

# UC Santa Barbara

## GIS Core Curriculum for Technical Programs (1997-1999)

### Title

Unit 14: On-Screen Digitizing

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### Authors

Unit 14, CCTP  
Haddock, Gregory

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## UNIT 14: ON-SCREEN DIGITIZING

Written by Gregory Haddock, Assistant Professor of Geography,  
Northwest Missouri State University

### Context

On-screen digitizing is an interactive process in which a map is created using previously digitized or scanned information. This method of geocoding is commonly called "heads-up" digitizing because the attention of the user is focused up on the screen, and not on a digitizing tablet. This technique may be used to trace features from a scanned map or image to create new layers or themes. On-screen digitizing may also be employed in an editing session where there is enough information on the screen to accurately add new features without a reference image or map.

The process of on-screen digitizing is similar to conventional digitizing. Rather than using a digitizer and a cursor, the user creates the map layer up on the screen with the mouse and typically with referenced information as a background.

The following two examples are scenarios that illustrate the use of on-screen digitizing.

### Example Application #1

**A tax mapping facility is charged with the responsibility of updating the planimetric property maps that the county Assessor uses to compute taxes. Although the county is committed to using a GIS to store the property information and to compute land areas, the accuracy of the existing maps is less than ideal. Rather than assume the nearly impossible task of making the entire GIS fit the recent updating information, the cadastral mapper fits the updated property lines to the existing data.**

**One lot in question needs to be split off into two separate lots reflecting a recent subdivision and sale of property. The legal description includes information dealing with a nearby road intersection, a section line, and the edge of an irrigation canal. The GIS dataset has layers that comprise road networks, township and range information and public works and canal information. These layers are consistent with the cadastral plan of the Assessor's property layer.**

**In the GIS editing process, the roads, canals and section lines are drawn as a background in separate colors. Armed with the proper information, the new line that reflects the split of property may be added using the proper reference of the background layers. It is important to realize that the background layers are not being edited themselves, they are only being referenced.**

**This process was necessary because the new data may have been more accurately digitized with other map sources but it would not have "fit" the less than ideal property map that is already in existence.**

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## **Example Application #2**

**This example uses a scanned image as the background reference in the heads-up digitizing approach.**

**A groundwater hydrologist is interested in modeling the impact of potential nitrate leaching in a particular study area. Two structures have been identified as being possible sources of pollution. The greater threat appears to be from animal confinement operations and to a lesser extent, a small percentage of septic tanks for rural homes could possibly be leaking.**

**None of the paper map sources has the detailed information necessary to readily digitize this information from. Fortunately, the hydrologist has obtained recent aerial photographs at a scale appropriate for discerning houses and feedlots.**

**To create the two layers identifying feedlots and houses, the images are scanned and used as a reference background in the editing process. The septic tanks are assumed to be near enough to the house for modeling purposes and a point is created for each house in that layer. Using the background image as a reference, the animal confinement locations are digitized by tracing the boundaries of the feed lots and any sludge lagoons that may be on the premises.**

**In this example, the accuracy of the digitized septic tank and feedlot locations is only as good as the resolution and accuracy of the scanned images.**

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## **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 achieve a general understanding of process of on-screen digitizing and its potential uses. The student should also possess a working knowledge of traditional digitizing (with a digitizing tablet) methodologies.

Competency:

The learning goals of this section are to develop the ability to perform specific on-screen digitizing operations. The student should be able to apply traditional digitizing techniques in order to update existing layers or create new ones on-screen using other layers in the background of an editing process.

Mastery:

The learning goals of this section are to be able to make all appropriate decisions in the digitizing process from beginning to end of a particular project. The student is able to use on-screen digitizing with images scanned from maps, photographs, or satellite data if suitable. The student should also be aware of accuracy issues dealing with these sources of data.

**Preparatory Units**

Recommended:

1. Unit 11 - Registration and Conflation
2. Unit 12 - Planning a digitizing project
3. Unit 13 - Digitizing Maps
4. Unit 15 - Labeling
5. Unit 16 - Planning a scanning project
6. Unit 17 - Scanning maps
7. Unit 18 - Scanning airphotos

Complementary:

1. Unit 8 - Error Checking
2. Unit 10 - Projecting data
3. Unit 47 - On screen visualization

**Awareness**

Learning Objectives:

1. Student can define basic vocabulary relating to digitizing functions.
2. Student understands appropriate situations where on-screen digitizing may be used.
3. Student can describe a real application of on-screen digitizing.

Vocabulary:

- attribute
- control point

- coordinates
- coverage
- cursor
- digitizer
- georeference
- georegister
- heads-up digitizing
- image
- on-screen digitizing
- projection
- raster
- raster-to-vector conversion
- real-world coordinates
- rectification
- registration
- resolution
- RMSE (root mean square error)
- rubbersheeting
- scanner
- scanning
- tie-points
- topology
- transformation
- vector
- vectorization

## Topics

### 1. Unit Concepts

**!** Digitizing on screen as well as traditional digitizing vary widely amongst software/hardware systems.

- Does the software have specific tools for registering scanned images?
- Does the software have the capability to show images or other layers in the background of an editing environment?
- Will the background layers be other GIS layers or a scanned image of a photo or map.
- Some software allows scanned images to be used as a raster layer, others may temporarily register and transform the working data against the image.

## Competency

### Learning Objectives:

1. Student will be able to use on-screen digitizing to perform the following tasks:
  - Enter the editing process and create a new layer with the same registration as an

existing layer.

- Be familiar with the editing process to show the proper information on the screen.
  - Set the editing environment for adding new features.
    - Editing tools may use keyboard as input.
    - Editing tools may use mouse as input.
  - Set the drawing environment to show the new features properly.
  - Set the background drawing environment to show the background layers for digitizing reference.

1. Student will be able to use on-screen digitizing to perform the following tasks:

- Set up the editing process and update an existing layer on the screen.
- Create and edit a new layer based on other layers entirely on-screen.

Tasks:

1. Update an existing map layer using other layers as a reference.

**!** This process uses traditional editing techniques, the only difference is that a digitizer is not the input device.

**!** Map registration is not necessary, it is assumed that the updated features will be placed in the proper location using visual cues from the reference layers.



### Heads-Up Digitizing - 1

2. Creating a new layer with on-screen digitizing.

**!** This process is exactly the same as updating a layer.

**!** The registration of the coverage needs to be addressed.

- Check for proper registration, missing data, and known objects in appropriate locations.



### Heads-Up Digitizing - 2

## Mastery

Learning Objectives:

1. Student will understand the map registration process and how it applies to on-screen digitizing.
  - Images may be warped unevenly across the image extent.

- Ground Control Points (GCP) must be established on the image to establish a link to real-world positions.
  - GCP information may be based on another coverage or on map values.
1. Scanned images may be maps, aerial photographs, or satellite data.
    - The process for on-screen digitizing is the same for each source.
  1. The registration process creates a model that describes how an image must be rectified.
    - ARC/INFO creates a world file that describes how an image must be scaled, translated, and rotated.
    - Scaling changes the size of the pixel cell.
    - Translation adjusts an X and Y offset to the real world coordinates.
    - Rotation adjusts the X and Y axis for the true coordinate system.
  1. Once images are registered, they may be rectified.
  2. Rectified images may be used for on-screen digitizing.
  3. Some raster-to-vector conversion programs may automate the digitizing process somewhat.

### On-Screen Digitizing Tasks

1. Register a scanned image to a real world coordinate system.
2. Rectify an image that has been registered.



#### Heads-Up Digitizing - 3

3. Update and create coverages using on-screen techniques and a rectified image.



#### Heads-Up Digitizing - 4

**!** All GIS systems do not have this functionality. Data can be exported to many spreadsheet software systems if necessary.

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## Follow-up Units

Suggested:

1. Unit 17 - Scanning maps

2. Unit 18 - Scanning airphotos
  3. Unit 1 - Acquiring existing digital data
  4. Unit 9 - Converting digital spatial data
  5. Unit 16 - Planning a scanning project
- 

## **Resources**

*[Outdated links have been removed.]*

The ESRI Arcscan site and a white paper dedicated to automated digitizing techniques.

An example of using heads-up digitizing to delineate contaminate areas in wellhead protection by Christopher Barnett, Yan Zhou, Steven Vance and Christopher Fulcher from the Center for Agricultural, Resource and Environmental Systems at University of Missouri - Columbia.

An example of medical facility placement that utilizes heads-up digitizing.

An example of heads-up digitizing in identifying locations of the Mojave Desert Tortoise.

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

## Heads-Up Digitizing - 1

The following is a listing of how to do this using ARC/INFO. All commands for ARC/INFO will be printed in bold here. In this example, a polygon representing an ownership parcel will be split and another combined using a background stream coverage as a guide. The polygon with label id = 84 will be split into two parcels along the stream while the two parcels (86 and 192) will be combined. The accuracy of the map is degraded enough to allow simple editing and on-screen digitizing.

---

1. Starting from your operating system prompt type **ARC**

2. When ARC Info starts, type: **lc** or **listcoverages**

A list of all valid coverages in your current directory will be returned:

```
Arc: lc
Workspace:          C:\ARCDATA\EX8

Available Coverages
-----
HYDRO  ROADS  PARCEL
```

3. To enter ARCEDIT and set the display, type: **arcedit** and **display 9999**

This will look something like this:

```
Arc: arcedit

Copyright (C) 1982-1997 Environmental Systems Research Institute, Inc.
All rights reserved.

ARCEDIT (COGO) Version 7.1.1 (Thu Feb 6 23:26:50 PST 1997)

Arcedit: display 9999
```

4. Set up the edit coverage, the drawing environment, and map extent to begin digitizing.

```
Arcedit: edit parcel

The edit coverage is now C:\ARCDATA\EX8\PARCEL

Arcedit: drawenvironment all label ids

Arcedit: mapextent 338697,4459053,345945,4464543
```

5. Set the background coverage with color 4, (blue).

```
Arcedit: backenvironment arc on
```

```
Arcedit: backcoverage hydro 4
```

```
C:\ARCDATA\EX8\HYDRO is now background coverage 1 with draw symbol 4
```



Figure 1

6. The graphical interface should look something like this.
7. Judging from this image, it is clear that the stream is dividing parcel 86 from 192 and could be used to reference the edit session and successfully delete the arc. To do this, merely set the editfeature and select the arc, then delete it.

```
Arcedit: editfeature arc
```

```
252 element(s) for edit feature ARC
```

```
Coverage has no COGO attributes
```

```
Arcedit: select one
```

```
Point to the feature to select
```

```
Enter point
```

```
Arc 143 User-ID: 38561029 with 9 points
```

```
1 element(s) now selected
```

```
Arcedit: delete
```

```
1 arc(s) deleted
```

```
Arcedit: draw
```

8. So far, the hydro coverage has been used as a reference location to determine that the line to be deleted was indeed along the stream boundary. Next, a new line will be digitized on the screen using the mouse and keyboard input. This is similar to using a digitizer with a tablet and cursor puck. In the on screen digitizing process, the vertex and node keys are on the keyboard rather than the digitizing puck.

```
Arcedit: editfeature arc
```

```
251 element(s) for edit feature ARC
```

```
Coverage has no COGO attributes
```

```
0 element(s) now selected
```

Arcedit: **nodesnap first 10**

Arcedit: **intersectarcs add**

Arcedit: **add**

-----Options-----

1) Vertex 2) Node 3) Curve

4) Delete vertex 5) Delete arc 6) Spline on/off

7) Square on/off 8) Digitizing Options 9) Quit

(Line) User-ID: 38564036 Points 0

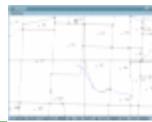
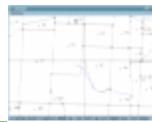


Figure 2

8. Here is what the display would look like: 
9. All techniques learned to edit and digitize coverages still apply when you are digitizing on-screen. The final stage of this example would be to finish the arc, edit any dangling nodes and then add the missing label point to the new polygon.
10. In this exercise, one coverage was used to edit and add new information to another coverage. This example utilizes rudimentary techniques in on-screen digitizing.

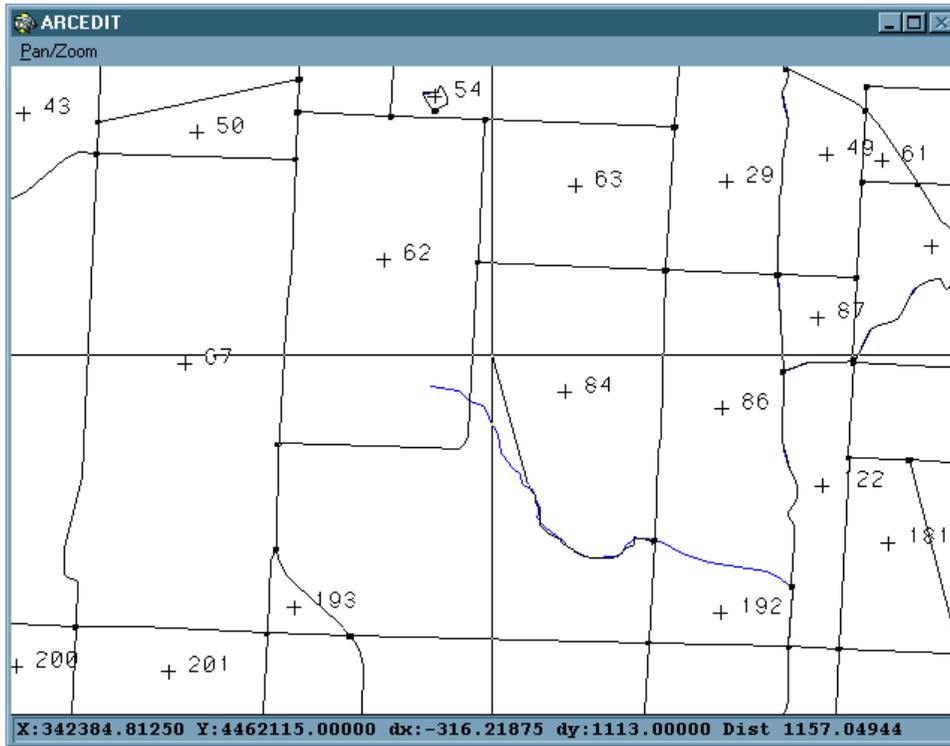


Figure 1

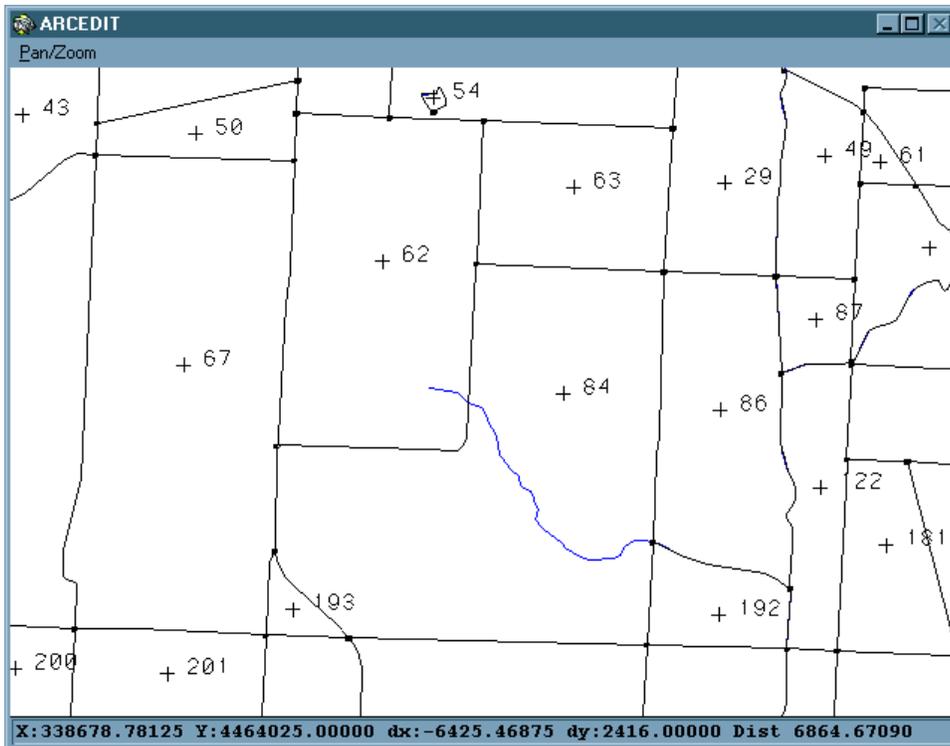


Figure 2

## Heads-Up Digitizing - 2

The following is a listing of how to do this using ARC/INFO. All commands for ARC/INFO will be printed in bold here. In this example, two coverages are used to create a new coverage. A situation calls for evaluating and determining stream gage locations within a certain study area. Proposed sites will be digitized in a new coverage called "gages." The project manager asks that a gage be placed near a road, and as directly upstream from a convergence of two streams, as possible. Using a map based on the gage coverage, a team may then inspect the locations *in situ* to determine if a gage location would be successful.

1. To enter ARCEDIT and set the display, type: **arcedit** and **display 9999**.

```
Arc: arcedit
```

```
Copyright (C) 1982-1997 Environmental Systems Research Institute, Inc.
```

```
All rights reserved.
```

```
ARCEDIT (COGO) Version 7.1.1 (Thu Feb 6 23:26:50 PST 1997)
```

```
Arcedit: display 9999
```

2. Create the new coverage, called "gages" that uses the same registration as roads.

```
Arcedit: create gage roads
```

```
Creating C:\ARCDATA\EX8\GAGE
```

```
The edit coverage is now C:\ARCDATA\EX8\GAGE
```

```
WARNING the Map extent is not defined
```

```
Defaulting the map extent to the BND of C:\ARCDATA\EX8\GAGE
```

3. Now set up the drawing environment with background coverages.

```
Arcedit: drawenvironment all
```

```
Arcedit: backenvironment arc
```

```
Arcedit: backcoverage hydro 4
```

```
C:\ARCDATA\EX8\HYDRO
```

```
is now background coverage 1 with draw symbol 4
```

```
Arcedit: backcoverage roads 2
```

```
C:\ARCDATA\EX8\ROADS
```

```
is now background coverage 2 with draw symbol 2
```

```
Arcedit: draw
```

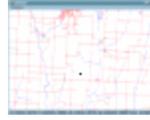


Figure 3

4. The graphical display would look like this:
5. Four arrows have been added to the image to show where the new points will be placed. Using the graphical information from the roads and hydro coverage, digitizing the points is as easy as adding labels.

Arccedit: **editfeature label**

0 element(s) for edit feature LABEL

Arccedit: **add**

-----Options-----

1) Add Label 5) Delete last label 8) Digitizing Options

9) Quit

(Label) User-ID: 1 Coordinate = 345490.899,4462056.457

(Label) User-ID: 2 Coordinate = 344763.013,4462905.657

(Label) User-ID: 3 Coordinate = 337666.128,4463997.486

(Label) User-ID: 4 Coordinate = 336907.914,4464452.414

4 label(s) added to C:\ARCDATA\EX8\GAGE

6. Save the new points and remove the roads coverage to inspect the potential gage locations.

Arccedit: **save**

Arccedit: **removeback roads**

Removing backcover: C:\ARCDATA\EX8\ROADS

Arccedit: **draw**



Figure 4

7. The final image should look something like this:

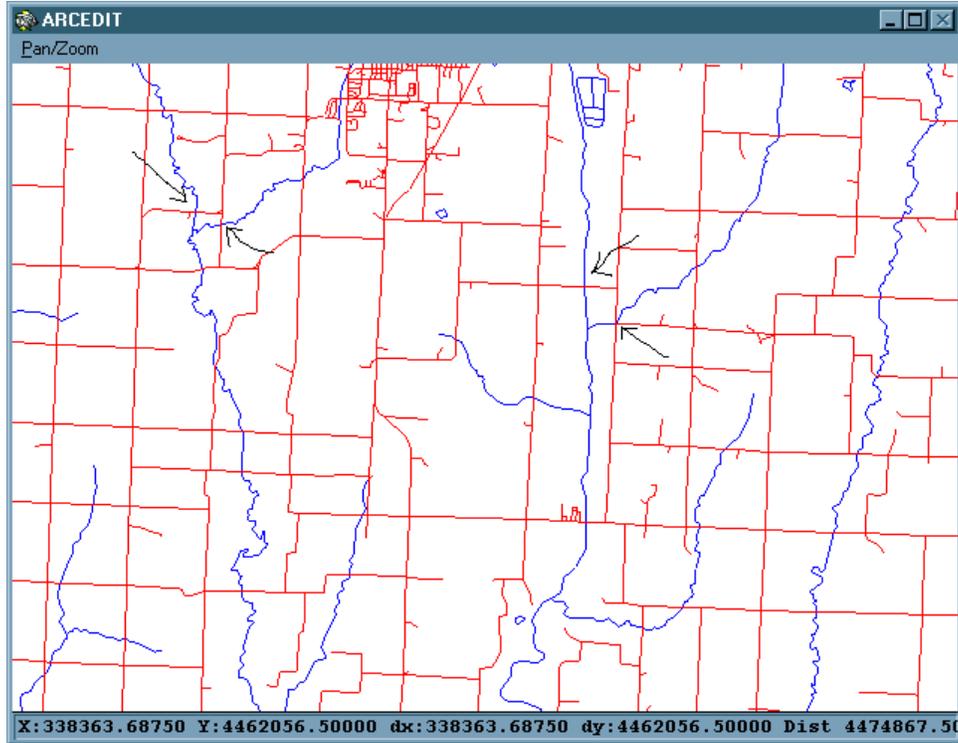


Figure 3

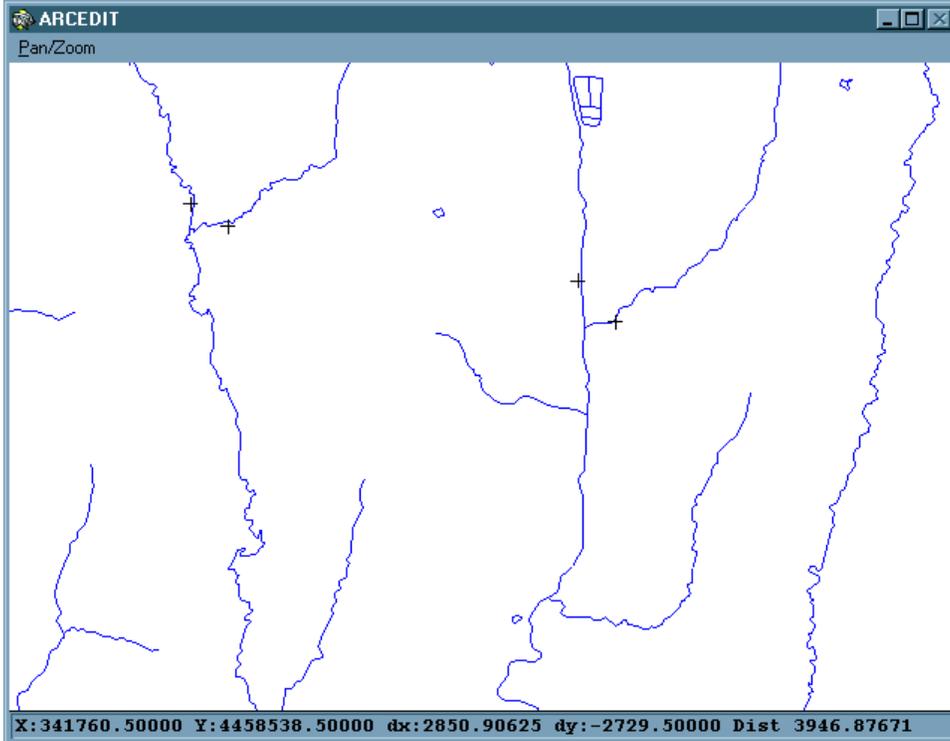


Figure 4

## Heads-Up Digitizing - 3

The following is a listing of how to do this using ARC/INFO. All commands for ARC/INFO will be printed in bold here. In this example, an image will be registered using information found in a coverage or the same extent. This image will be rectified using the information from the registration process.

1. To register the image, use the command **register** with the coverage containing suitable Ground Control Points (GCP).

Arc: **register**

Usage: REGISTER <image> {cover} {cover\_color} {band | COMPOSITE}  
{red\_band}

{green\_band} {blue\_band} {ARC | POINT | TIC | ALL}

Arc: **register campus.tif campus\_cov 4**

2. Align a similar area in both the Coverage and Image windows. Select "View:Redraw Overlay Campus" to draw both maps in the Overlay window.
3. Using the mouse as input, select a GCP on the image that may be found in the coverage. Click on the location in the image first, then the corresponding location on the coverage in the Overlay Window. ARC/INFO refers to this as a link.



Figure 5

4. After establishing several links, the output may look something like this:

5. After creating 4 or 5 links, you should have enough information to lock the image together. To do this, Select "View:Link Actions".
6. Select the Register button, and then the Redraw Overlay button with the Lock Image



Figure 6

box checked. The window that pops up looks like this:

7. In this Registration window, you can see that there are 10 links created. The pixels will need to be scaled at roughly 0.5 in both the X and Y directions, and the overall error is 5.1 pixels, or 2.58 feet.
8. When the Overlay is redrawn, the lines of the coverage might line up better with the image better. At this stage, you must create several more links across the image.
9. The image will be accurately registered if you choose GCP all across the image, and not just in a particular area. Sometimes, due to GCP restrictions with the coverage, you may not be able to select in more than a few locations on the image. Be warned: the overall RMS error is valid only in the areas that you have created links with, the error will be higher in areas without GCP links.
10. At any time, you may choose to delete a link that may be unusually high, but be careful. If care is taken during this phase, then all links are probably accurately placed. You may decrease the reported RMS error by deleting links but the RMS error may then not be entirely accurate. Discretion must be used when deciding which links were

misplaced and which are in the proper location.

11. There should be at least 25 links for an image. Any less may yield an inaccurate RMS error value. Having more than 40 or 50 links may provide redundant data and not provide new information.
12. This process is repeated until you have enough links to create an acceptable RMS error. Be sure to select the "Save Transformation" button. This creates a world file for the image. To look at this file:

```
Arc: type campus.tfw
```

```
Submitting command to Operating System ...
```

```
0.50053464870430
-0.01152274964816
-0.01100095996915
-0.50081913471566
392148.90499453183000
525587.55640567141000
```

13. This 6 line file describes how the image should be scaled, rotated and translated through rectification.
14. To rectify this image, use the **RECTIFY** command:

```
Arc: rectify
```

```
Usage: RECTIFY <in_image> <out_image> {NEAREST | BILINEAR | CUBIC}
      {DEFAULT | COLORMAP | NONE} {clip_cover | BOX} {xmin} {ymin}
      {xmax} {ymax}
```

```
Arc: rectify campus.tif rect-campus.tif bilinear
```

```
Rectifying...
```

```
Arc:
```

15. The new "rect-campus.tif" image is ready for on-screen digitizing.

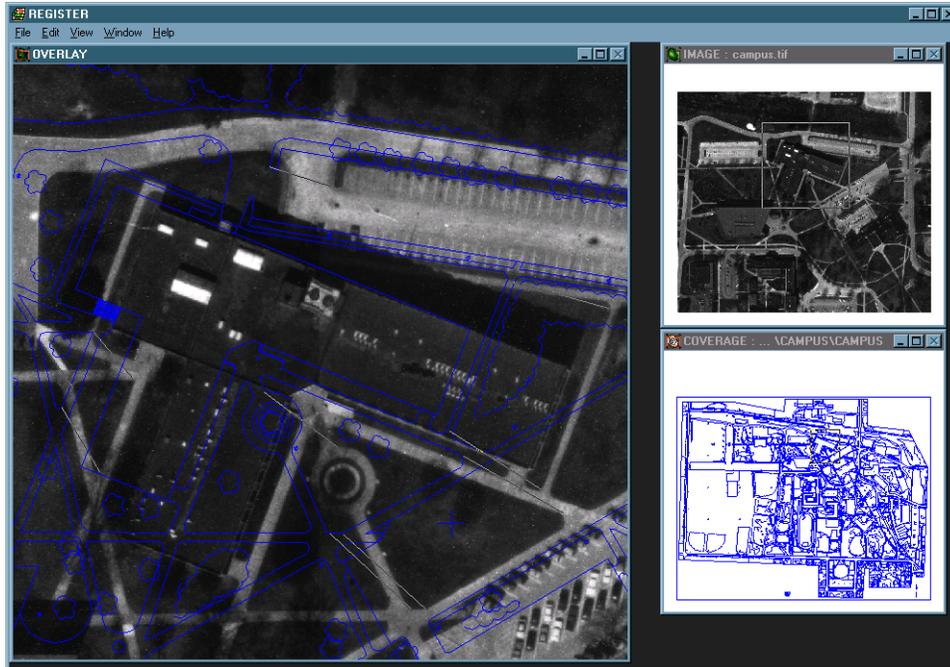


Figure 5

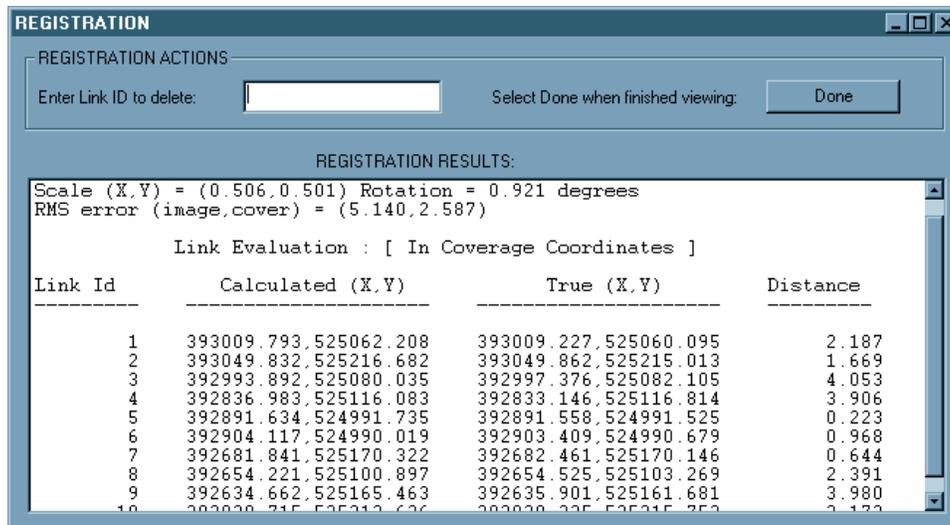


Figure 6

## Heads-Up Digitizing - 4

The following is a listing of how to do this using ARC/INFO. All commands for ARC/INFO will be printed in bold here. In this example, the campus image is used as a backdrop to add tree locations using on-screen digitizing.

---

1. To enter ARCEDIT and set the display, type: **arcedit** and **display 9999**.

```
Arc: arcedit

Copyright (C) 1982-1997 Environmental Systems Research Institute, Inc.
All rights reserved.

ARCEDIT (COGO) Version 7.1.1 (Thu Feb 6 23:26:50 PST 1997)

Arcedit: display 9999
```

2. Create the new coverage, called "trees" that uses the same registration as "campus".

```
Arcedit: create trees campus

Creating C:\ARCDATA\DIP\CAMPUS\TREES

The edit coverage is now C:\ARCDATA\DIP\CAMPUS\TREES

WARNING the Map extent is not defined

Defaulting the map extent to the BND of C:\ARCDATA\DIP\CAMPUS\TREES
```

3. It is possible that you may not have a coverage to "borrow" the registration tics from. In this case, you must create the location of the tics yourself. In this case, select areas on the coverage that may be easy to find later.
4. Set the map extent to be the same as the rectified image.

```
Arcedit: mapextent image rect-campus.tif
```

5. Create the drawing environment, including the image, and refresh the graphical display.

```
Arcedit: drawenvironment all on

Arcedit: image rect-campus.tif

Arcedit: draw
```

6. Set the edit feature to label and reset the map extent to focus on a particular area. Now add the tree locations. The graphical display window will something like this:

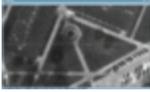


Figure 7

```

Arcedit: editfeature label
0 element(s) for edit feature LABEL
Arcedit: add
-----Options-----
1) Add Label 5) Delete last label 8) Digitizing Options
9) Quit
(Label) User-ID: 1 Coordinate = 393034.193,525101.468
(Label) User-ID: 2 Coordinate = 392935.896,525068.446
(Label) User-ID: 3 Coordinate = 392911.322,525088.797
(Label) User-ID: 4 Coordinate = 392804.577,525031.201
(Label) User-ID: 5 Coordinate = 392816.096,524970.149
(Label) User-ID: 6 Coordinate = 392700.521,524975.525
6 label(s) added to C:\ARCDATA\DIP\CAMPUS\TREES
Arcedit:

```

## 7. Save the coverage and exit ARCEDIT.

```

Arcedit: save
Saving changes for C:\ARCDATA\DIP\CAMPUS\TREES
Saving labels...
6 label(s) written to C:\ARCDATA\DIP\CAMPUS\TREES
from the original 0, 6 added and 0 deleted
Reopening labels...
Saving tics...
** NOTE ** Tic(s) unchanged
Reopening tics...
BND replaced into C:\ARCDATA\DIP\CAMPUS\TREES
Re-establishing edit feature POINT
Arcedit: quit

```



Figure 7