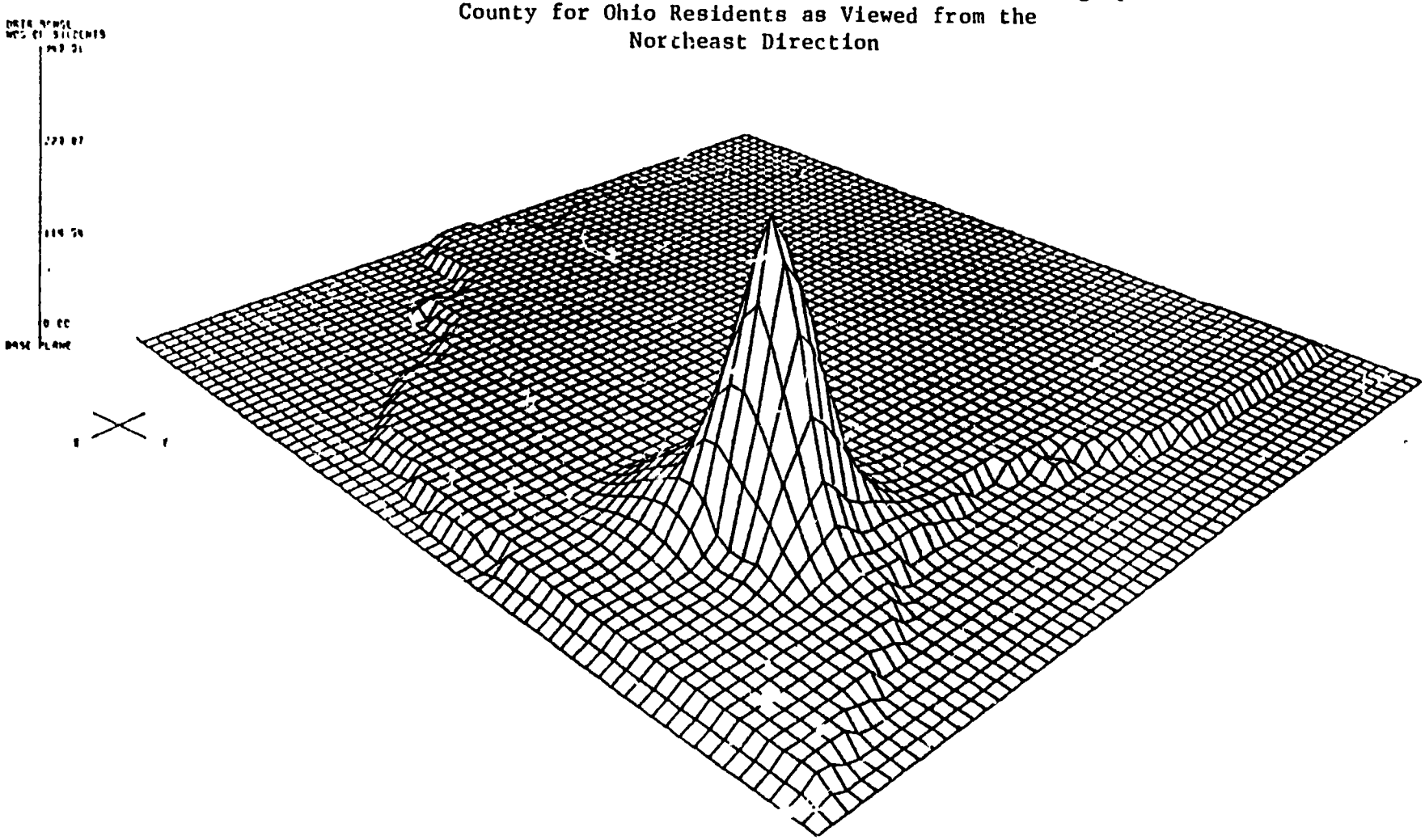
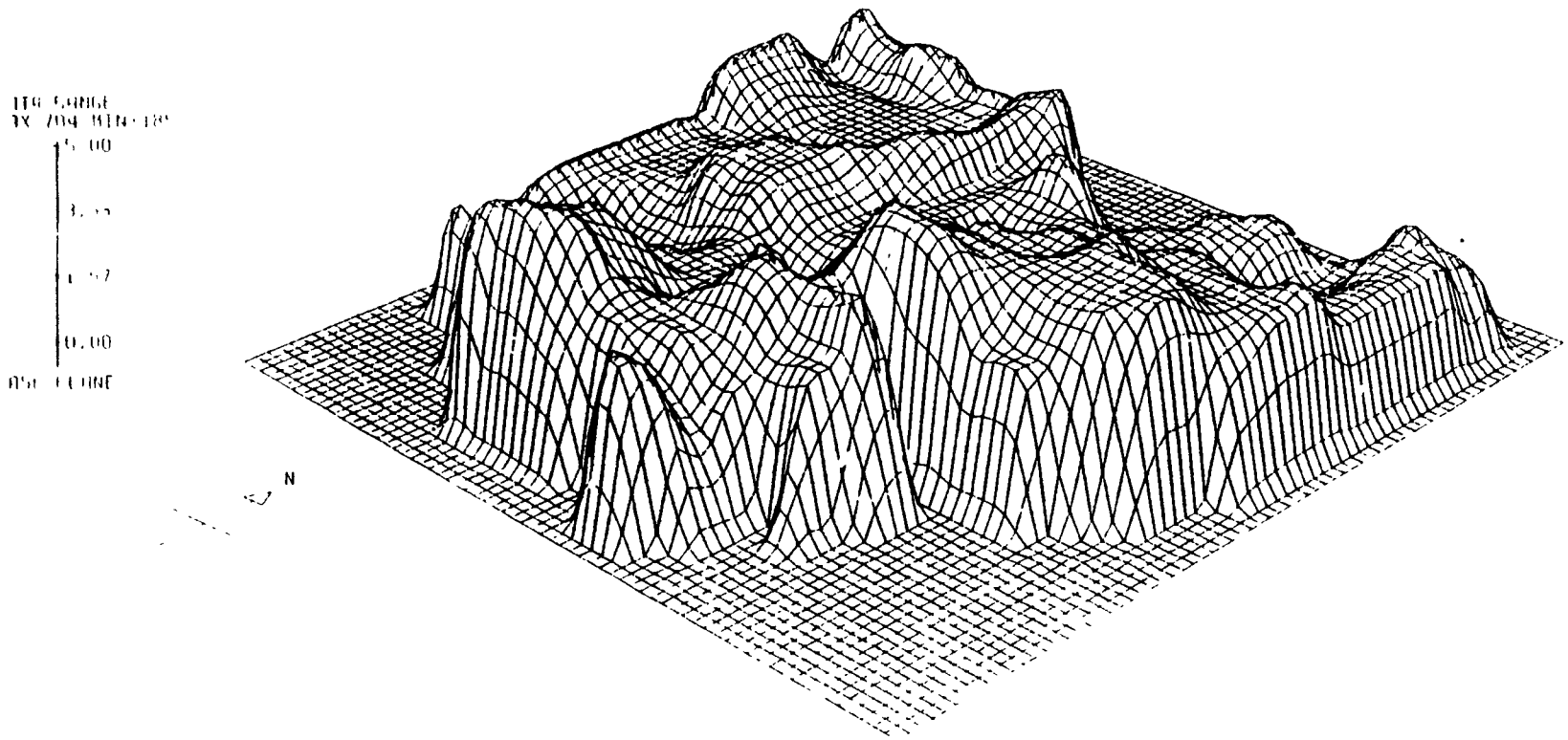


FIGURE 5

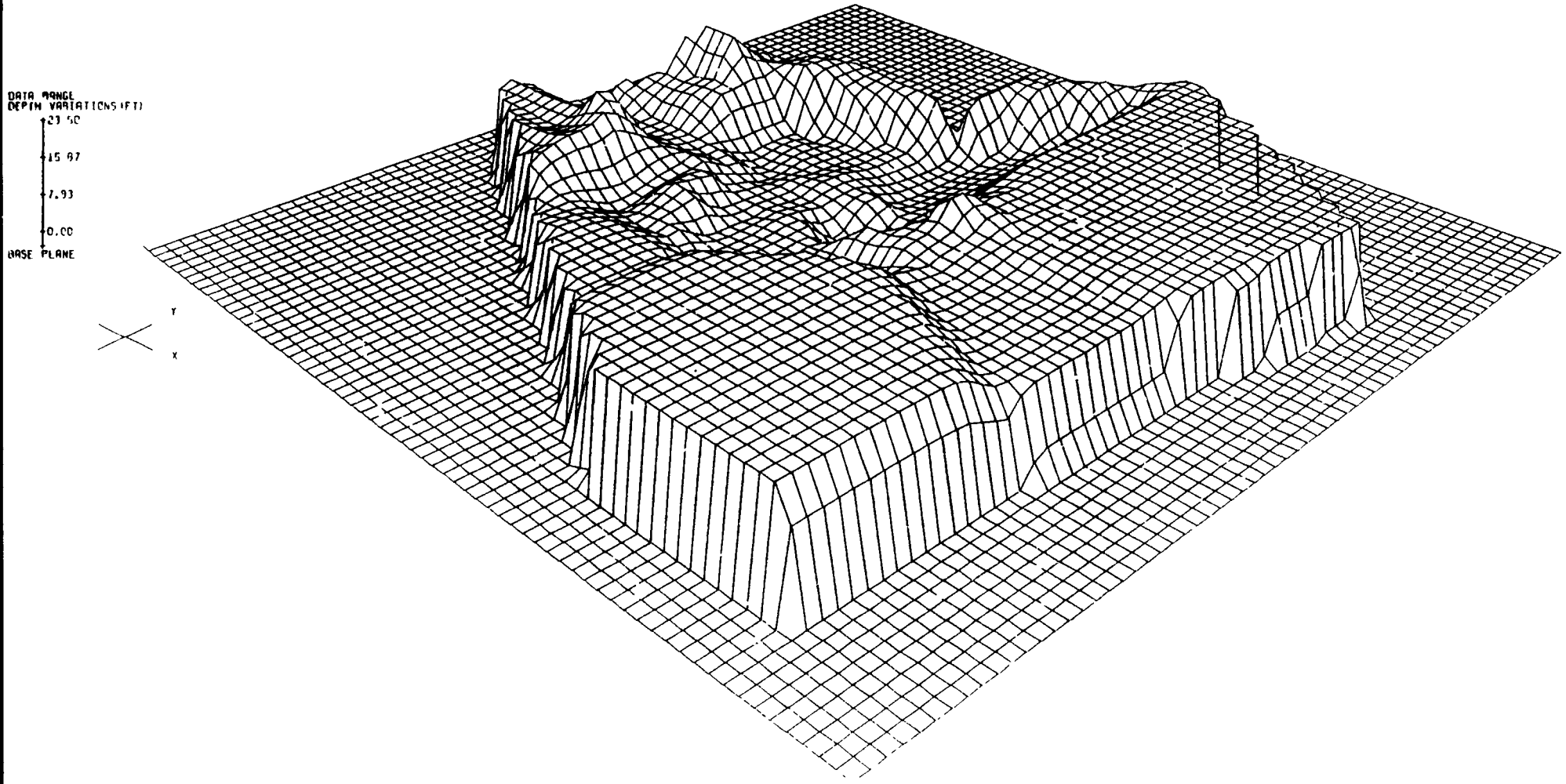
Spatial Distribution of Deaths per 100,000 of Population in the Counties of Ohio Due to Heart Attack



RELATIONSHIP OF DEATHS PER 100,000 IN THE COUNTIES OF OHIO DUE TO HEART ATTACK

FIGURE 6

Spatial Distribution of Depth in Feet to Bedrock from Surface of Boreholes



DEPTH TO BEDROCK IN FEET

FIGURE 7

Stuctural Joint Distribution Derived from Selected Outcrops in Shenandoh Valley (QUSMO)

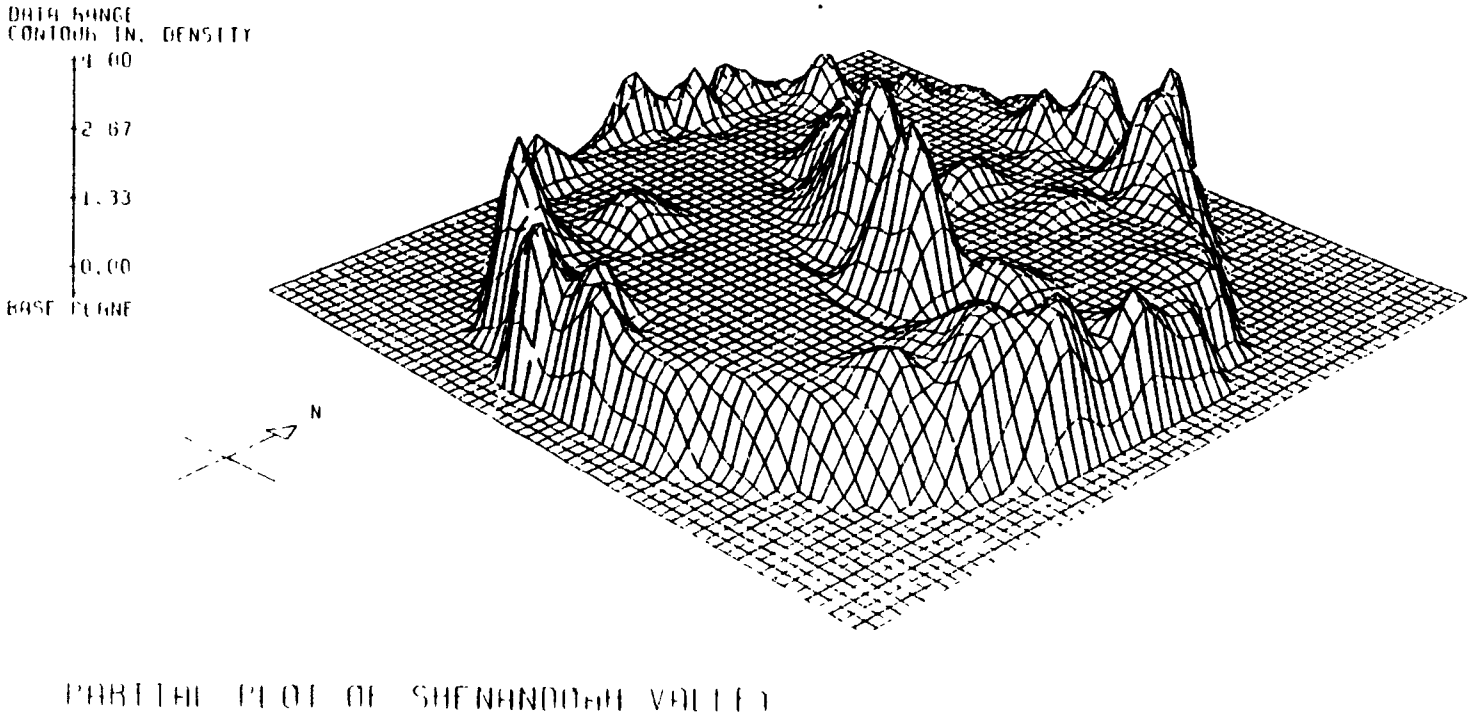
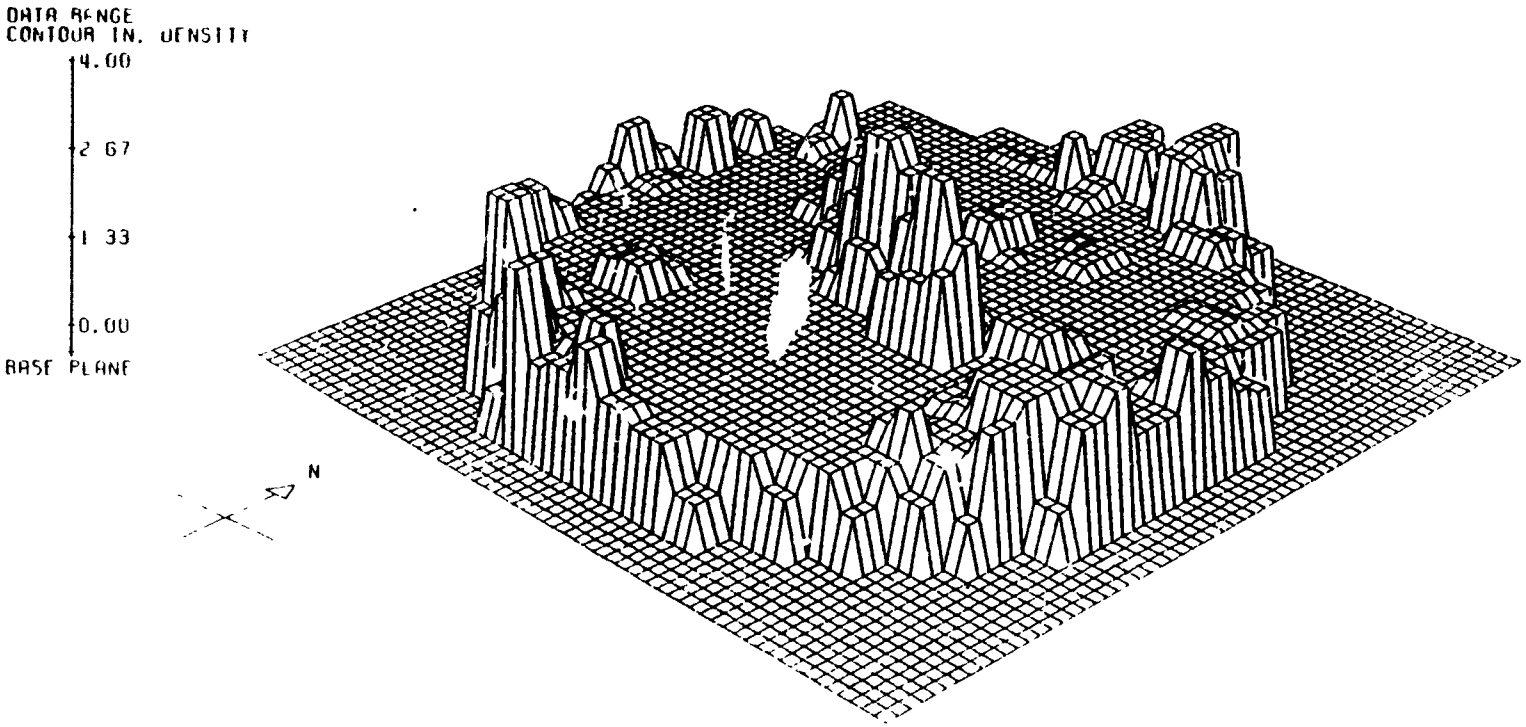


FIGURE 8

Structural Joint Distribution Derived from Selected Outcrops in Shenandoh Valley (OUTAB)



PARTIAL PLOT OF SHENANDOAH VALLEY