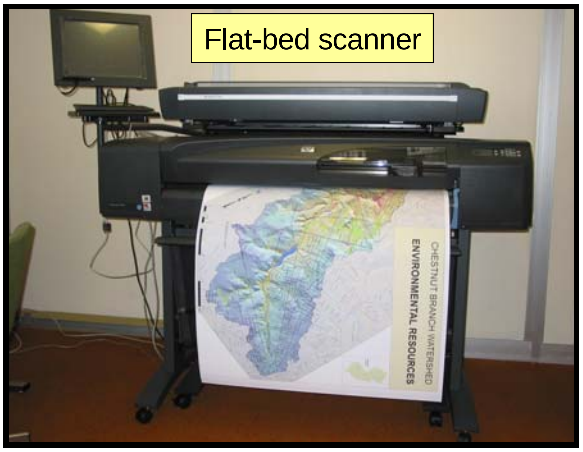
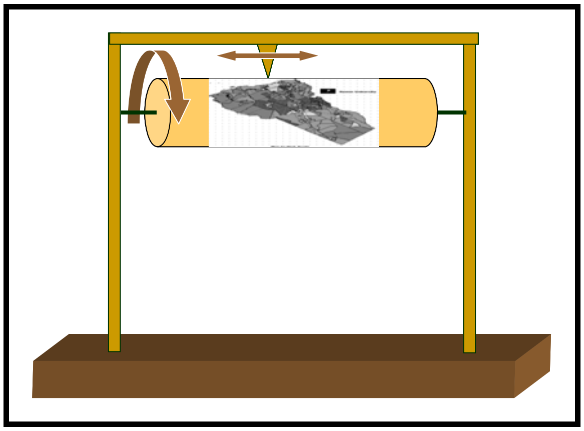
Chapter 20 Creating Your Own GIS Database: Heads Up Digitizing

In preceding chapters dealing with database issues, you have learned the techniques required to import, transform, manipulate and modify existing spatial datasets. The emphasis of those chapters on working with existing datasets is a reflection of the recent growth in the quantity and quality of spatial data and of the great improvement in the software tools that enable manipulation of those data. Generally, using existing data is quicker, cheaper, and much less frustrating than creating your own data sets from scratch. Nevertheless, there are times when you need a dataset that does not yet exist. In these cases the only option is to create your own spatial dataset.

As usual when working with cartographic data, techniques for the creation of spatial data divide into raster and the vector mode approaches. In raster mode the basic procedure is called scanning and the necessary piece of hardware is the raster scanner. These devices come in two basic configurations: flat bed and drum. In the case of a flatbed scanner the device includes a bed onto which the operator places the image to scan and a beam, containing light sensing elements, which passes over and illuminates the image. In some configurations, the light sensing elements are stationary and the medium the device is scanning passes under those elements. In either case, as the image passes by the light sensing device it records the intensity of reflected light pixel by pixel.



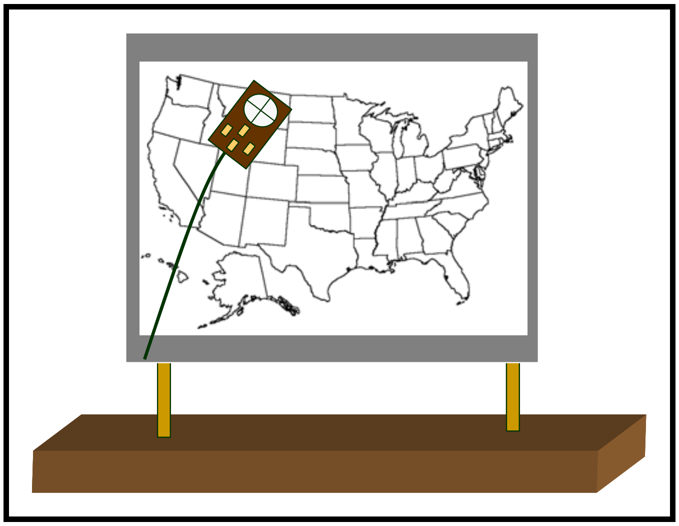
The drum scanner consists of a rotating drum or cylinder onto which the operator affixes the image to scan. As the drum rotates a light sensing device illuminates the image and records the reflected pixel values in either monochrome or color.



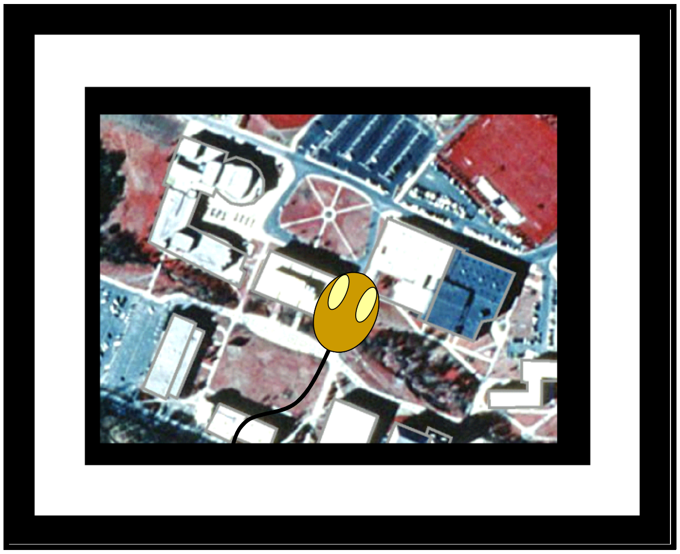
As you would expect, for raster mode devices the basic element captured is the pixel or picture element, which the hardware can encode as either a simple intensity ranging in value from 0 to 255 in the monochrome case or as a set of three values encompassing the same range, but with each value representing one of the additive primary colors, red, blue, or green. I

I n raster scanning, the initial data capture process is highly automated. Just put the map on the scanner and go. In this case the database builder performs the more time consuming activities in postprocessing operations that include georeferencing, feature identification and vectorization if there is a need to convert the raster to a vector dataset. The advantage of data capture through scanning is that it is highly automated and very fast. Traditionally, the main disadvantage has been that the hardware required for large format scanning is very expensive, but prices are coming down.

In vector mode the basic procedure is called is called semiautomatic digitizing or more recently simply digitizing and the basic piece of hardware is the digitizing tablet, which consists of a flat surface onto which you affix the map you are going to digitize and a puck or stylus that you use to identify the locations of the coordinates you wish to convert to digital form.



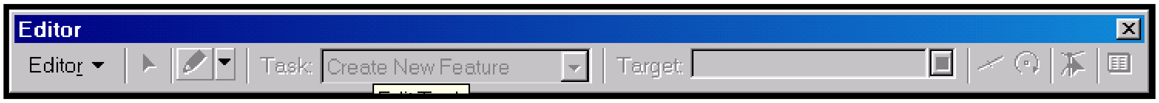
As its name suggests, the digitizer functions to perform the precise operation suggested by its name: it converts graphic images into digital form. In this case the basic element captured is the X and Y coordinate pair. With digitizing the process is much less automated than in the case of raster scanning. The operator of the digitizer moves the pointing device over the map, points to the positions of elements that he or she would like to convert to digital form and presses a button on the puck or stylus to send the coordinates of the current position of the cursor to the processor. In this case the georeferencing operations take place at the beginning of the digitizing process when the operator digitizes a set of at least three and usually four control points and then specifies geographic coordinates for each of those control points. Tying locations on the digitizer to locations on the earth enables the software to create a set of transformation equations that serve to translate positions on the tablet surface to geographic coordinates.

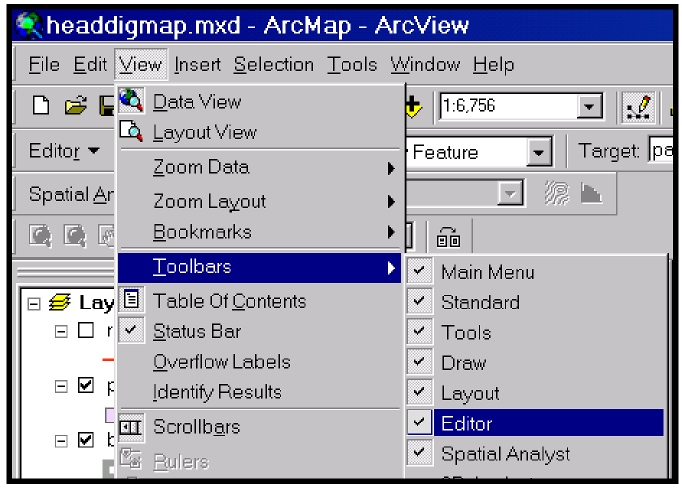


In heads up digitizing, which is what you will learn here, you are operating in vector mode, but rather than digitize from a paper map affixed to a digitizing tablet, you will use the mouse as the pointing device, to digitize an image displayed on the monitor. The image on the screen could be a scanned map, an orthographically corrected and geo-referenced air photograph, or a satellite image. Examples of features that you might digitize from an air photograph include roads, building footprints, parking lots, and other features easily seen on media of this type. One advantage of heads up digitizing is the ability to zoom in and out in order to alter the scale of the image so as to facilitate more precise capture of features of varying size.

HEADS UP DIGITIZING: For heads up digitizing, the very first thing you need to do is add the image that you will be using as a source from which to trace features to the ArcMap data view. The image that you add should, of course, be plotted in a known coordinate system and you should know the details of that system.

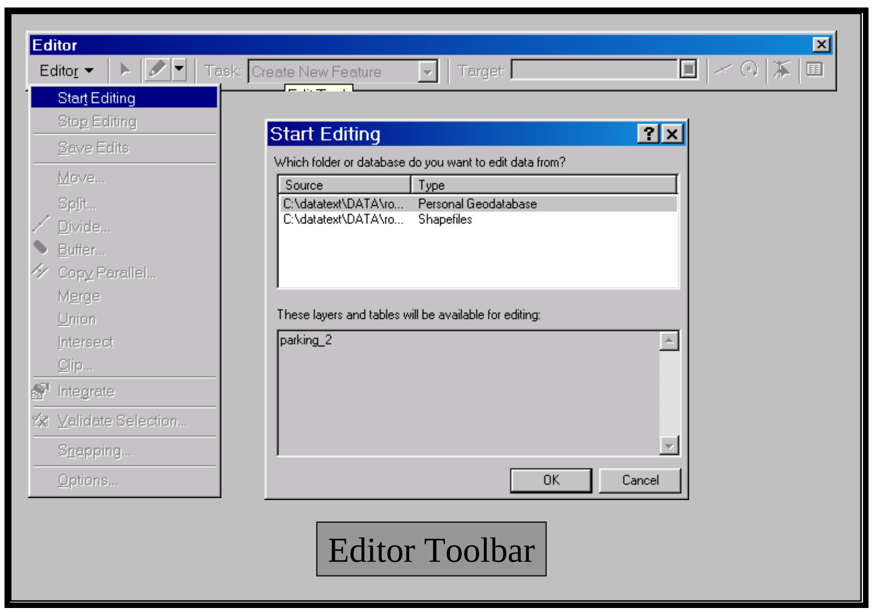
The second step in this process is to use Arc Catalog to create a new layer in which you will store the features you are creating. The layer can be a shapefile or a geodatabase feature class. After you create the layer, add it to the Arc Map Table of Contents.





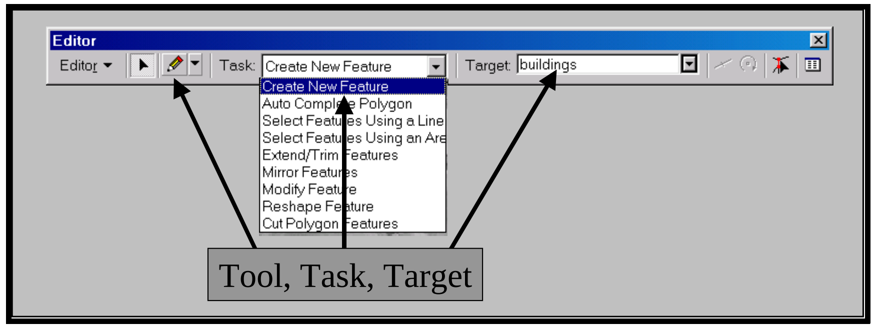
Before you can begin to add features to a new or existing layer, you need to make sure that the Editor Toolbar is open. If you can see the Editor Toolbar [displayed here] and if you have added the layer that you wish to edit, then you are ready to start editing.

If you can not see the Editor Toolbar, then you need to add it to the ArcMap window. To do this click on View in the Main Menu and select Toolbars from the drop down menu. The program will open a slide out menu with a listing of available toolbars. Those that are currently loaded appear with a check mark next the toolbar name. If the Editor toolbar has no check mark, click it to insert a check. The program will close the menu and open the toolbar. You can also open or close toolbars by right clicking on any open toolbar. The program will open a listing of all toolbars. To open an unchecked toolbar, click it. To close an open toolbar, click it.

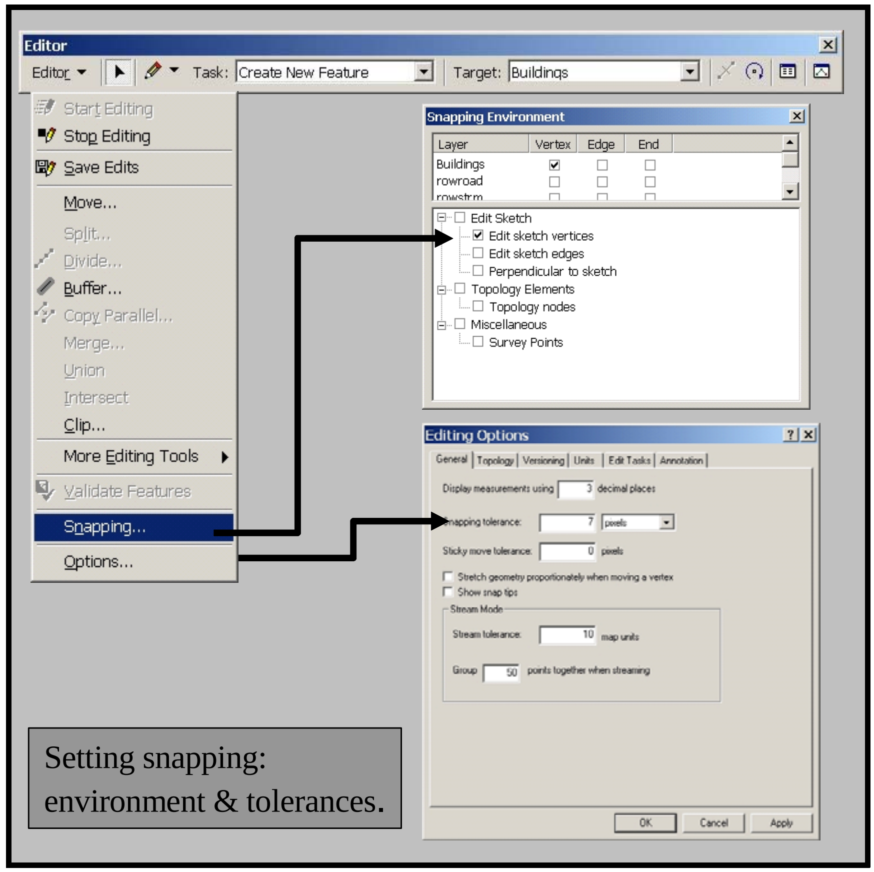


Start Edit Session. The illustration depicts the Editor Toolbar. To begin an edit session click the Editor button to open a drop down menu and then select Start Editing. If you have added layers to the Table of Contents that reside in more than one folder or database, then the program will open a Start Editing dialog from which you can select the folder or database containing the layer you want to edit. Toward the top of the dialog is a window that lists the folder or databases that you have added to the Table of Contents. When you click one of the database listings, then the window near the bottom of the dialog displays the layers and tables that you can edit in the folder or database that you just clicked. Click on the folder or database that contains the layer you wish to edit and then click the OK button.

Once you have added the layer you wish to edit and have started an editing session, you need to tell the program which Tool you wish to use to perform a Task on a Target. In the illustration I have selected the Create New Feature tool which is one of several available editing tools. From the Task list I have selected Create New Feature and as the Target, that is the layer I wish to edit, I have selected the buildings layer .



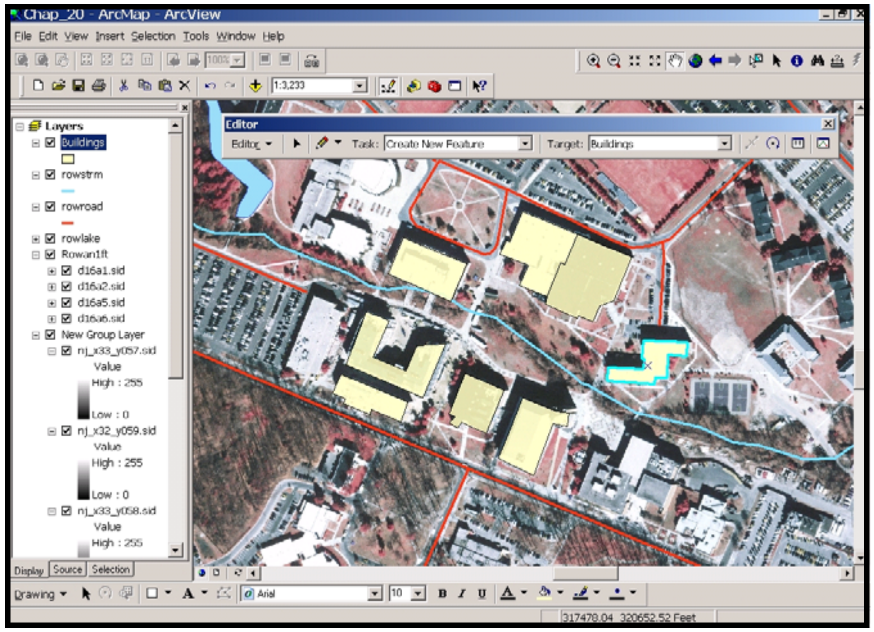
Set Snapping. Before you begin adding or modifying features, you should set the snapping environment. Snapping enables vertices, edges, or other feature components to snap together as if pulled by a magnetic force. There are three components of the snapping environment: tolerance, properties, and priority. Snapping tolerance is essentially the minimum distance, either in pixels or map units, that two vertices, polygon edges, or other feature components can be from each other before they snap together.



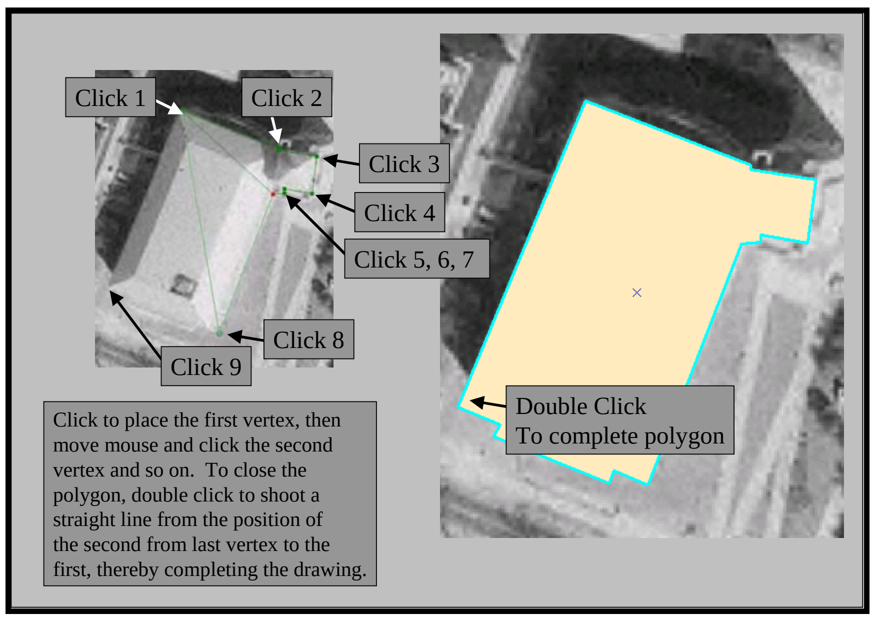
To set the snapping tolerance, click on the Editor button to open the drop down menu and then select Options to open the Editing Options dialog box. In the dialog use the Snapping tolerance field to select whether you want to measure snapping distance in map units or in pixels and then specify the distance in the units you selected [i.e., pixels or map units].

The snapping properties specify the feature components to which new features snap. For instance, if you set the snapping properties to Vertex, then as you add new features, when you bring the pointer within the snapping tolerance of an existing vertex, the pointer cursor will snap to the vertex of the existing feature. Of course, this enables you to ensure that the two vertices, one from the existing feature and one from the new feature you are creating share exactly the same coordinate values. To set snapping properties, click on the Editor button to open the drop down menu and select Snapping. The program will open the Snapping Environment window. In the window click to check the component of the layer for which you wish to specify properties. In the illustration, I have checked the Vertex box for the buildings layer. As I digitize features for the building layer, whenever I move the cursor within the snapping tolerance distance of an existing vertex, the cursor will snap to the existing vertex.

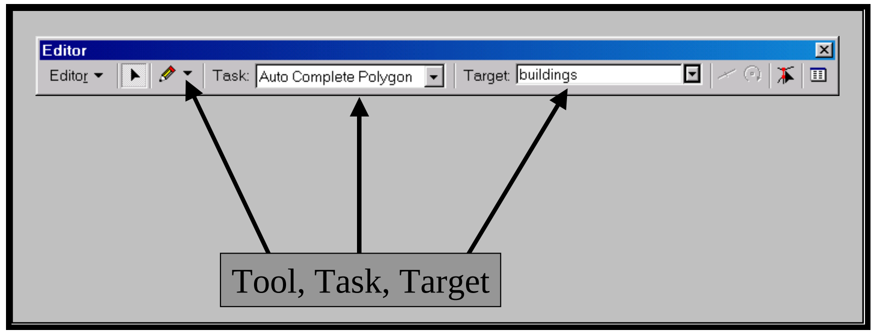
You also use the Snapping Environment dialog to specify snapping priority, which determines the order in which snapping takes place. The first layer in the listing in the Snapping Environment has the highest snapping priority. The second layer in the list has the next priority and so on. To change the priority of a layer, click it and drag it to a new position in the listing.



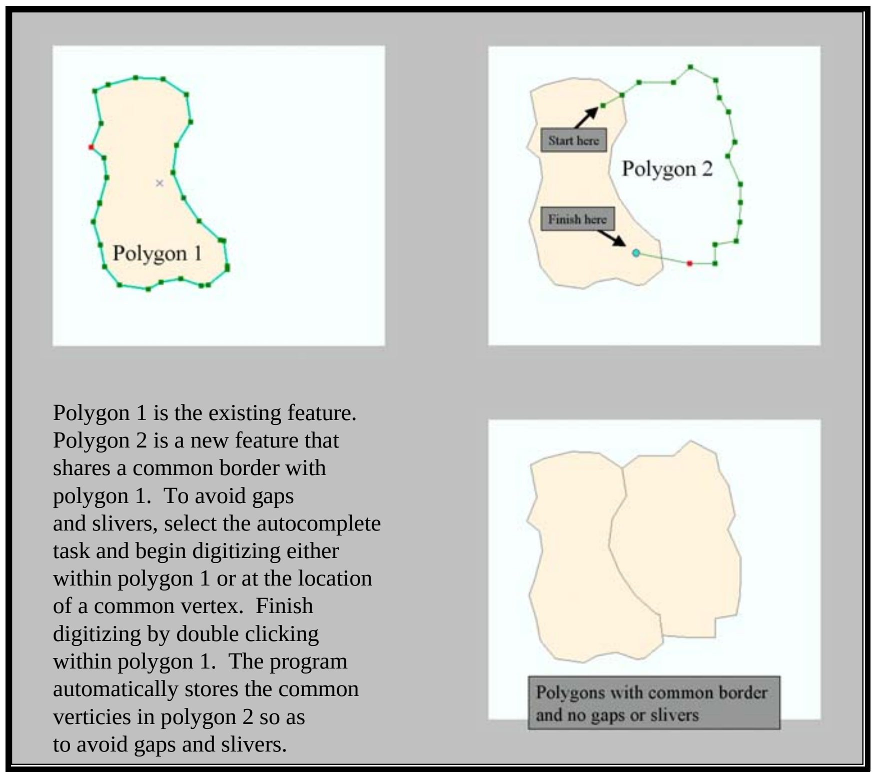
In the illustration, I have depicted a portion of the Rowan University campus. In the data view window you can see that I have digitized several outlines of building on the campus. In the following discussion of digitizing technique refer to this illustration as a general guide to the process. Notice that near the top of the air photograph you can see the Editor toolbar with the Create New Feature tool selected, the Task set to Create New Feature, and the Target set to buildings.



Adding Features. You are now ready to start adding new polygon features to the buildings layer. To digitize the polygon, begin by moving the mouse pointer over the location on the photo where you wish to create the new polygon feature. This is where you will place the first vertex that you will use to define the outline of the new feature. To insert the vertex, click the mouse. Now move the pointer to the next location at which you wish to insert a vertex and click again. Continue in this fashion until you have inserted all but the very last vertex. In the illustration you would click in the position I have identified as Click 9 to insert this vertex. To close the polygon and complete the feature, double click on the last vertex you need to specify in order to correctly represent the shape of the polygon. The program will draw a straight line from the position on which you double clicked to the position of the first vertex, thereby closing the polygon and completing the feature. The right portion of the illustration depicts the completed feature as it appears just after double clicking.



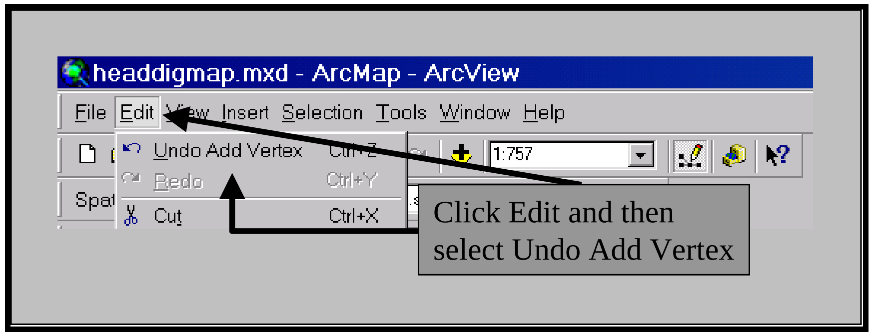
Auto Complete Polygon. One problem that every digitizing program must solve is the avoidance of gaps and slivers along the common borders of adjacent polygons. The essence of the problem is this: having digitized the first polygon, when you proceed to digitize the second polygon which has a border in common with the first, you must ensure that the coordinate values of all of the vertices that are common to both polygons have exactly the same numerical values. Given the very high resolution digitizing equipment, there is no possibility of attaining a correctly digitized common border by "eyeballing" it.



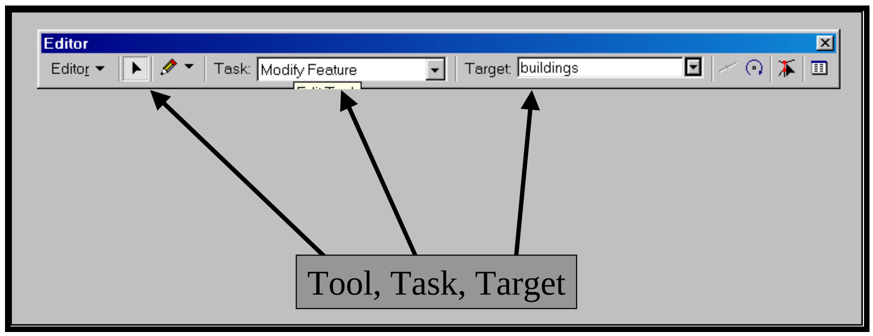
Polygon 1 is the existing feature. Polygon 2 is a new feature that shares a common border with polygon 1. To avoid gaps and slivers, select the autocomplete task and begin digitizing either within polygon 1 or at the location of a common vertex. Finish digitizing by double clicking within polygon 1. The program automatically stores the common verticies in polygon 2 so as to avoid gaps and slivers.

How do you solve this problem? In ArcMap you can create a correct common border by relying on the snapping feature. All you need to do is take care to make sure that each common vertex in polygon 2 snaps to its mate in polygon 1 [see illustration]. The problem with this approach is that you still need to digitize the common vertices twice: once when creating polygon 1 and a second time when creating polygon 2. A better way is to use the Auto Complete Polygon task in the Editor toolbar. To use autocomplete, prior to beginning to digitize a new feature that shares a common border with an existing feature, click the Task field in the Editor toolbar and select Auto Complete Polygon. To digitize the new feature place the pointer either over the existing feature or over an existing vertex in the feature so that the cursor snaps to the vertex. In the illustration, I have started digitizing polygon 2 by moving the cursor over the existing polygon and clicking. Next, I moved the cursor to the border of polygon and snapped on an existing vertex. From there I continued digitizing in the normal fashion, vertex by vertex. When I returned to the common border, I simply double clicked within polygon 1. The program finishes polygon 2 by assigning all of the common vertices along the eastern border of polygon 1 to polygon2. As a result, I have created polygon 2 with no gaps or slivers, and have saved myself the trouble of redigitizing the common vertices.

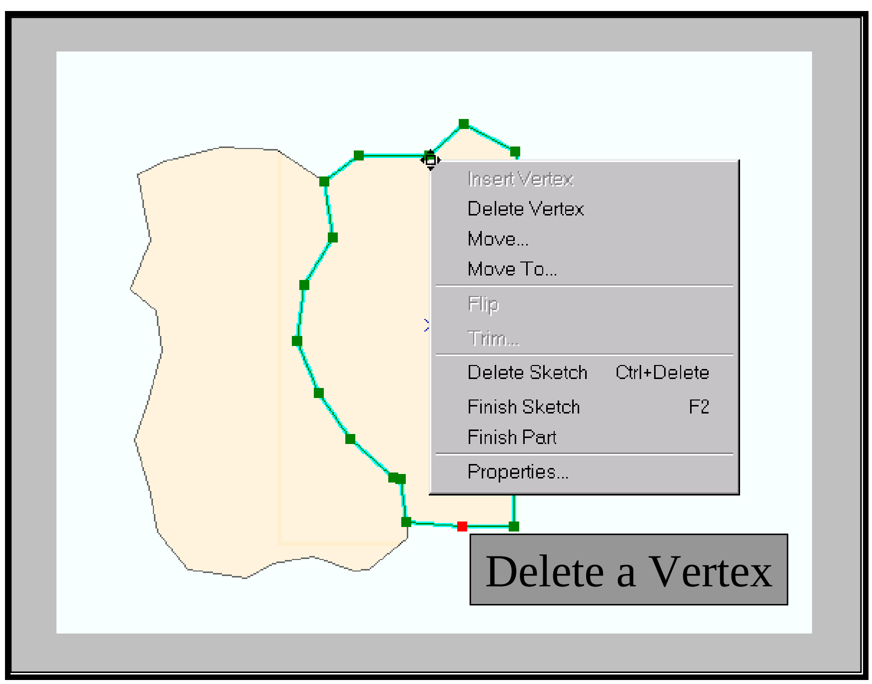
Whoops. Believe it or not, as you digitize there will be times when you make an error or maybe even two. If you commit the error prior to completing a feature, then the easiest way to remedy it is to delete vertices back to the point of the last correct point insertion. To delete vertices, click on Edit in the Main Menu and then select Undo Add Vertex from the drop down menu. The program will remove the last vertex you digitized. You can repeat this operation until you have removed as many vertices as you wish.



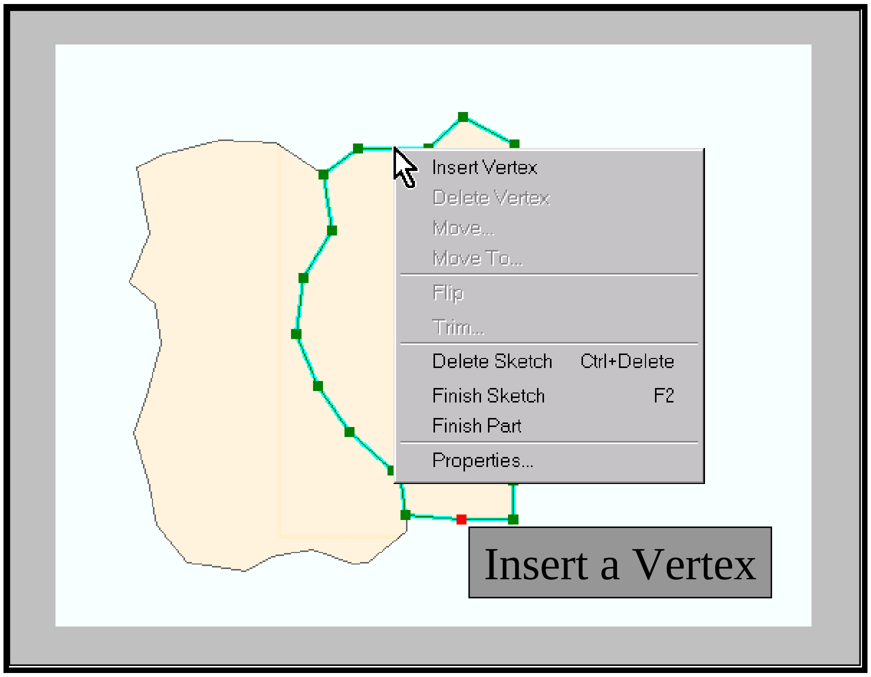
If you discover an error after you have completed digitizing a feature, then you can correct errors by to moving, adding, or deleting vertices. In short, you need correct the error by modifying the completed feature. To begin modifying a feature, in the Editor toolbar click the **Edit tool** [see illustration] and then select the **Modify Feature** task from the Task list. Finally, make sure that the Target is set to the layer containing the feature you wish to modify. To begin modifying the feature, click to select it. The program will outline the feature and display each of the vertices.



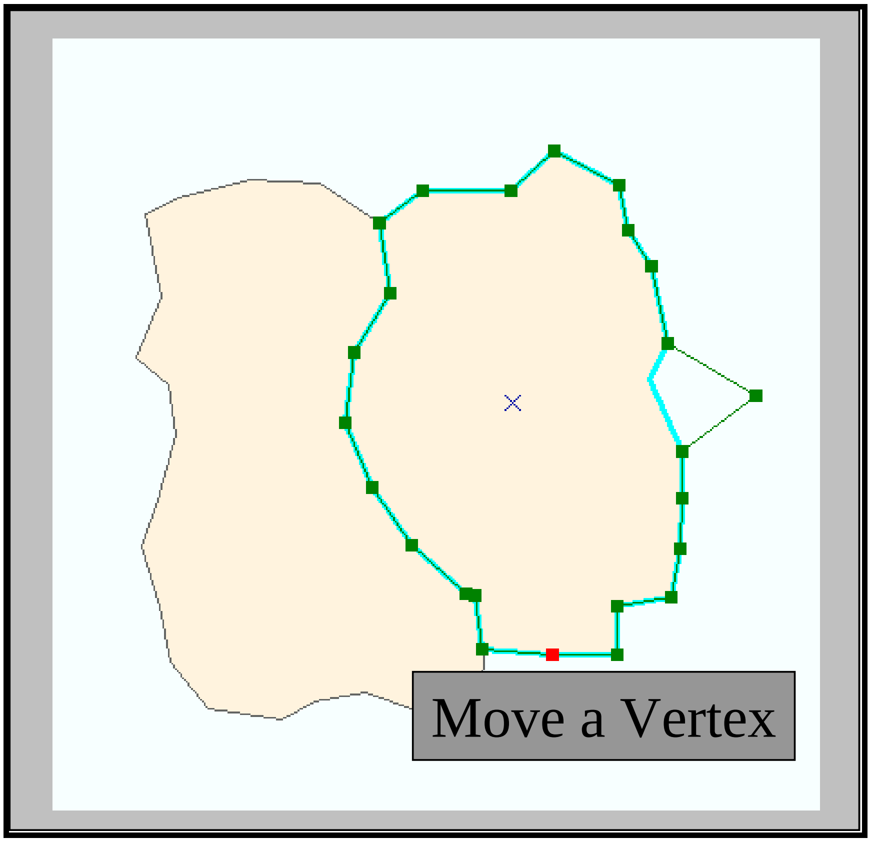
To delete a vertex, move the pointer over the vertex that you want to delete and right click the mouse. The program will open a popup menu on which one choice is Delete Vertex. Click this option to delete the vertex. Unless the mouse pointer is over the boundary when you right click, you will not see the option to delete a vertex.



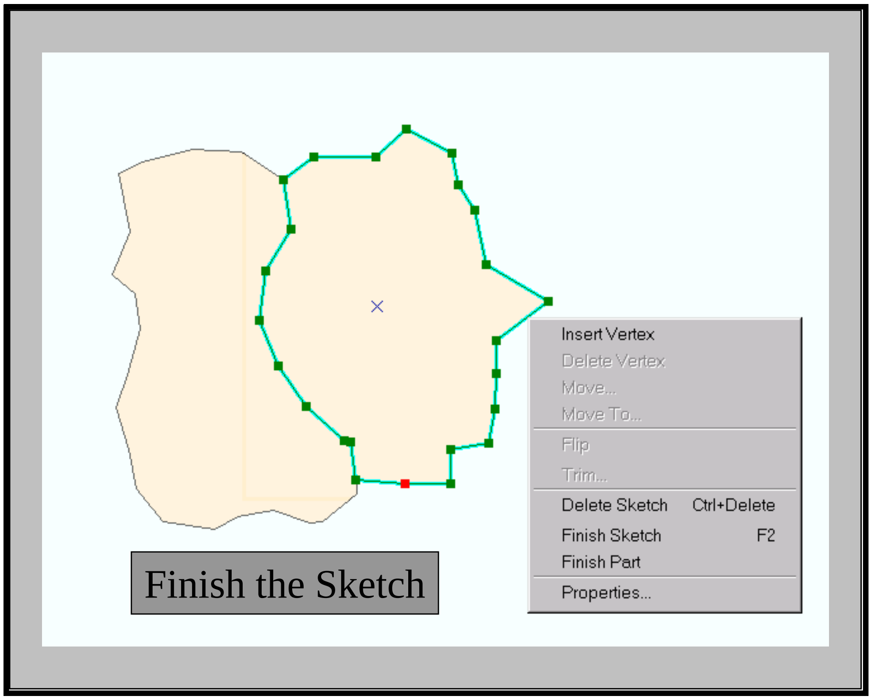
To insert a vertex in the feature, with the task set to Modify Feature, click to select the feature into which you wish to add a vertex. Move the pointer over the location on the polygon boundary where you wish to insert the vertex and right click the mouse. The program opens a popup menu from which you select Insert Vertex. As soon as you click that option, the program adds the vertex at the location you specified. Note that unless the mouse pointer is over the boundary when you right click, you will not see the option to insert a vertex.



To move a vertex by dragging, place the mouse pointer over the vertex, click to drag it to the new location and release the mouse button. The program displays the vertex in the new position, but does not alter the polygon boundary until you tell it to complete the sketch.

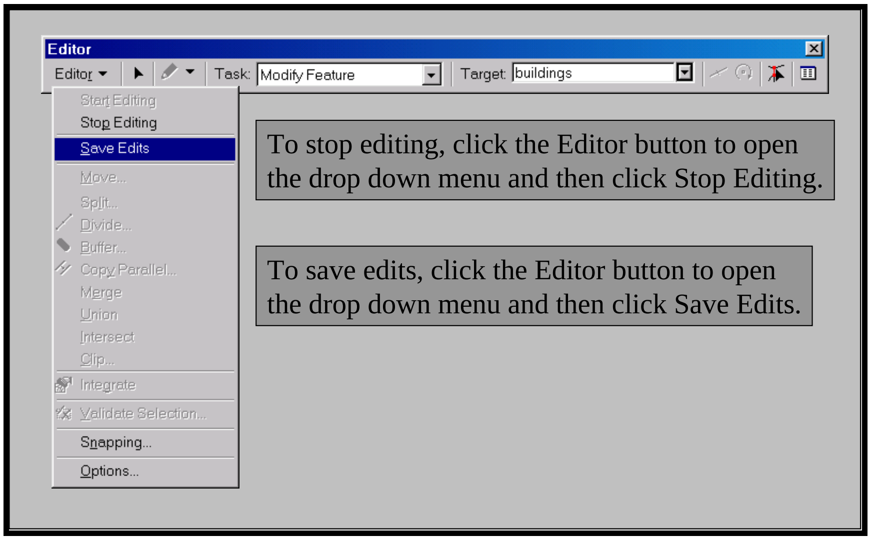


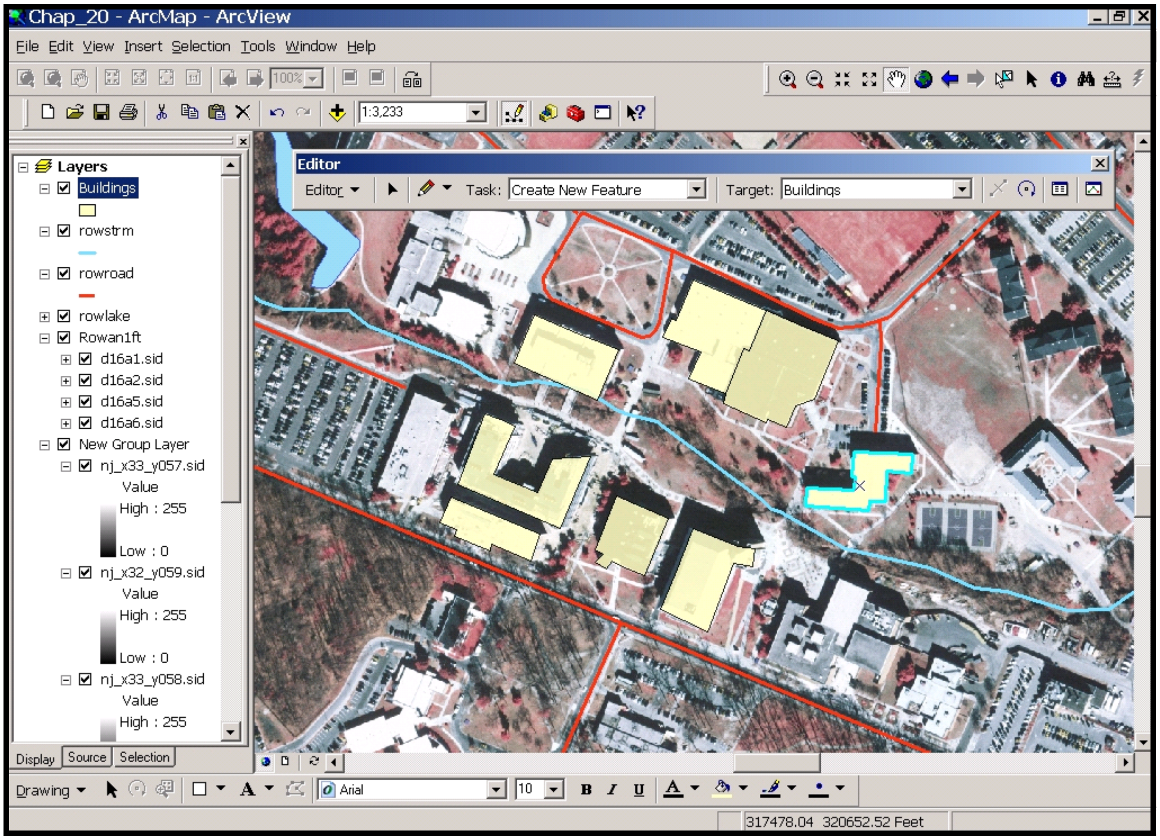
To complete the sketch, right click on the boundary to open the popup menu and select Finish Sketch. The "sketch" in Arc Map parlance, now becomes a feature.



After you have finished adding features and correcting any errors, you are ready to save the results of your work. To save your results, which you should do from time-to-time as you work, click the Editor button to open the drop down menu and then click on Save Edits.

To exit the editing session, click the Editor button and select Stop Editing from the drop down menu.





Assignment. Copy the Chapter 20 database from the open area to your H: drive or to the local hard drive [C:]. Load the map document file, Chap_20 . Use Arc Catalog to create three polygon layers:

1. Buildings
2. Parking Lots
3. Future Garages

Specify NJ State Plane coordinates for each file using the North American Datum of 1983.

Start an editing session and digitize the parking lots, storing the coordinates in the Parking Lots shapefile. Do the same for the buildings, storing the coordinates in the Buildings shapefile.

To digitize "Future Garages" you must georectify an image from the new Rowan Master Plan that is in unknown coordinates. Add the image "Rowan_Future_Parking.jpg" to the ArcMap view. Add the Georeferencing Tool from the view menu. In the Georeferencing Tool bar make sure that "Rowan_Future_Parking.jpg" is the active layer and then select "Fit to Display". Click on the "Add Control Points" button and then click on a place on the JPG that is identifiable in the ROWROAD layer and then make your second click on the corresponding point on the ROWROAD layer. Continue this procedure several times to adjust the Parking JPG map to fit the real-world data as close as possible. Digitize the outlines of the Future Garage locations from the JPG. Use the lecture PowerPoint if you need added guidance.

Create a print out map showing the 3 new data layers that you have digitized. Follow all the conventions of a cartographically excellent map. Make sure that your name is on the printout. This is exercise #9.