Chapter 4 *Digitizing*

Objectives:

In this portion of the course you will become acquainted with the several methods of data input for developing a GIS database. Although various percentages can be found, approximately 75% to 95% of the time spent using a GIS is devoted to data development. Since development of the database involves so much of the actual time spent using GIS software, it seems appropriate to start the first hands on exercises with digitizing.

Digitizing, whether manual or automated, is a crucial component of a GIS. Since your data can only be as accurate as your digitizing, several techniques should be employed to assure the highest possible quality of your data. These techniques will be discussed along with examples for using *v.digit*, the GRASS program used to develop data layers manually.

At the end of this chapter your should be able to:

1. Define the following terms:

   - registration
   - digitizing threshold
   - control points
   - residual
   - topology

2. Use the following GRASS commands:

   - v.digit
   - v.import
   - v.support
   - v.out.ascii
   - v.in.ascii
   - v.to.rast

Digitizing Overview:

The following pages of this chapter are drawn from two GRASS tutorials in the GRASS 3.1 manual. Editing has been made to accomadate the GRASS 4.0 commands and changes.

Definition:

The specific purpose of digitizing in GIS becomes clear when the general definition, process and purpose of digitizing are considered in relation to map information.

Two definitions for the word digitize are in common use. The first states simply that to digitize is to “convert [analog] data into digital form.” A more detailed second definition says that digitizing is “translating analog measurements [of data] into numerical descriptions, based in digits, in a scale of notation.” A scale of notation merely determines the electronic ratio of the assigned value to the real world value.

Digitizing Process:

There are manual and automated processes of digitizing. The term scanning is applied to automated methods. Both techniques have three basic steps.

1. Place the map or document to be digitized on the digitizing surface. This is commonly a table or tablet having a grid of wires imbedded near the surface to which voltages are applied, in the manual case. For scanning, an automatic roll feed is likely to be employed to move the document over a more limited surface area that does not require a wire grid.

2. Registration or Calibration of the document to the digitizing surface is required next. In manual digitizing, this amounts to recording grid voltages corresponding to the positions of control points located on the data source to be digitized. Control point locations are recorded automatically along with other data during scanning. These readings are used to provide the scale of notation for digital quantities translated from voltages. A default scale such as table inches is available in either method. Scanning relies on this type of scale.

When units other than the default are specified by an operator, a coordinate transformation algorithm is required to convert table units to those desired. Scanned data is transformed after data is digitized with the default scale. This could be done in manual techniques as well.

It is important to note that if the registered positions of control points do not agree with those calculated for the surface by inverse transformation algorithms, the recorded data is usually scaled in one or both dimensions of the digitizing plane. Quite simply, if a distance of 14 cm is recorded between two horizontal control points and the distance should be 14.5 cm for an accurate source, the transformed coordinates along the line connecting the two points are scaled to fit the accurate measure.

3. Digitize features of interest on the document by moving a recording instrument over them and recording their locations on the digitizing surface. Manual operators will likely use a device such as a puck which transfers voltages indirectly through magnetic fields. A scanning head which measures reflected light in terms of voltages is automatically passed over data on a scanning surface. Digitized information is stored in various computer files.

Purpose of Digitizing:

Different kinds of data are digitized for many uses but the primary purpose of digitizing is data automation. An automated system is one “in which many or all of the processes are automatically controlled as by electronic devices.” Computers rely upon automatic processes to display and manipulate data stored in files electronically.

Since we are in the business of GIS, we are concerned with constructing an automated digital cartographic database for reliable and efficient display or analysis of map information. Digitizing is a method by which we accomplish this purpose. We use digitizing to automate maps.

The process of digitizing can be costly. Fortunately, it is not the only way that digital data can be acquired. It is always a good idea to search for available data that has already been digitized and is suitable for the purpose at hand. TIGER data from the U.S. Census Bureau or GEODATA from USGS, containing roads, hydrology, and other features, may be purchased for a fraction of the cost of digitizing it.

Maps for Automation:

In order to accomplish the purpose of digitizing in GIS, maps must first be obtained. Since digitizing is only a means of translating map information, the maps themselves must satisfy all cartographic requirements of the database. Maps which are properly prepared for digitizing with consideration given to database requirements and digitizing technique will facilitate the digitizing process.

A new map composed of a variety of existing maps or information is called a compilation or manuscript in cartography. Those with a theme are called thematic maps. Compilations for digitizing may be simple or complex depending upon the number and types of features present. A simple manuscript may contain only roads for a county, whereas a complex one may depict highly erodible land within 500’ of perennial streams.

Once digitized, compilations are represented in the database as a set of geographically registered or referenced layers called coverages, tiles, or modules. The modules may be a direct representation of all data on a source manuscript or they may be components of one or many manuscripts, given the manipulative capability of GIS systems.

Topology:

Map features on compilations are represented in the database by digitally encoded topology. Topology is the form or data structure given to map entities. It may be a series of file entries or files. Topology allows features to be distinguished from or related to others in the data set during coverage manipulation.

Topology is composed of geographical as well as characterizing information. The geographical component of topology relates map features to real world coordinates. It provides the basis for geometrical analysis such as calculation of distances and areas. The characterizing component provides other information about map features. This data is called attributes or categories. Soil name or texture would be examples of this component.

There are three basic topologic entities common to vector and raster types of GIS data. They are the point, line and area. Complex topology will vary between types as well as between GIS packages.

Points are represented simply by a coordinate pair and perhaps an identifying number. Vector points and raster cells are the most basic elements of topology. Vector coordinates are in x, y format. Cell coordinates are in row, column format representing grid-cell position. Geographic control points called tics and labels for sites or areas are represented by this element. Points are the building blocks for more complicated map features such as lines and areas.

Lines are a collection of ordered points or cells. They are crucial in constructing vector polygon topology. Linear features such as roads and boundaries or neatlines are shown with lines. A neatline is a line surrounding or limiting the image area of a map. Vertices are points in vector lines. Nodes are endpoints of vector lines.

Polygons are used to represent areas. They may be a collection of contiguous cells or a closed plane figure bounded by vector lines. Lines used to form areas must connect precisely at nodes, otherwise areas and attributes will "leak" into adjoining polygons. A neatline must exist in order to form vector polygon topology at map edges. Topology may affect module sizes if it is dense or complex, due to system limitations on available memory, especially when layers are being manipulated. Compilations may need to be reduced in geographical extent or simplified to compensate for the effects of topology.

Cartographic Requirements:

In GIS, maps must meet certain cartographic requirements. They are required to have a projection, control points, a datum, map scale and must meet standards of accuracy. If compilations do not fulfill these requirements, then neither will the resulting coverages. That old saying "GARBAGE IN....." applies here as well as anywhere else.

Planar representations of the curved surface of the Earth have distortions in scale and direction that increase with geographical extent. These distortions are compensated for by the use of map projections which represent meridians and parallels as curved lines. A map projection provides the mathematical and graphical transformation required between coordinates on the ellipsoid of the earth and the map plane.

Projections are designed for use over specific geographical extents. See chapter 2 regarding map projections. An Albers projection is suitable for the coterminous United States. Smaller areas may be placed in UTM, Lambert or State Plane projections. Compilations that extend across projections, UTM zones for example, will develop errors in areas and distances. The map projection for a compilation must be adequate to cover its' geographical extent.

Control points are necessary to geo-reference compilations. They are used during map registration in digitizing to provide the basis for coordinate transformations. Map features should not extend beyond the limits of control to avoid transformation error. Four or more control points are recommended for a rectangular area. Fewer than this number will reduce the ability of transformations to compensate for inaccuracies of the base scale in two dimensions.

Control point locations on compilations to be digitized are affected by the datum used. NAD 27 is based on the Clarke 1866 ellipsoid originating from a point at Meades Ranch, KS. NAD 83 is Earth centered, based on the GRS 80 ellipsoid which is a best fit to the geoid. Control points from NAD 27 are still the most common in use, due to the fact that USGS has not re-drafted quadrangle maps to fit NAD 83 control.

All maps will have a map scale or representative fraction (RF) to indicate the relationship between map distances and distances on Earth. A mapscale of 1/24,000 is a larger mapscale than 1/2,000,000 but one map unit at a mapscale of 1/2,000,000 is a larger distance than one map unit on a 1/24,000 scale map. Units are unimportant in fractional scales because they always drop out. One inch to 24,000 inches is the same RF as 1 centimeter to 24,000 centimeters. The RF of a compilation is important because it determines what the accuracy of a map should be. RF can also be written like 1:24,000.

National map accuracy Standards for the U.S. states that a certain number of test points must be accurate within 0.03" for maps with scales larger than 1:20,000 and within 0.02" for maps with scales less than or equal to that scale. Soil or forrest boundaries are not considered test points. SCS has specified that soils data will be accurate within 0.01" at whatever mapscale is being used. This would correspond to 20' at a RF of 1:24,000.

Compilations containing data from maps with differing scales should only be considered as accurate as the least accurate scale used. Error migration will occur when database modules are plotted at scales other than those of the source map. Errors will increase or decrease with mapscale. Points located accurately within 0.01" on a map with a RF of 1/100,000 will be within 0.02” on a map plotted at 1/50,000 and within 0.005” when plotted at 1/200,000.

Map coordinates may be specified in a variety of units. The type of map units determines the size or range of coordinate values stored for map features. If the numeric precision of the GIS package being used is inadequate for the task, map accuracy will be in error. Double precision numbers or data shifts may be required in order to capture data within required accuracy.

Map resolution is the minimum distance allowed between map features or the minimum size of a feature that may be represented. When given in ground units it is called ground resolution. The resolution for map coverages in the database will depend upon the resolution of the digitizing equipment or parameters set by the digitizer operator.

High resolutions are represented by smaller numbers than low resolutions. A digitizing surface must have the resolution necessary to capture data within standards of accuracy. Map resolutions set during raster digitizing must not go lower than the accuracy required and cannot exceed that of digitizing equipment. Resolutions which are higher than necessary may result in increased data storage requirements if the quantity of data collected cannot be generalized.

Compilation modules must be edgematched physically to all adjoining modules before digitizing. This is done to insure the continuity of features or attributes extending across map boundaries. Lines for map features terminated by the neatline, must intersect it and be within 0.005” (centerline to centerline) of matching elements on adjacent modules. Edgematching is usually completed by computer, since drafting or digitizing within this tolerance requires special equipment or abilities.

Compilation Materials:

Materials used in map compilations should be accurate and stable. Paper can shrink or swell on the order of 1% with temperature or humidity. Vellum is more stable but film or mylar is recommended for use. Paper can provide satisfactory results when used in a controlled environment over short durations. USGS topographic quadrangles or orthophotoquads and maps should be used to obtain accuracy. Only orthophoto imagery is recommended for use because mosaics and aerial photographs are not corrected for relief. Never use photocopies.

Only fine line drafting equipment should be used. Choose colors that reduce confusion and eyestrain or aid scanning. The physical size of compilations must not exceed the usable portion of digitizing surfaces.

Use as few overlays as possible since they tend to bubble or slide. They also can be confusing, difficult to see through and cause eye fatigue. Overlays must contain precise control in order to match base maps and be registered properly. Use pinbars to keep bases and overlays together during compilation if possible. If the geographical extent or types of map features are limited, overlays can be eliminated by compiling maps that contain several types of topology. This technique is called integrated terrain unit mapping. Data types may be digitized separately or together later to form layers in the database. The most accurate feature common to several layers should be used as a template for all layers so that it will always be the same in the database.

Equipment:

Digitizing equipment must be functioning properly and be capable of capturing data with acceptable precision and resolution. Most equipment has diagnostic tests which can be run. In addition, operators need to posses the skills required to operate the equipment effectively. The best compilations for digitizing can not compensate for inadequate equipment or poor technique.

All of the equipment shown for a typical GIS in the course module for the History and Overview of GIS can be considered digitizing equipment, since it is or may be used somewhere in the digitizing process. The computer is required to run the digitizing software and manipulate digital data. The graphics display and keyboard provide a user interface with the equipment and database. Printers and plotters are used to obtain hard copy for data verification. Only digitizing surfaces and recording instruments require further mention at this point.

Digitizing tablets designed for menu operation generally do not have the resolution required for digitizing in GIS. High resolution tables or tablets with an accuracy of 0.005” or less or scanners capable of 200 Dots Per Inch (DPI) or more should be used.

The most commonly used instrument in manual digitizing is the puck. It is much easier to position than a stylus over map features since it rests on the table and has crosshairs. Pucks are usually more versatile because they contain more function keys. Scanners record data automatically with a scanning head. Since points can be entered on digital maps using a cursor, it qualifies as a recording instrument. A keyboard or mouse is used to position the cursor. A keyboard is more accurate than a mouse but is more difficult to operate.

Digitizing Technique:

Digitizing technique involves the proper use of equipment and procedures. It must be developed. Some methods are quicker than others but may be more difficult to accomplish. The best technique is the one which provides an accurate dataset for the least cost. This requires that editing be part of digitizing technique. Scanning is automated, fast and accurate. Scanned data may require more editing but the time saved collecting the data is well worth it. The following paragraphs pertain to manual methods.

- The manuscripts to be digitized should be secured to the table. Overlays must be positioned accurately and secured as well. Pinbars for punched bases and overlays will help keep overlays in the proper position.

- Careful registration must be used in order to obtain the lowest possible transformation error. RMS (Root Mean Square) errors less than or equal to 0.007” have yielded good results. The more control used, the more chance there is for operator error or inclusion of bad points. This can result in a higher RMS or residual error. Acceptable Cell Residual errors for some ideal maps are listed in the table below by scale.

Acceptable cell residual errors for some ideal maps.

MAPSCALE (RF)	RESIDUAL (meters)
1:100,000	20-30
1:50,000	5-10
1:24,000	1.2-2.4
1:4,800	0.5-1.0

- The proper digitizing environment must be set during data capture. Snaps or traps which cause entities to be snapped together if they are within a specified distance, will allow less than superhuman operators to connect nodes. Weeds or thresholds can be set to generalize data as it is being collected and reduce data storage requirements. Additionally, the graphics display can be set to show potential problems as data is being collected.

- Data capture must be accomplished using edit reducing techniques. Data is generally recorded point by point. For vectors this is called line segment digitizing. Grid-cell is the term applied to raster data. Points should be collected about every 1” and at inflection points. Keep the number of points collected under 500 for vector lines to obtain frequent rest, avoid loss of work in the event of a mistake and allow usage of the data on systems having limitations.

- Two point lines greater than 7.5’ or 0.125 decimal degrees should not be digitized unless they contain interior points. They are not transformed with the proper curvature.

- Use system generated neatlines. Those which are digitized do not edgematch as well.

- Avoid digitizing the same entity twice to avoid extras and slivers.

- Digitize only one type of topology at a time to save time lost switching input modes.

- Edgematch while digitizing by snapping to data from adjoining maps which have been copied into the coverage or are in background. A checkerboard scheme for modules will enhance this method. In lieu of this, for small uncomplicated maps, composite the data from all into a single larger module as it is collected. Clip out maps later.

- Take advantage of automated processes if possible. Stream mode digitizing may save some time provided the proper parameters are set (distance and or time) and the operator has sufficient skill. Spaghetti digitizing can be used with point to point or stream digitizing to avoid the need for node or cell snapping altogether. This type of data is cleaned up later with automated editing to find intersections and fix overshoots or undershoots.

- Leaning on the digitizing surface can create problems. Compilations might get shifted or become unattached, losing calibration. It may also be possible to warp the surface, changing the distance between the grid and recording instrument and thus readings in that area.

- Finally, the data is not digitized until it has been verified and archived. Rely on automated editing as much as possible. Perform screen edits before preparing hardcopy proof plots. Plots require money for time, paper, and ink. Check for missing, mislabeled and extra features or attributes. Edgematching and accuracy must also be validated.

Tutorial *v.digit: Its Use and Features*

Introduction:

GRASS map development entails the production of raster, vector, and support files that can be used within GRASS to represent map features. The GRASS programs that are used in map development are: *v.digit*, *v.import*, *v.support*, *v.in.ascii*, *v.out.ascii*, and *v.to.rast*.

The *v.digit* program is a highly interactive and menu-driven digitizing, labeling, and editing package. Most aspects of digitizing can be done entirely from within *v.digit*. This tutorial discusses all *v.digit* options and walks the user through a sample digitizing session.

Contents:

1. Preparing a Paper Map Suitable for Digitizing:

Although a great amount of information is stored on paper maps, this information can be much more easily manipulated in a computer database. To get map data into a GRASS database, map data (analog data) is converted into digital data by tracing relevant map features using a digitizer. The digitizer and *v.digit* convert map data into a GRASS vector format.

Frequently, map data cannot be digitized directly from original paper source maps. Paper maps will generally contain many types of information. The person that is digitizing must know exactly what information is to be digitized. It is therefore generally necessary for the user to prepare a map(s) containing only the information that is to be digitized before beginning to digitize.

A detailed GRASS tutorial entitled Map Preparation explains how maps should be prepared maps for digitizing and should be read prior to digitizing.

Have the following items before beginning to digitize.

- a stable medium, i.e., mylar, plastic, etc. on which the features to be digitized appear clearly and accurately,
- at least 10 marked points on the medium corresponding to UTM, state plane, x,y, or lat/lon coordinates,
- a window in UTM, x,y, or lat/lon coordinates defining the area being digitized,
- a window in UTM, x,y, or lat/lon coordinates defining the area of the resultant cell file,
- masking or drafting tape to secure the medium, and
- a planned final window and resolution for the cell file.

2. Entering the *v.digit* Program:

To walk through the examples in this tutorial you will need a digitizing workstation consisting of a graphics monitor, a pointing device (mouse), a digitizer, and optionally an ascii ‘dumb’ terminal with keyboard. Currently, *v.digit* runs on GeoGraphics, Altek, Calcomp, Hitachi, Numonics, and Kurta digitizers. If you are not already in GRASS, enter GRASS by typing the command:

```
grass4.0
```

See Chapter 3 for instructions on starting GRASS. You will then be asked to enter a location, mapset, and database with which to work. Select *spearfish* as the location and *PERMANENT* as the Mapset. The Database should be set to the directory in which your GRASS data is stored (i.e. /home/grass4/data).

```
spearfish
PERMANENT
```

Follow the instructions in Chapter 4, Display for starting GRASS. Start the graphics terminal following the startup instructions and then run the GRASS program *d.mon select=x0* to link the graphics monitor to your present session.

When you are back at the GRASS prompt you can then start the digit program by entering the command *v.digit*.

```
v.digit
```

The first message to appear one inside digit is a listing of the available digitizers on your system (i.e., those that were installed by your system manager). Note that you have the option of choosing to use no digitizer by selecting option *[none]*. The digit program may be run both with and without a digitizer. Many of its options are still available if no digitizer is chosen. For the purposes of this tutorial, chose the digitizer *[kurta]* here, by typing the number associated with it at the prompt.

Next you will be prompted for the name of the vector file to be used during the digitizing session. Both existing vector files and new vector files can be chosen. Entering the command *list* will show all the existing files under dig directory in your location.

```
list
```

Type a new vector file name and hit *<return>*.

```
myfile
```

You will now be asked if the vector file on which you have chosen to work is referenced in that LOCATION's coordinate system. The coordinate systems used in GRASS are the Universal Transverse Mercater (UTM),State Plane Systems, x,y, and lat/lon. Mixing of the two coordinate systems in the same LOCATION is not allowed in GRASS. If you choose a coordinate system other than that LOCATION's coordinate system digit will automatically exit and return you to the GRASS prompt.

The next screen (resembling that shown below) asks the user to enter information about the file to be worked on. This information is stored along with the user's mapset for use in future GRASS sessions. If this is a new file, this screen will contain blank lines. It is likely that the user will later need this information both inside and outside of *v.digit*. In addition, the user must fill most of the lines on this screen to continue with digit.

To move around this screen, use *<return>* or "*ctrl j*" to descend a line, "*ctrl k*" to ascend a line, and *<return>* or "ctrl j" to reach the top line from the bottom line. When happy with your responses, press the *<ESC>* key to continue to the next screen.

v.digit information screen.

```
Provide the following information:

Your organization   Arkansas Archeological Survey
Todays date (mon,yr)8/90_______________
Your name           grass______________
Map's name          Arkansas Base Map_______________________
Map's date          1967______
Map's scale         1:500000___
Other info          __________________________________________________________
Zone                15___
West edge of area   350000________
South edge of area  3645000_______
East edge of area   810000________
North edge of area  4045000_______




              AFTER COMPLETING ALL ANSWERS, HIT <ESC> TO CONTINUE
```

The coordinates on this page define a "digitizing" region. Once this region is established, only data that falls within this region will be recognized by *v.digit*. Therefore, the user should be careful to make this region large enough to completely cover the area of interest. A good practice is to make this region the same size as the default region for this location. This default region is located in the PERMANENT directory of your present location. You can find out what the default coordinates for your current location are by running the GRASS *g.region* command while you are outside of the *v.digit* program.

[Esc]

After the user hits the *[Esc]* key, the following message will appear:

v.digit - continue screen.

```
Shall we continue? [y]
```

[return]

Here simply enter *y* to continue, or *n* to exit the digit program. If you exit digit at this point, your title page will not be saved.

***Note**: If the digitizer you chose was [none], you will not see the following messages. Instead, you will continue on to Moving Through the v.digit Menus, section 3 of this tutorial.*

Tape the map securely to the digitizing surface, making sure that all areas to be digitized fit within the reach of the digitizing arm or pointer.

If this file has been worked on before, it may contain registration points that were used in the last digitizing session. You may use these same registration points, add additional ones, or add completely new points in this session. If this is a new file, you will not see the following message:

v.digit - last session registration points screen.

```
Use set of registered points from last session (y/n)?
```

Enter *y* to use the same registration points you used in the previous session, or enter *n* if you wish to register your map using new points.

Now input the coordinates of the registration points appearing on your map overlay. While *v.digit* requires that only four points be registered, it is a good practice to enter at least eight registration points, since you will probably have to eliminate some points later for various reasons. These points should be distributed throughout your map. Also, it is convenient to enter the coordinates in some order. For example, you might begin by entering the coordinates of the registration point nearest the lower-left corner of your map, and continue entering points in a clockwise direction until all of the coordinates are entered.

v.digit - screen for entering registration points.

```
MAP REGISTRATION POINTS
Enter 4 - 10 points:  points registered 0

Point #       X coord       Y coord
  1        590000.00___   4915000.00__
  2        590000.00___   4927000.00__
  3        599000.00___   4927000.00__
  4        600000.00___   4927000.00__
  5        609000.00___   4927000.00__
  6        609000.00___   4915000.00__
  7        600000.00___   4915000.00__
  8        599000.00___   4915000.00__
  9        0.00________   0.00________
  10       0.00________   0.00________

  Enter 0.0 to delete a coordinate pair.
  Those marked by '*' are registered.



          AFTER COMPLETING ALL ANSWERS, HIT <ESC> TO CONTINUE
                        (OR <Ctrl-C> TO CANCEL)
```

Here, enter the coordinates of the registration points. Move down through the menu by entering *[return]*. If you make errors while entering points, use "*ctrl k*" to move back one entry or "*ctrl h*" to move the cursor left. re-enter any mistyped points. You may, at most, enter ten points. Once you finish entering the coordinates of your registration points, press the *[Esc]* key to continue.

[Esc]

The following screen will then appear:

v.digit - point registration screen.

```
|-------------------------------------------------------------------|
|                      POINTS TO REGISTER                           |
|     POINT        EASTING (X)      NORTHING (Y)                    |
|      * 1.          590000.00      4915000.00                      |
|      * 2.          590000.00      4927000.00                      |
|      * 3.          599000.00      4927000.00                      |
| ->     4.          600000.00      4927000.00                      |
|        5.          609000.00      4927000.00                      |
|        6.          609000.00      4915000.00                      |
|        7.          600000.00      4915000.00                      |
|        8.          599000.00      4915000.00                      |
|                                                                   |
|                                                                   |
| Number of points: 8,   Points registered: 0                      |
|                                                                   |
|                                                                   |
|                                                                   |
|                                                                   |
|-------------------------------------------------------------------|
|           USING DIGITIZER CURSOR FOR INPUT                        |
|  Key <1> - register point,      Key<4> - add more points         |
|  Key <2> - skip point,          Key<5> - accept residuals        |
|  Key <3> - unregister point                                      |
|-------------------------------------------------------------------|
```


This screen provides you with many ways of dealing with your registration points. To register a point, move the pointer of the digitizer onto the registration point and hit key *[1]*. As you register points, an asterisk will appear beside each point registered. Once a point is registered, *v.digit* will automatically take you to the next point. If you don't want to include a particular point in the registration, enter key *[2]* to skip to that point followed by key *[3]* to unregister it. You may for whatever reason wish to enter the coordinates of additional points that do not appear on this screen. Choosing the key *[4]* option will bring back the previous screen, enabling you to add more points.

Once you register at least four points, a fourth column will appear listing the residual error associated with their placements. Each residual represents the accuracy of this point in relation to each of the other registration points. Try to make the overall residual less than 10, and try to make each individual residual fall within 2 integers of the other residuals listed. Residuals can sometimes be lowered by re-entering points, or by eliminating specific points using the option key *[3]*. Once you are happy with the residuals, choose key *[5]* to continue. If you return to this file in a different session, register your map using the same registration points if possible.

The next feature allows you to list the coordinates of any point on your overlay, to momentarily suspend display of the coordinates, and check the operation of the foot switch (if one is included with your digitizer). This feature is used to test the positions of the registration points and to collect the coordinates of points to be used in GRASS site files and in geo-referencing.

v.digit - accuracy check screen.

```
CHECK MAP:   Key '1' to preserve point;  Any other Key to continue

      Coordinates:                X - Current - Y         X -  Saved  - Y
     0                      267300.95     52141.00         0.00         0.00
```

If you are not happy with what you have done so far, and wish to re-register your overlay, answer *no (key [2])* to the following prompt.Otherwise answer *yes (key [1])*.

v.digit - accept registration screen.

```
  USING DIGITIZER CURSOR FOR INPUT
Key '1' for YES   :   Key '2' for NO
|
If satisfied with the registration, enter 'y', else 'n'
```

Answering *no* will return you to the registration part of digit.

At this point you have entered *v.digit* and registered your map layer; you are now ready to begin work. The “digitizing region” that you created (defined by the coordinates shown on the title page) will almost always be too large a window in which to work comfortably. You will therefore define a “working region” for *v.digit* using the digitizing cross-hairs (see screen below), describing any subset of your “digitizing region” in which you wish to work throughout your *v.digit* session. It will not affect any other GRASS program, nor will it be saved after you exit *v.digit*. It is only used to conveniently zoom in on and display small areas in which you are digitizing. Understanding the differences between the “digitizing,” “working,” and “current” regions is very important.

v.digit - working region definition screen.

```
Identify corners of graphics window.
  Locate digitizer cursor on one corner of desired window.
  Then hit any digitizer <Key>
```

Use the digitizer cursor to identify the two diagonal corners which will define your working windows.

3. Moving Through the *v.digit* Menus:

All of the options are presented in the Main, Digitize, Edit, Label, Customize, Toolbox, and Window menus.

Only one menu appears on the terminal screen at any given time. Options may be chosen only when they appear on the current menu page. Each menu contains at least two fields: a title field (top field), and a global field (bottom field). The top field displays the menu name, while the bottom field displays global options. Movement between menus is done by choosing a global option found in the global field. For example, the menu now appearing on the terminal screen is the Main Menu. Choosing "*D*" (for Digitize) from this menu will cause the Main Menu to be replaced by the Digitizing Menu. Each menu has its own set of global options - where each set is a subset of the global options found at the bottom of the Main Menu. To choose a global option, type in the first letter of that option (using upper case letters only).

Take some time to look at the layout of this Main Menu screen and the information it contains. Note that most of the information on it was taken from the title page information entered by you earlier.

v.digit - main menu screen.

```
|-----------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                        Main menu  |
|-----------------------------------------------------------------------------|
| MAP INFORMATION                                 | AMOUNT DIGITIZED          |
|   Name:         Arkansas Base Map               |   # Lines:         0      |
|   Scale:        500000                          |   # Area edges:    280    |
|   Person:       grass                           |   # Sites:         0      |
|   Dig. Thresh.: 0.0300 in.                      | - - - - - - - - - - - - - |
|   Map Thresh.:  381.00 meters                   |   Total points:    4889   |
|                                                 |                           |
|-----------------------------------------------------------------------------|
| OPTIONS:                                        |                           |
|                                                 |                           |
|     Digitizer:     Disabled                     |                           |
|                                                 |                           |
|                                                 |                           |
|                                                 |                           |
|                                                                             |
|-----------------------------------------------------------------------------|
| Digitize  Edit  Label  Customize  Toolbox  Window  Help  Zoom  Quit  *  !  ^|
|                                                                             |
|                                                                             |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]        |
|-----------------------------------------------------------------------------|
```

The first technique to master before actually using *v.digit* is moving through the menus. The first six global options in the Main Menu are themselves menu names. Typing the first letter of any of These six global options will replace the present menu with the menu just chose.

There are three Main Menu global options that are not menu names. The global option "*Quit*" will exit you from digit. saving all your work; the "*Quit*" option is only available from the Main Menu. The "*Help*" option displays on-line help to the user. The option "*!*" replots the terminal screen text without altering any work there 'to erase garbage appearing on the screen and the "*" option redraws the graphics screen. The "*Help*","*" and the "*!*" options can be chosen from any menu.

Enter the letter *D* to move to the Digitize Menu, shown below:

.

v.digit - digitize nenu screen.

```
|----------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                   Digitize menu |
|----------------------------------------------------------------------------|
|  Mouse Digitizer                                 | AMOUNT DIGITIZED        |
|                                                  |   # Lines:         0    |
|                                                  |   # Area edges:    280  |
|                                                  |   # Sites:         0    |
|                                                  | - - - - - - - - - - - - |
|                                                  |   Total points:    4889 |
|----------------------------------------------------------------------------|
| Digitize options:                                | CURRENT DIGITIZER PARAMS.|
|                                                  |                         |
|  <space> Digitize                                |  MODE       TYPE        |
|    - Toggle MODE                                 |   >POINT<     line      |
|  t - Toggle TYPE                                 |    stream    >AREA EDGE<|
|  l - Auto Label                                  |               site      |
|  q - Quit to main menu                           |                         |
|                                                     AutoLabel:  DISABLED   |
|----------------------------------------------------------------------------|
| Edit  Label  Customize  Toolbox  Window  Help  Zoom  *  !  ^               |
|                                                                            |
|                                                                            |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]       |
|----------------------------------------------------------------------------|
```

Notice the menu name in the field at the top of the screen. Ignore for the moment the center two fields and look at the bottom field. Notice the global options. These are slightly different than the ones available in the Main Menu. Typing the first letter of any of the available global options presented here will cause the Digitize Menu to be replaced with the menu option chosen.

Enter *E* to bring to the screen the Edit Menu:.

v.digit - edit menu screen.

```
|--------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                      Edit Menu |
|--------------------------------------------------------------------------|
| Edit options:                                                            |
|  r - Remove line                                                         |
|  i - Remove site                                                         |
|  s - Snap line to node                                                   |
|  b - Break a line                                                        |
|  m - Move a point                                                        |
|  M - Move a line or site                                                 |
|  t - Re-type a line  (AREA/LINE)                                         |
|  d - Display nodes in threshold                                          |
|  R - Remove BLOCK of lines                                               |
|                                                                          |
|                                                                          |
|  q - Quit to main menu                                                   |
|                                                                          |
|                                                                          |
|--------------------------------------------------------------------------|
| Digitize  Label  Customize  Toolbox  Window  Help  Zoom  *  !  ^         |
|                                                                          |
|                                                                          |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]     |
|--------------------------------------------------------------------------|
```


Once again, notice the global options at the bottom of the screen.

Now let's try returning to the Main Menu by typing M. Notice that nothing happens, because the global option "Main Menu" does not exist above. To return to the Main menu, simply type *q*.

Practice moving through the various menus. When you are confident with the menu structure, continue with the next section.

4. Using the Mouse:

Many *v.digit* options make use of a pointing device (mouse). A mouse usually has three buttons: a left, center, and right. (Some mouses have only two buttons; in this case, use of the middle button is simulated by pressing the left then right mouse buttons in quick succession.) Once the mouse is activated, movement of the mouse corresponds with movement of a pointer on the monitor screen. (Although this pointer may appear as the edge of a movable box, two perpendicular lines, an arrow, or some other type of pointer, we will here refer to this simply as the pointer.) The mouse is used to identify or define the extent of something shown on the monitor.

1. When in *v.digit* you can identify an object using the mouse by moving the pointer onto the object to be identified, then pressing the left mouse button. The object identified will be high-

lighted on the monitor in yellow. (This highlight color may be changed with an option in the *v.digit - customize menu*). If the object identified is not the desired one, move the pointer to the feature desired and choose it by pressing the left button. You can identify an unlimited number of objects. The last one chosen will be the only object identified.

2. Once you have identified the object you want, accept your choice by pressing the right mouse button. To end or abort use of the mouse at any time, press the middle button.

5. Digitizing:

Digitizing is the process of converting analog data into digital data by tracing the desired objects with the sight of a digitizer. (Here, sight is used to refer to that part of the digitizer by which the user traces features (sometimes referred to elsewhere as pointers, cursors, arrows, cross-hairs, etc.) In general, it consists of two perpendicular lines, several circles, or a combination of other objects, imposed on a transparent surface.) The digitizer collects points that are traced by the user through the sight in one of two modes: “point” mode, or “stream” mode. In point mode the digitizer will only collect points when the user tells it to, no matter where the digitizer’s sight is moved. In stream mode, the digitizer continually collects points as its sight is moved. Point mode is useful for digitizing straight lines and features requiring a small number of defined points (i.e., straight roads, parts of boundaries, transect lines, etc.), where the user does not wish to pick up extraneous points. Stream mode works well when digitizing curves, complex lines, soil polygons, streams and features where frequent collection of points is needed.

All features to be digitized are grouped into three types: points, lines and area edges. Area edges contain something within them. For example, the map boundaries circumscribing a roads map would be digitized as area edges (because they contain the roads within them), although the roads themselves would generally be digitized as lines. Such features as soils polygons and area geology would be digitized as area edges, while such features as roads and railroads would generally be digitized as lines. Sites indicate point locations such as water wells.

The Digitizing Menu is shown below:.

v.digit - digitize menu screen.

```
|-----------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                    Digitize menu |
|-----------------------------------------------------------------------------|
|  Mouse Digitizer                                 | AMOUNT DIGITIZED         |
|                                                  |   # Lines:        0      |
|                                                  |   # Area edges:   280    |
|                                                  |   # Sites:        0      |
|                                                  | - - - - - - - - - - - - -|
|                                                  |   Total points:   4889   |
|-----------------------------------------------------------------------------|
| Digitize options:                                | CURRENT DIGITIZER PARAMS.|
|                                                  |                          |
|  <space> Digitize                                |  MODE       TYPE         |
|    - Toggle MODE                                 |   >POINT<     line       |
|  t - Toggle TYPE                                 |    stream    >AREA EDGE< |
|  l - Auto Label                                  |               site       |
|  q - Quit to main menu                           |                          |
|                                                     AutoLabel:  DISABLED    |
|-----------------------------------------------------------------------------|
| Edit  Label  Customize  Toolbox  Window  Help  Zoom  *  !  ^                |
|                                                                             |
|                                                                             |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]        |
|-----------------------------------------------------------------------------|
```

At this point you should be familiar with the title (top) field and the global (bottom) field (refer to section 3 of this tutorial). Now look at the two center fields.

The first field is entitled “*KURTA digitizer*”. This field will differ depending on the type of digitizer in use.

The menu’s right side has a field entitled “*AMOUNT DIGITIZED*”. The numbers here reflect the number of lines and areas digitized, and the amount of points digit required to represent these objects. These numbers continually change to reflect changes in what has been digitized.

The field titled "*CURRENT DIGITIZER PARAMS*” displays the status of the digitizing parameters. Digitizing can occur either in point or stream mode. Also, objects may be lines (i.e., roads). sites (i.e. water wells), or area edges (i.e., soil polygons). This field lists which of these parameters are currently set.

The field titled “*DIGITIZE OPTIONS*” contains several options.

[space] Activates the digitizer, and begins reading and recording points.

m Toggles between the two modes of picking points: point/ STREAM.

t Toggles between the two types of objects capable of being digitized: *Line/AREA EDGE*. (Active settings are shown in *UPPERCASE* letters.)

q Returns the user to the main menu, saving any work done in this menu.

6. Editing:

This is the Edit menu:.

v.digit - edit menu screen.

```
|--------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                      Edit Menu |
|--------------------------------------------------------------------------|
| Edit options:                                                            |
|  r - Remove line                                                         |
|  i - Remove site                                                         |
|  s - Snap line to node                                                   |
|  b - Break a line                                                        |
|  m - Move a point                                                        |
|  M - Move a line or site                                                 |
|  t - Re-type a line  (AREA/LINE)                                         |
|  d - Display nodes in threshold                                          |
|  R - Remove BLOCK of lines                                               |
|                                                                          |
|                                                                          |
|  q - Quit to main menu                                                   |
|                                                                          |
|                                                                          |
|--------------------------------------------------------------------------|
| Digitize  Label  Customize  Toolbox  Window  Help  Zoom  *  !  ^         |
|                                                                          |
|                                                                          |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]     |
|--------------------------------------------------------------------------|
```

Edit Options:

r Removes a previously drawn line. Position the pointer on the line to be removed. Choose a line by pressing the left mouse button. If the line highlighted is the desired line, confirm it by pressing the right mouse button. The line will then be removed.

s A node that you wished to be connected (i.e., snapped) to another node may not be. you may manually connect one node to another using this option. Move the pointer to the line you want snapped and choose it by pressing the left mouse button. if the node chosen is the correct node, accept your choice by pressing the right button. Now, choose and accept the node you want the line snapped to. The line will be attached to this selected node.

b Breaks a line inserting a node. A line is defined by its two endpoints. Choosing this option breaks a line into two separate lines by inserting a node at the break point. Use the selected pointer to choose a place on a line where the break is to occur. (Select pointer in customize menu.)

m Moves a point. Choose a line and the point on it that you want moved, and then choose the position where you want the point moved.

p Create a temporary node. The node can be used as a location reference or a point to snap another line to. Use either the mouse or digitizer, as selected from within the Customize menu. This node will exist until the end of the session or until you choose the write out session function.

d Displays nodes within a given threshold level of distance. When two nodes are within (closer together than) this defined snapping threshold, digit will snap the two nodes together and thereafter consider them to be the same node. this threshold distance is adjustable by the user. The d option will display the nodes that fall within a user-specified threshold.

t Changes the type of the line. If a segment was digitized as a line, but was meant to be digitized as an area-edge (or vice versa), choosing this option will toggle its type.

R Removes a block of objects. Sometimes it is desirable to remove all objects that lie within a defined area (e.g., to make a boundary map by removing all lines within the boundaries from a copy of another existing map). Using the mouse pointer the user outlines the area from which lines are to be removed.

q Returns the user to the Main Menu.

7. Labeling:

Labeling is the process of assigning category values to digitized objects. The user chooses a category value, moves the pointer onto the object to be labeled, chooses the object to be labeled, and accepts the chosen object. You may label an object more than once, but only the last label placed will be kept. To abort the labeling process, press the center mouse button.

The labels can only be numerical values. Before beginning to label, identify all the different values to be used. The value “0” is reserved for the category “*no data*”. You may not label anything with the value 0. Label the objects sequentially beginning with category value 1 and continuing as needed.

Labeling options are presented in the menu below:.

v.digit - label menu screen.

```
|--------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                     Label Menu |
|--------------------------------------------------------------------------|
| Label options:                                                           |
|  a - Label Areas                      m - Label Multiple Lines           |
|  l - Label Lines                      M - Un-Label Multiple Lines        |
|  s - Label Sites                                                         |
|                                       c - Label Contours                 |
|  A - Un-Label Areas                   i - Contour interval:     <    5>  |
|  L - Un-Label Lines                                                      |
|  S - Un-Label Sites                                                      |
|                                                                          |
|  B - Bulk Label Remaining Lines                                          |
|                                                                          |
|  h - Highlight Lines of category #                                       |
|  d - Display Areas of category #                                         |
|                                                                          |
|  q - Return to main menu                                                 |
|--------------------------------------------------------------------------|
| Digitize  Edit  Customize  Toolbox  Window  Help  Zoom  *  !  ^          |
|                                                                          |
|                                                                          |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]     |
|--------------------------------------------------------------------------|
```


Label options:

a Activates the mouse for area labeling. Enter a category value at the prompt appearing on the terminal screen. Position the pointer anywhere inside the area you want labeled. Choose and accept the area. Next, position the pointer on any line bounding the area to be labeled. Choose and accept this object.

l Activates the mouse for line labeling. Enter a category value at the prompt appearing on the terminal screen. Position the pointer on the line to be labeled. Press the left mouse button to choose the line and the right mouse button to accept and label the chosen line.

A Activates the mouse for unlabeling areas. Place the pointer anywhere within the boundary of the area to be removed. Choose this area by pressing the left mouse button, and accept the chosen are by pressing the right mouse button. The area will be removed.

L Activates the mouse for unlabeling lines. Position the pointer on the line to be removed. Choose the line by pressing the left mouse button, and accept the chosen line by pressing the right mouse button. The line will be removed.

B Bulk label ALL remaining unlabeled lines. You will be prompted for attribute number. Use 0 to abort. note this is only available for labeling lines.

s Displays the lines of a given category value. Enter the category value at the terminal prompt. All lines containing the category value will be highlighted.

d Displays the areas of a given category value. Enter the category value at the terminal prompt. All areas containing the category value will be highlighted.

q Returns the user to the main menu.

8. Windowing:

v.digit - window menu screen.

```
|----------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                      Window Menu |
|----------------------------------------------------------------------------|
| Window options:                                                            |
|  a - Show area markers                   W - Define new window             |
|  A - Show area labels                    C - Clear window                  |
|                                                                            |
|  i - Show lines                          c - Display scale                 |
|  l - Show labeled lines                  w - Where am I                    |
|  L - Show line labels                      - Display Overlay Map           |
|                                            - Display Backdrop CELL Map     |
|  s - Show sites                                                            |
|  S - Show site labels                                                      |
|  n - Show nodes                                                            |
|                                                                            |
|  q - Return from whence we came                                            |
|                                                                            |
|                                                                            |
|----------------------------------------------------------------------------|
| Help  Zoom  *  !  ^                                                        |
|                                                                            |
|                                                                            |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]       |
|----------------------------------------------------------------------------|
```

When digitizing, you need to be aware of three regions: the current, digitizing, and working regions. Once GRASS is initiated, the user is given a current region. It is within this region that all GRASS commands operate, unless otherwise noted. The current region is initially set to the location default window, but can be changed by the user numerous times. The current region is remembered from one GRASS session to another. The current GRASS region has little impact on digitizing, until you create a cell file from the digitized map.

The digitizing region is defined in the *v.digit* start-up page. This region defines an area that must be large enough to encompass all of the data to be created within a particular digitizing session. This region is often set to the same dimensions as the default region for a particular location. However, this need not be the case. The setting of the digitizing region has no effect on the current region. The digitizing region only affects the digitizing session.

The working region is also only available inside of *v.digit*. This window has no permanence, i.e., it is not saved from one session to the next. This is the window that is changed to facilitate the zoom option in digit.

Each time a new region is chosen, the monitor screen replots itself. Parameters may be set that control what gets displayed each time the monitor replots. These may be set through the *Display options menu* available as a menu item in the *Customize menu*. The following options allow you to display specific features at any time.

W Starts an interactive procedure to define a new window. The options are to zoom in or to zoom out. Use either the mouse or the digitizer sight to define a window.

a Displays area markers. These are the locations in which area labels have been placed.

A Displays all the area labels.

i Displays all the lines.

l Displays all the labeled lines.

L Displays all the line labels.

n Displays all the nodes (line endpoints).

s Displays a scale in the upper left corner of the window.

C Erases the monitor screen. This erase does not remove any information from the digitized field; it only erases the contents of the working region displayed.

q Returns the user to the location occupied just prior to this one.

9. Using the Customize Menu:

The *Customize menu* contains options with which to customize a digitizing session. Options set within a digitizing session do not carry over into a different session. Default values are reset each time *v.digit* starts up.

v.digit - customize menu screen.

```
|--------------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                         Window Menu |
|--------------------------------------------------------------------------------|
| Window options:                                                               |
|  a - Show area markers                W - Define new window                   |
|  A - Show area labels                 C - Clear window                        |
|                                                                               |
|  i - Show lines                       c - Display scale                       |
|  l - Show labeled lines               w - Where am I                          |
|  L - Show line labels                   - Display Overlay Map                 |
|                                         - Display Backdrop CELL Map           |
|  s - Show sites                                                               |
|  S - Show site labels                                                         |
|  n - Show nodes                                                               |
|                                                                               |
|  q - Return from whence we came                                               |
|                                                                               |
|                                                                               |
|--------------------------------------------------------------------------------|
| Help  Zoom  *  !  ^                                                           |
|                                                                               |
|                                                                               |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]          |
|--------------------------------------------------------------------------------|
```

Customize Options:

d Sets digitizing threshold.

s Sets snapping threshold.

b Toggles beeps emitted from the terminal between on off [default on].

t Toggles terse mode between on off [default off]. When terse mode is on, unnecessary text does not appear on the terminal screen.

a Toggles auto window on off [default off]. When labeling an rea. Often an are being labeled is not completely within the working window. When auto window is on, the working window automatically adjusts itself to encompass the area being labeled.

w Toggles between mouse/digitizer [default digitizer]. Windowing may be done using either a mouse or a digitizer.

p Toggles between mouse/digitizer [default mouse]. In edit menu, the point marker function and the break line function can be performed with the mouse or digitizer. This option allows you to choose which device to use.

O Overlays a vector file on top of what is being digitized. This option enables the user to overlay an already existing vector file onto the features currently being digitized for visual comparison. References elsewhere affect the way this map is displayed.

D Moves the user into the Display Menu (only accessible through this menu).

C Moves the user into the Color Menu (only accessible through this menu).

q Returns the user to the menu accessed prior to accessing the Customize Menu.

Every time the graphics monitor refreshes itself (displays a new image whether through a change in region or through the beginning of a new *v.digit* session) the monitor only displays what it is told to. For example, it may display lines, area labels, nodes and the points that make up lines, or it may only display area labels. The user can specify which features will appear each time the screen is redrawn. The values shown below are the default settings.

v.digit - customize/display menu screen.

```
|---------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                    Display Menu |
|---------------------------------------------------------------------------|
| Display options:          Current:                                        |
|  a - Area Labels                OFF                                       |
|  l - Line Labels                OFF                                       |
|  s - Site Labels                OFF                                       |
|  m - Area Markers                ON                                       |
|  A - Area Border lines          OFF                                       |
|  L - Labeled lines               ON                                       |
|  i - Lines                       ON                                       |
|  S - Sites                       ON                                       |
|  n - Nodes                       ON                                       |
|  p - Points in lines            OFF                                       |
|                                                                           |
|  r - Reset Defaults                                                       |
|                                                                           |
|  q - Return from whence we came                                           |
|---------------------------------------------------------------------------|
| Help  Zoom  *  !  ^                                                       |
|                                                                           |
|                                                                           |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]      |
|---------------------------------------------------------------------------|
```

a Displays the category values associated with area. This option should be turned on when labeling areas.

l Displays the integer attributes associated with lines. This option should be turned on when labeling lines.

m Displays the area markers of a labeled area. When an area is labeled, the location where the area was placed is marked with a point. (This point is only visual and does not affect the contents of the *v.digit* file.) It is often helpful to turn this option "*on*" when not labeling, instead of option "*a*" above. This prevents cluttering of the screen.

A Displays, in a unique color, all the line that make up labeled areas.

L Display, in a unique color, all the labeled lines.

i Displays digitized area lines in blue, and digitized area edges in white.

n Displays nodes as dots.

p Displays all the points (not just nodes) that describe a line.

O Displays a second vector map to aid in referencing the current vector file with it.

r Resets default values. This option resets all options to their default values.

q Returns the user to the menu accessed prior to accessing the Display Menu and redraws the working window if any parameters have been changed.

Features in *v.digit* are color-coded for ease of identification. Every time *v.digit* is started, colors representing different objects are reset to their default colors.

v.digit - customize/color menu screen.

```
|-----------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                        Color Menu |
|-----------------------------------------------------------------------------|
| Color options:                     Current:                                 |
|  a - Areas                              grey                                |
|  l - Lines                              blue                                |
|  s - Sites                             green                                |
|  A - Labeled areas                    orange                                |
|  L - Labeled lines                   magenta                                |
|  S - Labeled Sites                      aqua                                |
|  1 - Nodes w/ 1 line                   green                                |
|  2 - Nodes w/ 2 or more lines            red                                |
|  h - Highlight                        yellow                                |
|  B - Background                        black                                |
|  O - Overlay map                       white                                |
|  r - Reset Defaults                                                         |
|                                                                             |
|  q - Return from whence we came                                             |
|-----------------------------------------------------------------------------|
| Help  Zoom  *  !  ^                                                         |
|                                                                             |
|                                                                             |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]        |
|-----------------------------------------------------------------------------|
```

The values above are the default settings. The average user should have little need to change these.

a Sets area color.

l Sets line color.

s Sets site color. (At this time, sites are not supported in digit.)

A Sets labeled area color.

L Sets labeled line color.

0 Sets the color of nodes that have no lines attached (see edit option ‘p’).

1 Sets the color of unsnapped nodes (nodes with only 1 line attached).

2 Sets the color of snapped nodes (nodes with 2 or more lines attached).

h Sets the highlight color. Many options in digit make use of highlighting. Any object that is chosen is highlighted. The default highlight color is yellow.

B Sets background color.

O Sets overlay map color.

r Resets all the colors to their default values.

q Returns the user to the Customize Menu.

10. Using the Toolbox Menu:

The Toolbox Menu has additional options that are useful while in *v.digit*. Of special note, it has several commands to help diagnose digitizing problems.

v.digit - toolbox menu screen.

```
|-------------------------------------------------------------------------|
| GRASS-DIGIT Version  4.00                                  Toolbox Menu |
|-------------------------------------------------------------------------|
| Toolbox options:                                                        |
|                                                                         |
|  w - Write out session                                                  |
|    - Register map                                                       |
|    - Build Neat line                                                    |
|                                                                         |
|  u - Display Unlabeled Areas                                            |
|  o - Display Open area lines                                            |
|  d - Display Duplicate lines                                            |
|                                                                         |
|  n - Display Node lines                                                 |
|  i - Display Islands                                                    |
|                                                                         |
|  q - return from whence we came                                         |
|                                                                         |
|-------------------------------------------------------------------------|
| Window  Help  Zoom  *  !  ^                                             |
|                                                                         |
|                                                                         |
|GLOBAL MENU: Press first letter of desired command. [Upper Case Only]    |
|-------------------------------------------------------------------------|
```

Toolbox Options:

w Writes the present session “to disk” and returns control to *v.digit*. If your digitizing session lasts for a long period of time, it is good practice to choose this option occasionally. Writing your session to disk involves taking your active session, and writing it to disk.

R Allows you to re-register a map to the digitizer surface. This is very useful if, for example, you have more than one quad sheet that will make up a single *v.digit* file.

u Display Unlabeled Areas (see below: Diagnosing Problems).

o Display Open-area Lines (see below: Diagnosing Problems).

n Display each line attached to a node (see below: Diagnosing Problems).

q Returns control to the menu accessed prior to accessing the Toolbox Menu.

11. Diagnosing Problems:

There are a number of tools provided to help find and solve problems that can occur in digitizing. The tools are listed below along with a description of the situations in which they are useful.

- Display Unlabeled Areas *[Toolbox Menu]*. This function is NOT guaranteed to work at all times. It will work best immediately after running the GRASS programs *v.support* or *v.import*. This is because areas are not necessarily known to *v.digit* unless they are labeled or have just been built by *v.support*. This function will attempt to highlight all areas of which it is aware that are currently unlabeled. This will only show those unlabeled areas which are inside of the working window. Not that in a large, cluttered map these areas may be very small and not noticeable. Try using the *[Window Clear]* command before using this function.

- Display Open-area Lines *[Toolbox Menu]*. This function is NOT guaranteed to work at all times OR in all cases. This function can help to locate problem areas. It is recommended that this be used only after labeling all areas OR running the GRASS program *v.support*. If there were any areas built incorrectly or not at all, this function will attempt to locate and highlight the lines of these areas. It works on the assumption that if a line is defined as an area edge, then it should bound an area. All area edge lines that do not bound any known areas will be highlighted. *v.support* may give warning messages about not being able to match up labels. This function can help find the areas in question in these cases. See the previous entry for more information.

- Display Node Lines *[Toolbox Menu]*. Highlights the lines emitting from a chosen node. Select and accept a node and you can then view each line attached to it individually. Press the right mouse button to view lines counter-clockwise around the node, and the left button to view them clockwise. This utility is useful for two common situations. The most common reasons for an area to be built incorrectly or not be built at all are overshoots, and digitizing of the same line twice. Because areas are built in digit by following the angles with which lines go into and come out of nodes, overshoots could cause bad angle information to be stored. this means that users can catch overshoots by noting whether the lines extending from a given node fail to be highlighted in the proper order around the node. Double-digitized lines can be caught by noting whether what was though to be one line is highlighted twice by *v.digit*. (Note that islands are always highlighted twice; this does not mean that island areas have been digitized twice.)

- There is one more debugging tool that is available in an incomplete and totally unsupported form. It is the Debug Menu, available to the user from any menu by pressing the *[-]* (minus) key. This menu, designed for debugging *v.digit* during its development, is not part of the supported *v.digit* program and is not guaranteed to be complete. It is useful for finding information on objects by their internal reference numbers. The programs *v.support* and *v.import* may occasionally provide a warning message about finding more than one label for a given line or area. (For this example, we will speak of areas; however, it also applies to line labels.) This can be caused by two events. Either there are in fact duplicate labels in the file for one reason or another, or a label from a nearby area was interpreted to belong to the wrong area. In this case, you would desire to find the problem areas and correct them by hand. These warning messages supply the problem area's internal reference number. To find these areas, you could use the debug menu option "*A*" to display areas by number. This option will highlight each area individually, and in sequence. To view a specific area, type its number and press *[return]*. To exit that function, type "*q*" and press *[return]*.