UNIT 13: DIGITIZING MAPS

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Context

Digitizing refers to the process whereby an analog (or paper) map is converted into a digital format. This data conversion process is also known as geocoding. Digitizing is one of the key ways in which data can be input and stored in a GIS. Apart from the manual technique of digitizing, geocoding can also be performed by scanning the source document.

Points, linear features and areas (or polygons) can all be input by manual digitizing. All features have real world geographic coordinates associated with them as well as topological data that are input as part of the digitizing process. There are two modes or methods by which features are captured - point mode and stream mode. Both have advantages and disadvantages and are better suited to capturing certain features and not others.

The following example illustrates some of the challenges faced by a digitizing operator.

Example Application

A hydrologist working on a subregion of a watershed is interested in examining the changes that have taken place in the drainage network over the past 100 years as a precursor to making a recommendation on the best location for a dam. Using maps obtained from 1896, 1946 and 1996, the scientist determines that questions about river capture, changes in stream meanders etc., would be best answered by overlaying the drainage networks from each of the three time periods.

In order to accomplish this, the hydrologist needs to:

1. **create a drainage layer for 1896, 1946 and 1996 by digitizing the river network from the source maps.**
2. **the streams are then labeled according to one of the hydrologic conventions for**

stream ordering.

3. **a simple map overly of the colour-coded stream layers could reveal which parts of the river network had remained unchanged, as well as locations where changes had occurred.**
4. **alternatively, a more quantitative statement of how much change had take place could be derived from map differencing (a change detection technique).**

The GIS operator will be responsible for verifying the completeness of each digitized layer, as well as for checking for and eliminating any positional and attribute errors that may have been introduced during the digitizing process.

Learning Outcomes

The following list describes the expected skills which students should master for each level of training, i.e. Awareness/Competency/Mastery.

Awareness:

The expected learning goals of this section are to understand the importance of map preparation prior to digitizing, the actual procedures involved in digitizing, the potential errors that may occur and the ways of correcting them, as well as a working knowledge of digitizing terminology.

Competency:

The learning goals of this section include key pre-digitizing tasks such as map preparation and map registration, digitizing in each of the two modes, as well as error detection and elimination.

Mastery:

The learning goals are to be able to make a wise choice between the digitizing modes, as well as to perform post-digitizing operations such as edge-matching adjoining map sheets, converting to raster structures if necessary, add topology and labels either as part of the digitizing procedure or in post-processing.

Preparatory Units

Recommended:

1. Unit 11 - Registration and Conflation (Using control points)
2. Unit 12 - Planning a digitizing project
3. Unit 15 - Labeling
4. Unit 10 - Projecting data

Complementary:

1. Unit 8 - Error checking

2. Unit 5 - Natural resources data
3. Unit 6 - Terrain data

Awareness

Learning Objectives:

1. student can define the basic terminology involved in digitizing.
2. student can distinguish between point and stream modes.
3. student can explain which mode is suited to points, lines or polygons.
4. student can operate both the digitizing hardware, as well as the various menus used for detecting and eliminating errors.
5. student can describe a real world application and implementation of the digitizing procedures.

Vocabulary

- node
- line segment
- area edge
- vector
- topology
- attribute
- attribute table
- point mode
- stream mode
- control points
- map registration / georeferencing
- map preparation
- zooming

Topics

1. Unit Concepts
    - pre- and post-digitizing tasks needed to ensure accuracy
    - use of the pointing device and the digitizing menu for controlling data input
    - correct use of point mode versus stream mode
    - using the digitizing menu for digitizing and toggling between modes
    - use of editing capabilities of the software to correct digitizing errors and for snapping nodes

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Competency

Learning Objectives:

1. Students will be able to use the digitizing hardware and software to perform the following tasks:
    1. launch the digitizing module
    2. perform map registration
    3. outline the region of interest to be digitized if necessary
    4. digitize:
        - networks
        - polygons
        - points
        - contours
2. Students will also perform the following during data input or in a post-digitizing phase:
    1. add feature identifiers or labels
    2. identify and correct errors.

Generic List of Tasks

Pre-digitizing tasks

1. Map preparation
    - determine the number of map sheets needed to provide coverage for the region of interest
    - working on one map sheet at a time, perform the following:
        - smooth out the map to remove folds or wrinkles
        - place a stable medium (e.g. Mylar) over the map (keeping it in place with paper clips around the edges)
        - on the Mylar, carefully trace out with a sharpened pencil, all the significant features to be digitized
        - control points should also be marked out on the Mylar
        - for closed features like hill tops or lakes, put a starting tick mark on the redrafted trace (this will also act as the finishing point during digitizing)
2. Mounting the map on the digitizer
    - place the map on the digitizing table and smooth out any folds, bubbles or creases before taping it to the table (using tape that will neither tear the map nor leave a sticky residue on the table surface).
    - always ensure that the section of the map to be digitized falls entirely within the active area.
    - align the Mylar sheet on which the redrafted features have been drawn, on top of the map and tape the edges to the table.
3. Map registration or Georeferencing

! Needs to be performed for each new digitizing session, as well as for each time a new section of the map is placed on the digitizer.

- after launching the digitizing module, enter the map scale
- enter the geographic coordinates of the control points and digitize their locations using the pointing device
- enter at least four control points to register the map. Some software will permit a total of ten well-spaced control points.
- always use the same control points for each session of a particular map sheet.
- some systems may require the establishment of the size of the digitizing window by clicking in the lower left corner and upper left corner of the region of interest
- check for scaling or inversion errors (in which case the map is either stretched or flipped) that may indicate an incorrect setup of the control points

Digitizing tasks

In the actual digitizing process, the operator traces over the feature (e.g. river, soil polygon , oil well) with a pointing device or cursor. The cursor has a number of buttons (4, 12, 16 or more) that can send a signal via the digitizing table to the computer to indicate that a point has been se ected. The student can also use the function keys to toggle between point and stream modes.

- Point Mode
  - position the pointing device over the point element to be digitized.
  - press the cursor button once.
  - move the pointing device and a new point element and repeat the process.

    ! this mode is useful for individual locations (e.g. elevation benchmarks) as well as for straight lines that only require a few points to be digitized.

- Stream Mode

  After pressing a button to begin the data collection, the digitizer continually collects points as the cursor is moved along a linear feature, until the operator presses another button to end digitizing.

- LINES

  1. place the cursor at the beginning of the line and press the button that initiates the recording of coordinates

     ! a start node will appear
  2. move the cursor along the line at a fairly constant speed, following the curves in the line as care fully as possible
  3. at the end of the line, press the button to stop recording data coordinates

     ! an end node will appear

     ! for very long or complicated lines, digitize the line in portions. Trace a part of the line, then stop the data collection. Without moving the cursor, press the start button and recommence digitizing the subsequent portion of the line. Repeat this procedure until the line is complete.

Figure 1

- NETWORKS

  1. starting at one end of the network, digitize a line as described above
  2. where this first line meets another line, click to end digitizing. Then, without moving the cursor from this end node of the first line, begin digitizing the second line.
  3. repeat this procedure until the entire network has been digitized

  In order to be topologically correct, lines should never cross each other. A node should represent the intersection of two or more lines.

Figure 2

- POLYGONS/AREAS

  also digitized in stream mode

  digitized as an area edge or common line

  1. using the previously marked starting point (on the Mylar sheet), trace out the feature and bring the cursor back to the starting point, before clicking to end the digitizing. The start node and end nodes should coincide.
  2. if the start and end nodes do not coincide, use the snapping or automatic closure menu
  3. digitize each area edge only once, even if it is a boundary between two polygons. The topology about the nature of the adjacent polygons can be added in a later editing exercise

Figure 3

- CONTOURS

  1. determine in advance whether all of the contour intervals are to be digitized
  2. in mountainous regions where the contours may be closely spaced, trace out the selected intervals on the Mylar sheet with a sharpened pencil
  3. start at the innermost contour and work outwards
  4. follow the procedure for digitizing long or complicated lines
  5. for enclosed contours, follow the procedure for digitizing areas
  6. for lines that contain elevation labels, trace through the middle of the label as you digitize. Labels can be added later.

Figure 4

Post-digitizing tasks

Sometimes the computer screen that is being used to display the map being digitized has a lower resolution than the digitizer. In this case, it may be difficult to see objects that have

been digitized very close together, until one zooms in to see whether they are separate lines.

Zooming also helps in performing three other tasks that are necessary in creating an accurate digitized layer. They are:

1. error identification and elimination
2. editing
3. labeling of features

- Error identification and elimination
    - check the digitized map for the following errors:
        1. sliver polygons
        2. line segment errors or dangling chains, where lines in a network do not meet at the appropriate nodes. This is corrected by snapping.
        3. polygonal errors which may include duplicate line segments, missing line segments, mislabelled line segments, unlabeled polygons and conflicting names.
        4. strange polygons which do not appear on the original map, but which have occurred due to operator negligence.
    - check for positional accuracy by comparing the digitized map against an independent map of higher accuracy.
- Editing
    - review the digitized maps, checking for errors.
    - remove duplicate lines where they occur.
    - snap nodes for polygons that should be closed.
    - snap lines to the relevant nodes where under- or overshooting occurs.
- Labeling of features

  ! Each digitized point, line segment or area edge must have a label or identifier associated with it. These feature identifiers represent a category of a feature (e.g. "1" for highways, "4" for dirt roads) and can either be added using an EDIT or LABEL menu in the post-digitizing phase, or during digitizing (as will be discussed under Mastery).

Mastery

Learning Objectives:

The student will be able to perform the following tasks:

1. decide when the point mode could be judiciously used to digitize linear features
2. add feature identifiers as the lines or points are being digitized.
3. patch adjacent map sheets in cases where the region of interest involves digitizing more than one map.

Generic List of Tasks

- Choice of Modes
    - linear features are usually digitized in stream mode. However, with sufficient expertise, the student can determine the best places along a line where point mode can be used instead.
    - with sufficient skill as well, the student can trace out features at a fast enough speed, such that the number of points recorded for a linear feature in stream mode is reduced.
- Labeling features
    - involves the manual entry of an identifying code via the keyboard, during digitizing. For example, in creating a road layer, the student can select a feature identifier for highways (1) and then proceed to digitize all the features that correspond to it. These identifiers are stored in a separate attributes table, where they can be linked with other information about a given feature. In the road example, the identifiers could then be associated with other data like traffic counts, road widths, etc..
- Edge matching
    - or patching involves the adjustment of two or more adjoining map sheets along their edges, so that the features that are common agree. This may involve snapping or rubber sheeting.

Follow-up Units

Suggested:

1. Unit 11 - Registration and Conflation (Rubbersheeting)
2. Unit 15 - Labeling
3. Unit 26 - Editing point data
4. Unit 27 - Editing linear data
5. Unit 28 - Editing polygon data

Created: May 14, 1997. Last updated: October 5, 1998.

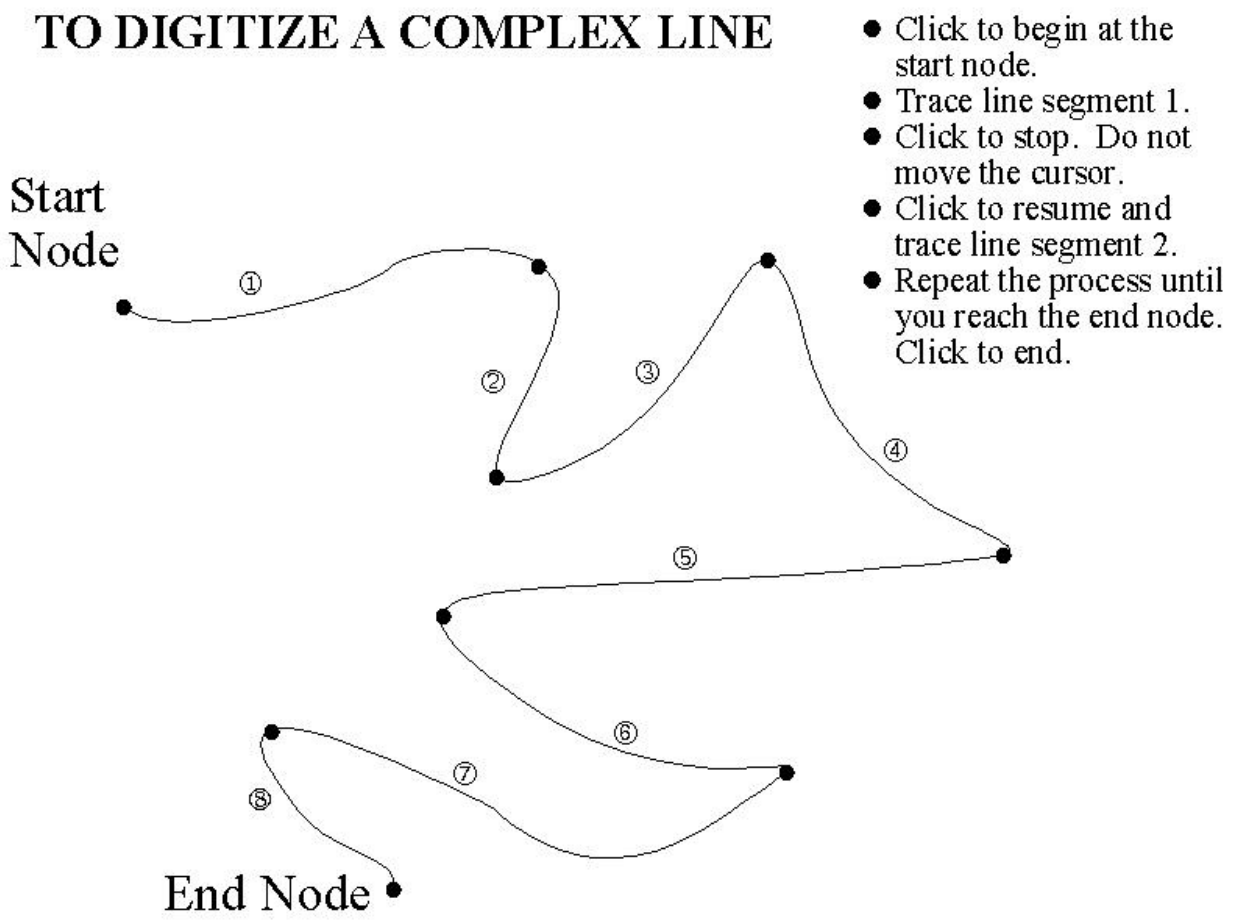
TO DIGITIZE A COMPLEX LINE
Click to begin at the start node.
Trace line segment 1.
Click to stop. Do not move the cursor.
Click to resume and trace line segment 2.
Repeat the process until you reach the end node. Click to end.
Start Node
①
②
③
④
⑤
⑥
⑦
⑧
End Node

Figure 1

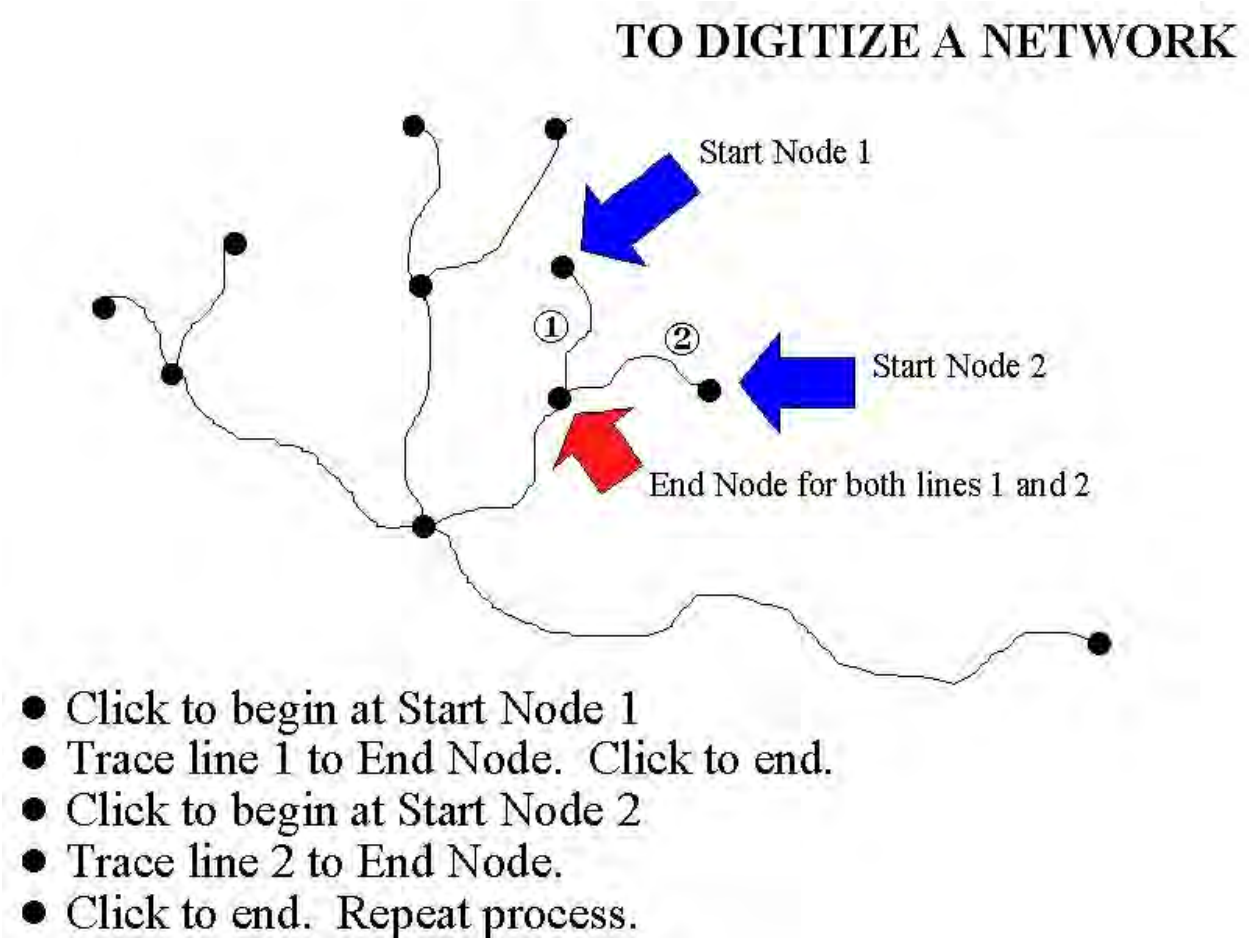
TO DIGITIZE A NETWORK
Start Node 1
1
2
Start Node 2
End Node for both lines 1 and 2
Click to begin at Start Node 1
Trace line 1 to End Node. Click to end.
Click to begin at Start Node 2
Trace line 2 to End Node.
Click to end. Repeat process.

Figure 2

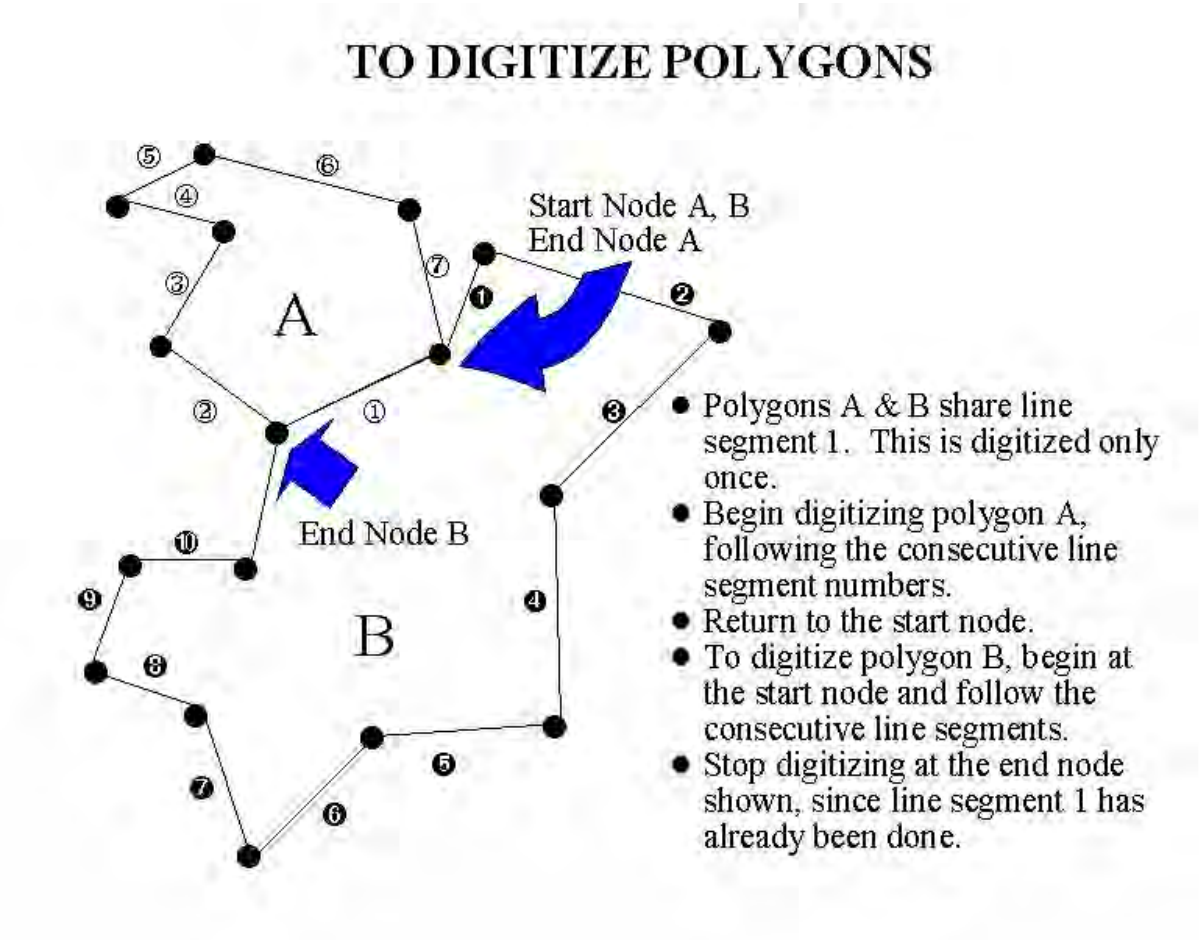
TO DIGITIZE POLYGONS
Start Node A, B
End Node A
End Node B
A
B
Polygons A & B share line segment 1. This is digitized only once.
Begin digitizing polygon A, following the consecutive line segment numbers.
Return to the start node.
To digitize polygon B, begin at the start node and follow the consecutive line segments.
Stop digitizing at the end node shown, since line segment 1 has already been done.

Figure 3

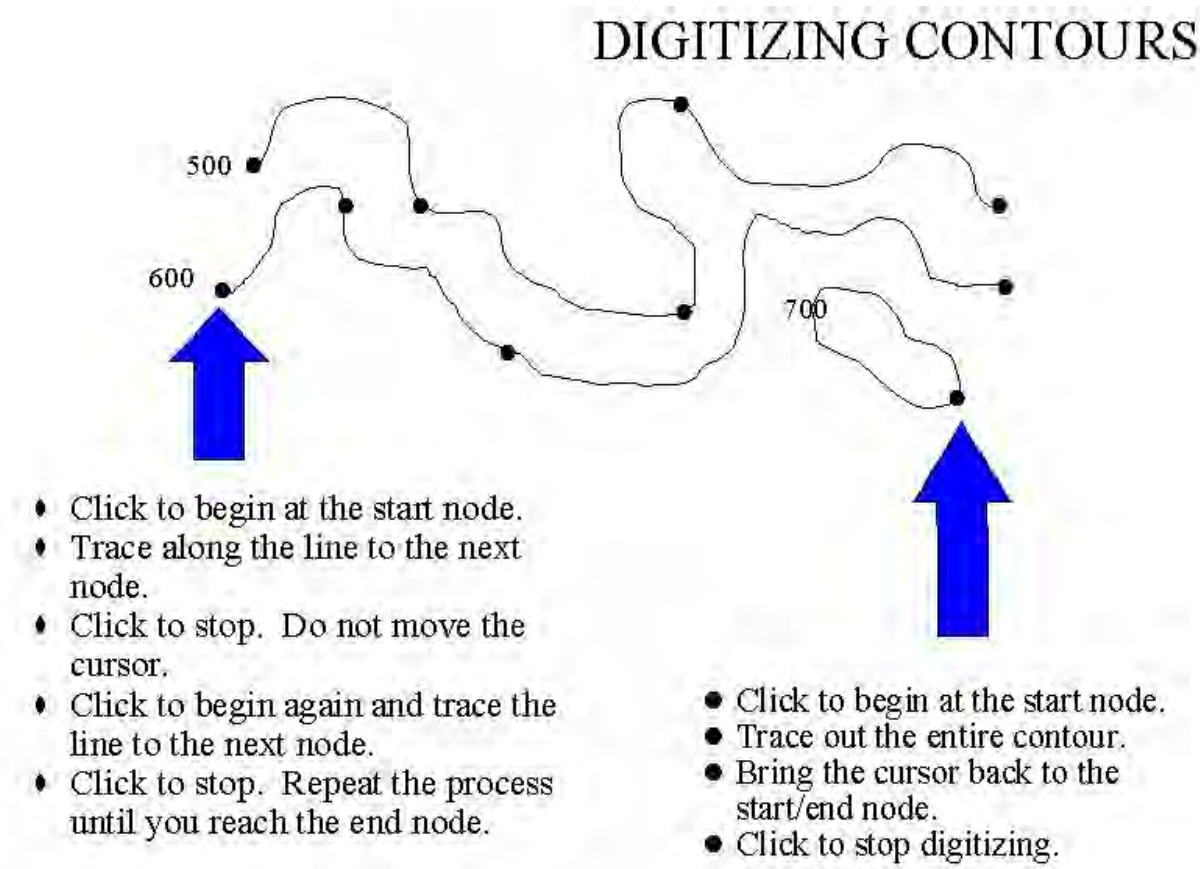
DIGITIZING CONTOURS
500
600
700
Click to begin at the start node.
Trace along the line to the next node.
Click to stop. Do not move the cursor.
Click to begin again and trace the line to the next node.
Click to stop. Repeat the process until you reach the end node.
Click to begin at the start node.
Trace out the entire contour.
Bring the cursor back to the start/end node.
Click to stop digitizing.

Figure 4