AN ADVANCED MAPPING SYSTEM FOR THE SOIL CONSERVATION SERVICE

C. Gene Johnson
U.S. Department of Agriculture

AMS is an automated cartographic application that will produce base, topographic, soil and interpretive maps ready for black and white or multicolor lithographic processing. Map data will be digitized and stored, together with associated tabular data, in computer format and then processed, analyzed, and retrieved as desired.

Data for producing interpretive maps will be obtained from published soil surveys. The automatic scanner will digitize the soil information. The features will be identified both automatically and manually. The data will then be edited for accuracy and stored for later interpretive use. In addition, base and topographic maps will be manually digitized using a coordinatograph table or stereoplotter. The maps will be edited and photographically plotted at the desired scale.

The system is designed around four minicomputer subsystems to be located at the Hyattsville, Maryland, Cartographic Unit. These subsystems are for scanning, identification, editing, and automatic drafting. Each subsystem will independently perform one or more operations. One remote system for digitizing base and topographic maps will be located at each of three field cartographic units. The cost for software and hardware, excluding the automatic drafting subsystem, is $1,400,000. The contract was awarded February 28, 1975. Delivery is scheduled for February 28, 1976, and the equipment is to be in full production in May 1976.

The scanning subsystem will automatically scan, at the rate of 4 square inches per second, each individual sheet of a published soil survey. An average soil survey area has 70 map sheets. A map sheet will consist of one, two, or three overlays containing alphanumeric, cultural, and soil information. The overlays will be film positives and be in one of three formats:

- All soil and planimetric information on one overlay,
- Soil lines and soil symbols on one overlay and planimetric detail and place names on a second overlay,
- Soil lines on one overlay, planimetric detail on a second overlay, and all alphanumeric information on a third overlay.

Scanning of the alphanumerics in the AMS requires manual preparation and Recognition. Because of the state of the art at the time the system was ordered, only semiautomated techniques were available. Software for recognizing characters is being developed, and we will eventually automate the character recognition to reduce time and manpower requirements. Before the alphanumerics can be scanned into AMS, a red line must be drawn under each name to determine the angle and location of the character string for positioning on the final map. As the map sheet is scanned, the alphanumerics are stored on disks in raster format, processed into vector format, and stored on magnetic tape for use in the identification subsystem.

The identification subsystem will use the magnetic tape created in the scanning subsystem as input data. Once the soil maps of an area or county are stored on disks, the data are ready for identification. For data on one overlay, significant manual identification must take place. For data on two and three overlays, software features will be used to automatically identify soil lines, roads and drains. Discrepancies occurring in automatic identification will be stored and displayed for manual identification. Character strings are displayed sequentially on a 19-inch cathrode ray tube (CRT). An operator will use the keyboard to enter the character string that is displayed. The characters will then be displayed on the CRT at the correct location and angle. When this step is completed, the next character string will appear on the CRT for identification. The identification subsystem will also do the processing required to produce interpretive maps. A list of the soil mapping symbols and interpretations will be entered for processing. The processing will then produce a magnetic tape for the edit subsystem to edit the automatic drafting subsystem to photographically plot.

The edit subsystem will correct errors in the data base or digitized data, produce a plot of the overlay or map, and prepare megnetic tapes for photographic plotting of base and topographic maps. A plotted map will be given to an editor who will check it manually against the original map. Errors will be noted on the plot, and the plot will then be sent back to the edit subsystem for corrections. These corrections are made on a 19-inch CRT or a coordinatograph table, depending on the accuracy required. Magnetic tapes from the remote systems also will be read in, plotted, edited, and a magnetic tape produced for the automatic drafting machine.

The automatic drafting subsystem, which we have, consists of a Gerber Model 1275 automatic drafting table controlled by a Hewlett-Packard Model 2114 mini-computer. The 5' X 8' drafting table is capable of drawing with a pen on paper or a beam of light on photographic film. The resolution of this subsystem is $\pm$ 0.002 inches ($\pm$ 0.05mm) and accuracy is $\pm$ 0.005 inches ($\pm$ 0.127mm). This subsystem will produce all the alphanumerics and line work for base, topographic, soil and interpretive maps. The output will be film positives or negatives ready for lithographic processing.

The primary software features of AMS follow. The scanner software will record coordinate data for lines, symbols, and alphanumerics for each sheet of a published soil survey. It will recognize whether a line is solid or broken and classify it. It will recognize the placement and orientation of character strings so that these can be displayed for identification. The identification software will tag all alphanumerics, cultural, and line information in the data base and store it on different layers for ease of extraction at a later time. It will link soil symbols to line segments. Line segments will be linked together to form polygons to calculate area and to classify soils according to a list. Four different styles of characters are available in upper and lower case. Up to 64 special line types will be available. The area of closed polygons will be calculated and listed. The scale of the output can be changed as required. Color separations will be produced for color maps.

Editing software will provide the ability to add, delete, or move a feature, correct alphanumeric data, change the endpoint of a line, connect a line to another line, eliminate a crossover, change the line type, add or delete symbols, join feature parts that come from two different sections of a drawing, extract a section of a map by defining as many as 100 coordinate points, eliminate common lines between adjacent soil types that are the same, and automatically join data that come from two different sources.

AMS will digitize 70 soil surveys and 1,000 base and topographic maps per year. The daily throughput of the entire system is 24 soil survey publication sheets, four base maps and four topographic maps per 8-hour day. The system will be able to produce graphic displays and engineering drawings from sketches. In addition, it will be used as a computer for processing other computer programs. The system will require nine people to maintain the required work flow.

To conclude, AMS is an integral part in automating the soil survey program. Its intent is to automate the cartographic phase for producing interpretive maps from a completed soil survey publication. AMS will be integrated with ADP files on soil survey interpretations to automate completely the preparation of interpretive soil maps. Digitized information from the AMS system will be combined with digitized cartographic data from local and state planning agencies to produce plans in which soils are only one of many considerations for decision makers.