# Manual for Digitizing in ARC/INFO: Utilizing UNIX-Based ARC/INFO, Version 7.0 on a Silicon Graphics Workstation

Chris Arneson

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Wyoming Department of Environmental Quality
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and

Wyoming Water Resources Center
University of Wyoming
Laramie, Wyoming

Chris Arneson
Wyoming Water Resources Center
University of Wyoming
Laramie, Wyoming

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# Introduction

This manual was written at the request of the Wyoming Department of Environmental Quality, Land Quality Division. It is intended to be a guide for the inexperienced or occasional ARC/INFO user on the process of digitizing mining permit maps. It assumes that the user is working on a UNIX-based workstation running ARC/INFO version 6.0 or higher equipped with a digitizer. This manual also assumes that the user has a general understanding of the computer's operating system. These skills include directory and file management, changing directories, creating and deleting directories, text editor syntax and use, windowing system management, and use of the mouse buttons. For further UNIX assistance, the local system administrator should be consulted.

# ARC/INFO Concepts

ARC/INFO is a software system made of up of several modules. Each of these modules is designed to do a certain type of GIS process. These modules are ArcEdit, ArcPlot, TIN, Network, COGO, GRID, ArcScan, ArcSTORM, and INFO. ArcEdit is the module for coverage creation and editing, ArcPlot is for map-making, TIN allows the user to represent continuous surfaces, Network allows for dynamic segmentation of lines, and COGO utilizes coordinate geometry as an input source for the software. ArcScan and ArcSTORM, added in rev. 7.0, are modules for scanning maps and storing large amounts of data, respectively. The INFO database is made up of the contents of several data files, feature attribute tables and related files stored in each ARC/INFO workspace. (If more information is needed refer to the *ARC/INFO Data Model, Concepts, & Key Terms* manual.)

The ARC/INFO GIS software package utilizes concepts and specific terminology which some users may not be familiar with. Below is a simple glossary of common ARC/INFO terms. If additional questions are raised regarding commands and usage, either refer to the ARC/INFO manuals or use the **help** command to provide additional information.

workspace - A directory containing geographic data sets for use with ARC/INFO. A workspace typically contains an INFO directory for the feature attribute tables.

coverage - The term for an ARC/INFO vector data layer. It is commonly abbreviated as "cover."

grid - The term for an ARC/INFO raster data layer.

feature - An element within a coverage. The three feature types are points, lines, and polygons.

item - A data field within an INFO database table.

| | |
|---|---|
| tic - | Geographic control points for a coverage representing known locations on the Earth's surface. They allow all coverage features to be recorded in a common coordinate system. |
| arc - | A coverage feature used to represent linear features or the boundaries of polygons. Each arc starts at a node and ends at a node while having vertices in between. |
| node - | The beginning and ending locations of an arc. |
| polygon - | An areal feature defined by the series of arcs making up its boundary. It contains a label point inside its boundary and has attributes within a point attribute table that describe the geographic feature it represents. |
| puck - | The mouse-type keypad attached to a digitizer. |
| RMS Error - | Root Mean Squared Error. Describes the deviation between the tic locations in the input coverage and those of the output coverage. |

Throughout this manual, file names will change with almost every step. When specifying file names throughout a project, consistent naming conventions should be followed to insure that the user is able to know what each name represents. This can be done with by using suffixes affixed to a filename to represent what version of the file it represents. The format used in this manual will be:

| | |
|---|---|
| <cover>_tc01 | Initial tic coverage |
| <cover>_dg01 | Initial digitizing coverage |
| <cover>_dg02 | Second digitizing coverage |
| <cover>_ed01 | First editing coverage |
| <cover>_ed02 | Second editing coverage |
| <cover>_fn01 | Final coverage |

Other possible names:

| | |
|---|---|
| <cover>_jn01 | Joined version of coverage |
| <cover>_cn01 | Cleaned version of coverage |
| <cover>_bd01 | Built version of coverage |
| <cover>_pj01 | Projected version of coverage |

Using this format, <cover> should be substituted with a short name representative of the layer being digitized. (For example, 'roch' could be used to represent the Rochelle Mine permit. In that case the initial digitized coverage would be named **roch_dg01**.) Using this system a substantial number of names can be created as needed. ARC/INFO is non-case sensitive, but 13 characters is the maximum length for a coverage name.

If more information is needed throughout the project, ARC/INFO on-line documentation is always available on any command by using the **help** command. The **usage** command is also helpful by showing the proper usage for a command. The responses from these commands use several different text styles in the sample computer dialogue. For example:

Arc: **usage clean**
Usage: CLEAN <in_cover> {out_cover} {dangle_length} {fuzzy_tolerance} {POLY | LINE}

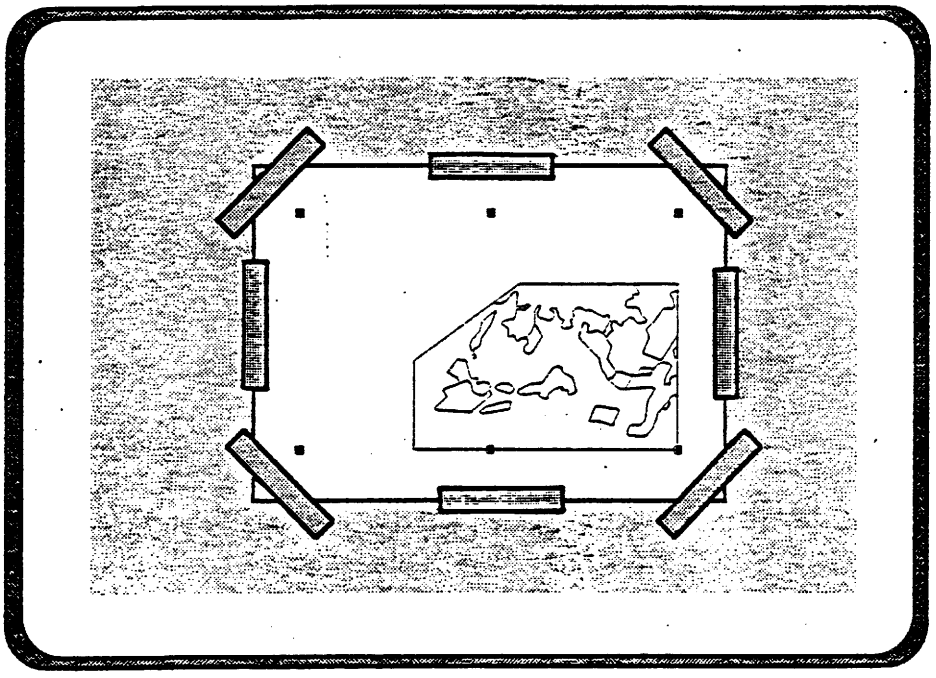
In this example, as in the rest of the manual, the bold text signifies items the user must actually type in. The plain text represents output from the computer. Of this text, items in <brackets> represent parameters the user must specify, while items in {parenthesis} show optional parameters. Parameters represented by words in CAPITAL letters separated by a '|' specify the exact syntax to be used for the option. In this example the user can chose to enter POLY or LINE, with POLY being the default value because it is listed first.

Useful ARC/INFO Commands:

| | |
|---|---|
| **kill** <coverage> **all** | deletes an arc/INFO coverage |
| **describe** <coverage> | gives information about a coverage or grid |
| **rename** <cover1> <cover2> | changes the name of a coverage |
| **copy** <cover1> <cover2> | makes a copy of a coverage |
| **create** <newcover> <oldcover> | makes a new coverage utilizing an exact copy of the tic file from another coverage |
| **additem** | adds an item to the feature attribute table of a coverage |
| **dropitem** | removes an item from the attribute table of a coverage |
| **help** <command> | gives proper usage and documentation for any ARC/INFO commands |
| **usage** <command> | gives proper usage for any command |
| **commands** | displays ARC/INFO commands |

# Map Preparation

- Here are some guidelines:
- Place the map in a position comfortable for digitizing
- Do not place the map near the extreme edge of the table because points in these areas are often less accurate or inactive.
- Use only drafting tape on the digitizer tablet; other adhesive tapes might damage the surface of the tablet and the map.
- Make sure the manuscript is flat and securely mounted to the digitizing table



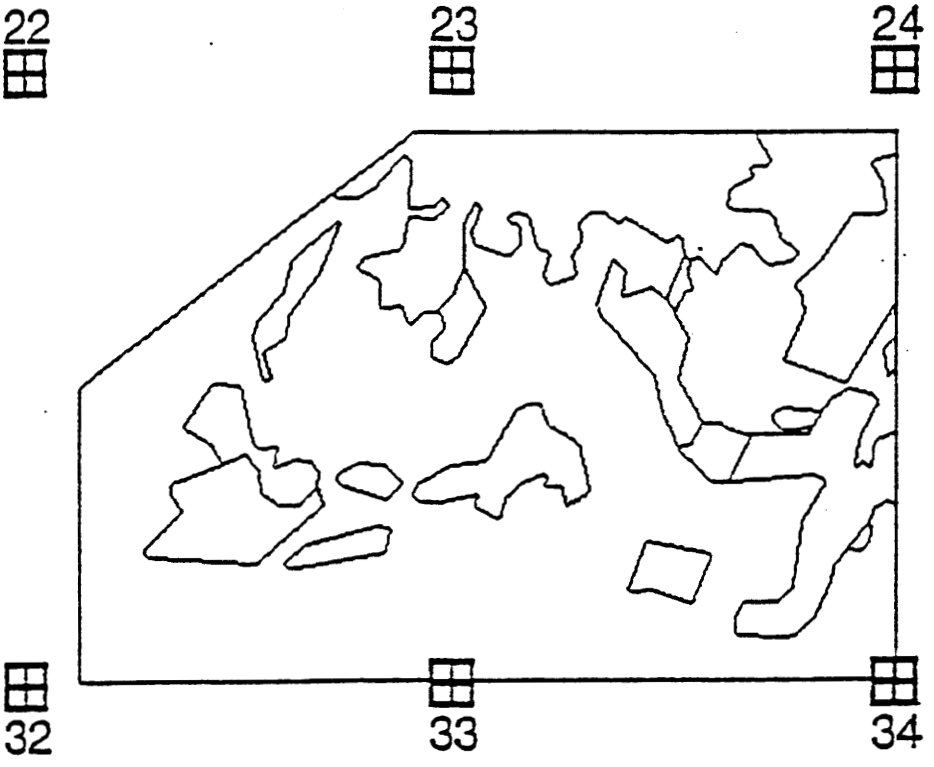
## DISCUSSION

Care taken in the map preparation steps will save time in the editing process later. For a map to be digitized accurately, it should be free from folds, tears, or any other properties which could cause distortion of the data. The use of photocopies or blueline copies should also be avoided because of the possibility that the map has been distorted in the copying process. Always use the best quality maps available. The ideal map media for data automation would be a stable media such as MYLAR which has no shrink or swell potential.

A map should be tightly affixed to the digitizing tablet with eight pieces of drafting tape. Be sure the map is secured well or data can become severely distorted. Additionally, if the map media has high shrink and swell potential, a piece of clear acetate or mylar should be taped over the map to eliminate the potential of moisture from the digitizer's hands distorting the data.

# Label Tics

Locate tic registration points and assign them a unique number; these must be known points for which you can obtain real-world coordinates. Once established, the same tic numbers and locations will be recorded and used for each separate manuscript.



## DISCUSSION

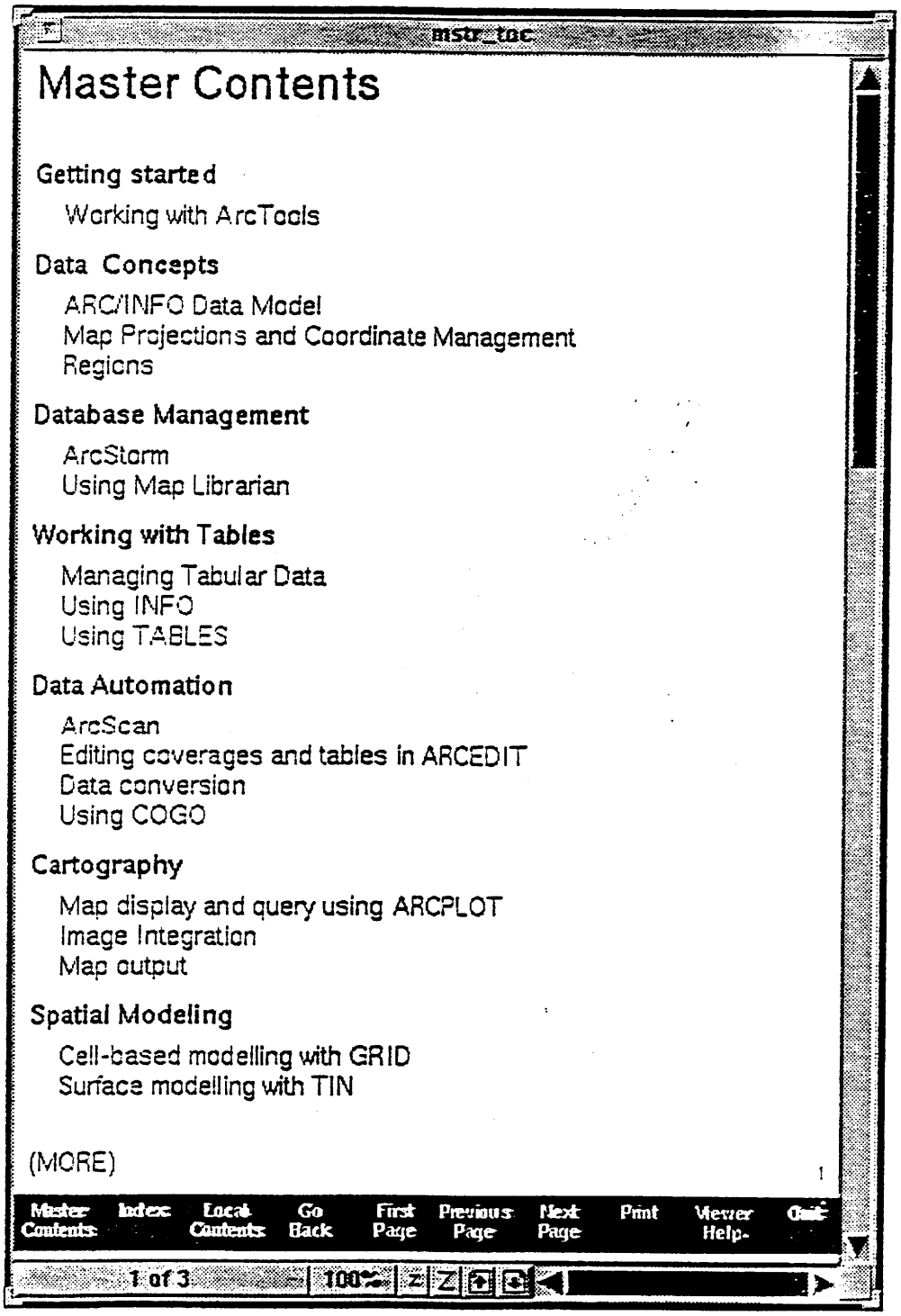
Identify points on the map to be digitized that have exact known real-world coordinates. Each map should have at least ten tics that are evenly spread throughout the map. Label each tic with a unique number and write it next to the tic on the manuscript. This number will be known as the "tic-id."

# Getting Help

Type :

**help**

and a popup menu will appear :



## DISCUSSION

Help is always available at any point through the following commands:

| | |
|---|---|
| **help** | (see opposite page) |
| **usage <command name>** | displays proper usage for any ARC/INFO commands |
| **commands** | displays ARC/INFO commands |

# Create Tic File

Enter ArcEdit

Arc: **arcedit**

Configure display for current workstation

Arcedit: **display 9999 3**

Arcedit: **&term 9999**

Arcedit: **coordinate keyboard**

(specifies that input will come from keyboard)

Arcedit: **drawenvironment tic ids**

Create coverage and tics

Arcedit: **create <ticcover>**

Enter unique tic identification number, X position, and Y position, all separated by commas and then press [ENTER]. For example, a tic-id of 12 could look like **>12,-107.5,41.25**. The program will then prompt for the next tic-id. Continue this process until all tics have been entered. Type **0** and then [ENTER] to stop entering tics-ids.

Save Changes and exit

Arcedit: **save**

Arcedit: **quit**

## DISCUSSION

Tics are reference points identified by known coordinates on a map that are used to orient a coverage. These tics should be entered in the coordinates which they are known for. For example, even though a map may be in a UTM projection, if the tics you intend to use are labeled in latitude-longitude, then the tics should be entered as decimal degrees.

Tics may be digitized in any order. At least four tics must be entered. Using more than four tics can increase the accuracy of the digitized coordinates for map registration.

# Project the Coverage

The coverage that has been created has no current definition of map projection or of coordinate units. If the map projection and map units are identical (ie. StatePlane Coordinates) then this coverage needs only to have its projection defined using the **projectdefine** command as explained in section A. However, most maps use latitude and longitude to define tics, requiring a more involved process. For this process skip to section B.

A. Using projectdefine

Make a copy of current coverage

Arc: **copy** <ticcover> <ticcover-1>

(Where <ticcover> is the original cover and <ticcover-1> is the name of a new coverage.)

Define the projection

Arc: **projectdefine cover** <ticcover-1>

The prompt will change and parameters will be requested

project: **projection** <projection>

project: **units** <meters or feet>

project: **zone** <zone number>

The zone number can usually be found at the bottom of most maps or consult the PROJECT section of the ARC/INFO Commands manuals

project: **parameters**

B. Using project

Change the projection and units of tics

Arc: **project cover** <ticcover> <ticcover-1>

The prompt will change and parameters will be requested

project: **input**

project: **projection geographic**

project: **units dd**

project: **parameters**

project: **output**

project: **projection** <projection>

project: **units** <feet or meters>

project: **zone** <zone number>

This last line is optional, but if the zone number is known the parameters command is easier

project: **parameters** (answer all questions prompted)

project: **end**

## DISCUSSION

Each ARC/INFO coverage can store information about the projection it is currently in. The procedures on the opposite page, not only initially store that information in the coverage, but also can change the actual coordinates that the tics are labeled in and therefore their shape also. The goal is to put the tics into the same "shape" as the original map. This is absolutely necessary to obtain accurate data.

# Register Map

Enter ArcEdit

Arc: **arcedit**

Specify coverage to be edited

Arcedit: **editcover** <ticcover-1>

Configure program for current workstation

Arcedit: **digitizer** <model> <port>

(Ask the local system administrator for this information.)

Arcedit: **drawenvironment arc label node dangle**

Arcedit: **weed 0**

Arcedit: **nodesnap closest**

Arcedit: **draw**

Arcedit: **coordinate digitizer** <ticcover-1>

Enter tics through digitizer. Using digitizer puck, enter first tic number followed by 'A'. Assuming the first tic-id was 1, this will be shown on the monitor as **>1*** where the asterisk represents 'A.' Define where the tic should be placed by accruurately placing the puck on the map and pressing any button. Once the tic is entered move on to the next tic using the same method. Once all tics have been entered, end the program by pressing '0A'. (ARC/INFO knows that no tic can be labeled with a zero and therefore assumes that all tics have been entered.) At this point the map on the digitizing tablet has been spatially referenced to the computer and other features can be added. If the map is removed from the tablet or to a different spot on the tablet, it must be reregistered.

## DISCUSSION

An RMS Error number is now displayed on the monitor. It is comprised of two numbers, the second of which is a relative estimate of the accuracy of the tics entered based on where they should be. This number should be as close to zero as possible. An upper limit for this value is commonly set at 0.006 but errors of up to 0.008 can sometimes be accepted depending upon the source map and the number of tics used. The first value of the RMS Error shows how much error is expected in coverage units (usually meters or feet). If this RMS Error is higher than the upper limit set for the project, then either the map should be reregistered, or a new map should be found before moving on.

# Add Features

Specify what type of feature will be added or edited and begin

Arcedit: **editfeature** <feature>

Feature can be **arc, label, point,** or **node.**

Arcedit: **add**

Begin creating features by following the directions in the command window. All entries will be made through the digitizing puck and this mode can be exited by pressing **9** on the puck. (For example, to add arcs press **2** to start an arc, **1** each time a vertice is needed, and **2** to end the arc. When all arcs are entered press **9** to end.)

## DISCUSSION

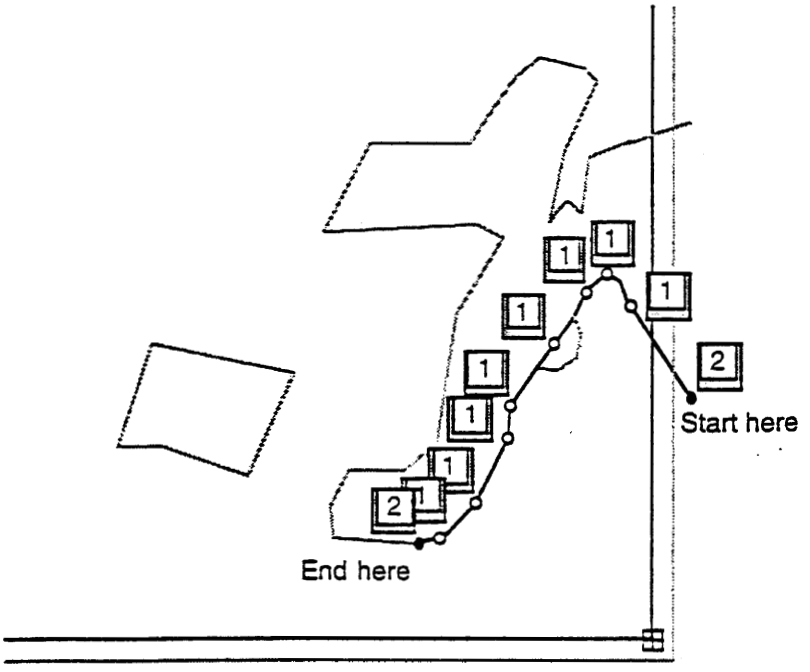
This step can be performed as many times as is necessary for all features to be added.

If the coverage being digitized is to be a polygon coverage each polygon must have one label within it, in which to specify its attributes. These are added using the directions in secion 5. The user must also remember to save additions or edits periodically throughout the session to prevent excess data loss in the event of a machine error.

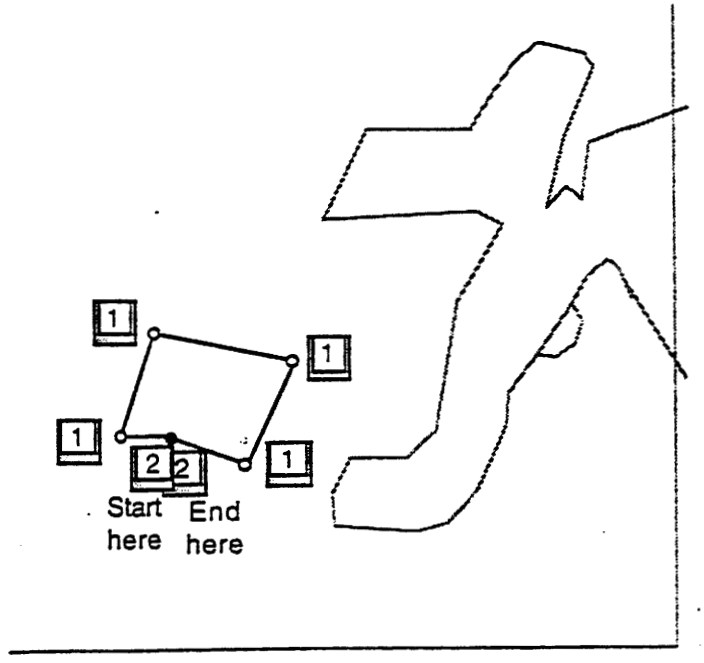
## DISCUSSION

### Adding Arcs:

Position the keypad crosshairs and enter the button numbers as shown. Carefully trace the shape of the arc with the keypad crosshairs, pressing the 1 button repeatedly to enter vertices as you go.




*Notice that, as before, nothing appears on the screen until the ending node is entered; then, the entire arc is drawn.*



## DISCUSSION

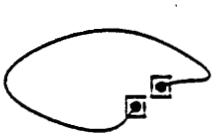
Adding Labels:

No labels are needed for coverages that are to be attributed as lines (such as contour maps), but each polygon within a polygon coverage must have EXACTLY ONE label. This label will store all attributes for the polygon. If a polygon has more than one label, only one will be recognized as having attributes even though the attributes in each may be different.

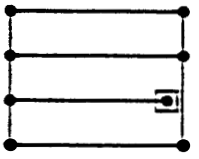
# DISCUSSION

## Types of Errors

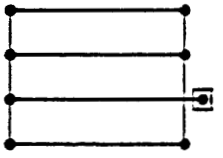
If nodes are to be drawn, there are several choices on how to draw them. If the command **de nodes** is specified, then nodes will be drawn as small black boxes. However, if errors are drawn by choosing to entering **de node dangle**, dangle errors and pseudo errors are drawn. A dangling node represented by a square symbol, connects to only one arc. It is the unconnected node of a dangling arc. They are created when digitized arcs stop short of, or extend past, an intended intersection point. There are instances, however, when dangling nodes do not necessarily represent an error. One example of this would be the headwaters of a stream. The line would simply begin wherever the drainage obtained enough water to be classified as such. Several examples are shown below:



An open polygon

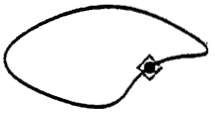


An undershoot



An overshoot

Pseudo nodes will be drawn with the **de node pseudo** command or shown as updates when dangles are specified. Pseudo nodes, drawn with a diamond symbol, occur where a single line connects with itself or where only two arcs intersect. Pseudo nodes do not necessarily mean that there is an error or a problem. For example, pseudo nodes that represent island polygons or the point where a road changes from pavement to gravel are acceptable. Several examples are shown below:



An island pseudo node

Pseudo node marking a two-arc intersection

# DISCUSSION

## Tolerances

Nodesnap - This is the largest distance in which a new node will automatically snap to an existing one. This helps you to ensure that arcs connect correctly to adjoining arc. The default node snapping tolerance is usually quite small. This example assumes that the nodesnap is 0.05 inches.

*As each new arc is added, the starting node may fall within a given distance (e.g., 0.05 inches) of an existing node.*

*This new node location will snap to the existing node if it is within the node snap tolerance.*

Weed - This is the minimum distance that can exist between any two vertices on a line. If a vertice is added closer than this distance to another vertice an error will be displayed and the vertice discarded. The purpose of this is to eliminate tiny "slivers" that can be created if the user makes an error while digitizing. This is commonly set to 0 by experienced digitizers.

# Editing Cover

Features can be continually added, edited, or deleted from the coverage using combinations of the following commands:

| | |
|---|---|
| **coordinate mouse** | moves control from the digitizer to the mouse. To switch back use the **coordinate digitizer** command |
| **add** | add more of the current editfeature to the coverage |
| **select** | selects one feature from the current editfeature |
| **select all** | selects all features from the current editfeature |
| **select many** | selects features as the user clicks on them |
| **select box** | selects all features within a user defined box |
| **select poly** | selects all features within a user defined polygon |
| **select box passthru** | can be added to any select commands |
| **select dangles** | selects all dangling arcs (Use drawselect to highlight them.) |
| **select** <equation> | (this equation usually looks like **code = 1**) |
| **delete** | deletes the selected feature from the coverage |
| **oops** | Undoes any action done by the last command (ie. if something is deleted it will be restored) |
| **move** | move selected features from one spot in the coverage to another |
| **nodesnap closest *** | lets user set the maximum distance within which nodes will automatically snap together |
| **extend** | extends selected arc out to the next arc and creates a node where they join |
| **split** | splits the currently selected arc into two arcs |
| **drawselect** | highlights all selected features in yellow |
| **help** <command> | gives all available information about any Arcedit command |

| | |
|---|---|
| **save** | saves changes made to the coverage |
| **save** <filename> | saves the coverage to a new coverage name without altering the original coverage |
| **quit** | quits arcedit and asks if the user wants to save changes |

# Building Topology

Make a copy of the coverage

Arc: **copy** <ticcover-1> <cover-attrib>

Add topology

Arc: **build** <cover-attrib> <feature type>

** If an error is received stating that arcs intersect, either edit the coverage so that lines no longer intersect, or use the **clean** command.

## DISCUSSION

Currently the coverage has no topology associated with it. Topology is a spatial relationship between various elements in a coverage. There are three types of topology that a coverage can have. Polygon topology is used for features with area, line topology is used for line features such as roads or streams, and point topology is for non-area features like wells or benchmarks. Once all features are created, topology can be added with the **build** or **clean** commands. Although these commands are similar, **build** does not have the sometimes undesirable functionalities that **clean** has. The major difference is that **build** will tell the user if arcs cross one another without nodes while **clean** will split the arcs and add nodes where arcs cross. For example, if the user is digitizing contour lines which should never cross, chosing **build** will provide a signal of an error in digitizing.

# Attributing

Add user defined fields (substitute .pat for .aat in polygon coverages)

Arc: **additem** <cover-attrib>**.aat** <cover-attrib>**.aat** <item> <width> ~
<width> <type> <decimal places>

(item type can be **c** for character, **i** for integer, or **f** for floating point real number. If **f** is specified then the number of decimal place must be specified.)

Change or add attributes

Arc: **arcedit**
Arcedit: **&term 9999**
Arcedit: **display 9999**
Arcedit: **editcover** <cover-attrib>
Arcedit: **drawenvironment arc label**
Arcedit: **draw**
Arcedit: **editfeature** <feature>

A. Using **calculate**

Arcedit: **select** (Any of the other select variations can also be used)
Arcedit: **calculate** <item> = <value>
(for character fields the value is placed in 'single' quotes.)

(This step is repeated until all features are attributed)

B. Using **forms**

Arcedit: **select box** (Any of the other select variations can be used)
(skipping this command selects every feature)
Arcedit: **forms**
> click on **first**
> begin adding values
(after each value is added, click on **next**)
> to end, double-click on icon in upper-left corner of menu
Arcedit: **save**

## DISCUSSION

Now that topology has been added, the coverage can be attributed. These attributes are added to different files depending on what kind of topology has been created. If the coverage has line topology the attributes are stored in a file called <cover-attrib>**.aat** (arc attribute table), however, if the coverage has either polygon or point features the attributes are in the <cover-attrib>**.pat** file (point or polygon attribute table depending on type). To look at these files type **list** <cover-attrib>**.aat** or **list** <cover-attrib>**.pat**.

Initially, there are no fields for user-defined attributes in the database. It is up to the user to add one or more using the **additem** command. Each field must be specified as to field type and length.

There are several ways within ArcEdit to change or add values to these fields once they are created. The first method, detailed in section A on the opposite page, uses the **calculate** command to add a value to a field within the selected feature's attribute table. The second method, outlined in section B, uses the **forms** utility. It provides a menu for the user to attribute the selected features one at a time.

# Recreate Topology

If the user has changed features within ArcEdit the coverage topology must be recreated. This can be done by re-running **build** or **clean**.

Make a back-up copy of the coverage

Arc: **copy** <cover-attrib> <cover-final>

Create topology

Arc: **build** <cover-final> {feature-type}

# DISCUSSION

Topology: If you are unsure whether a coverage has topology or want to know specific information about it use the describe command.

Arc: **describe <cover>_at02**

It will show a table similar to:

```
Arc: describe soilstex
               Description of SINGLE precision coverage soilstex

                                FEATURE CLASSES

Feature Class          Subclass    Number of Features   Attribute data (bytes)   Spatial Index?   Topology?
-------------          --------    ------------------   ----------------------   --------------   ---------
ARCS                                         1368
POLYGONS                                      542                  98                            Yes
NODES                                         957

                              SECONDARY FEATURES

Tics                                          40
Arc Segments                               96567
Polygon Labels                               541

                                 TOLERANCES

Fuzzy  =                30.000 V          Dangle  =                      7.000 V

                             COVERAGE BOUNDARY

Xmin =                528287.437          Xmax =                  579040.875
Ymin =               4601310.000          Ymax =                 4717913.000

                                   STATUS

The coverage has not been Edited since the last BUILD or CLEAN.

                        COORDINATE SYSTEM DESCRIPTION

Projection                 UTM
Zone                        13
Units                   METERS              Spheroid       CLARKE1866
Parameters:
Arc:
```

# Quality Checking

There are several ways to quality check a digitized coverage. First, a plot is made showing all linework at the same scale as the original map. (This process is discussed further in Lesson 8 of *Understanding GIS - The ARC/INFO Method.*) These two maps are then compared on a light-table to detect errors. Errors are corrected through Arcedit as discussed in Chapter 5. To detect labelling errors, the user runs the **labelerrors** routine which tells if there are polygons with multiple labels or if there are polygons without labels.

To check attributing, a separate plot is made showing how the features are attributed. This is done with varying shade patterns or by printing the value of the attribute on the feature.

Often, fixing an error creates another. Repeat the quality check as outlined until no errors are found.

# EarthVision Conversion

EarthVision 1.2 is a 3-D topographic modeling software that runs on UNIX-based Silicon Graphics workstations. ARC/INFO coverages can be converted to EarthVision format by using the following steps as stated in the *EarthVision 1.2 Users Guide*:

In EarthVision, the *ARC/INFO Coverage Import* funnel converts ARC/INFO coverages into EarthVision annotation, polygon, and scattered data file formats.

The type of ARC/INFO coverage to import (points, lines, and/or polygons) as well as the type of EarthVision file to create must be selected. As the ARC/INFO data are imported, numerous options are available with regards to colors, labels, linetypes, pattern types, pattern factors, etc., for the output EarthVision file.

Once an ARC/INFO coverage is imported the newly created EarthVision file is automatically named and entered under *Files to Display* for use on base or contour maps. The new file is also written to disk for subsequent display and/or editing.

This funnel is accessed from the Base & Contour Maps window. Selecting the funnel button located just to the right of the Files to Display button produced the Funnels window.

Refer to Appendix K of the *EarthVision 1.2 Users Guide, Volume II* for further information.