What is editing?

Introduction to editing

ArcGIS allows you to create and edit several kinds of data. You can edit feature data stored in shapefiles and geodatabases, as well as various tabular formats. This includes points, lines, polygons, text (annotations and dimensions), multipatches, and multipoints. You can also edit shared edges and coincident geometry using topologies and geometric networks.

Whether you are using ArcView, ArcEditor, or ArcInfo, you use the same editing tools in ArcMap to compile and update your geographic data. Certain editing operations may require additional licensing, such as ArcEditor, ArcInfo, or an ArcGIS extension. For example, ArcView allows you to edit simple features in a geodatabase but cannot be used to edit more advanced geodatabase capabilities such as topologies, dimensions, geometric networks, and ArcSDE geodatabases. The Editing help topics identify when ArcEditor or ArcInfo is required.

Methods of creating data

Digitizing data

Digitizing, the process of converting features into a digital format, is one way to create data. There are several ways to digitize new features. These include digitizing “on-screen” or “heads up” over an image, digitizing a hard copy of a map on a digitizing board, or using automated digitization.

Interactive, or heads up digitization, is one of the most common methods. In this method, you display an aerial photograph, satellite image, or orthophotograph on-screen as a basemap, then you draw features, such as roads, buildings, or parcels, on top of it.

In hard-copy digitizing, you use a digitizing table connected to a computer that converts positions on the table surface into digital x,y coordinates as you trace them with a handheld puck (a pen or mouselike device).

Automatic digitization is another method of digitizing features. The ArcScan for ArcGIS extension enables you to perform automatic or interactive raster-to-vector data conversion with high precision and little or no operator intervention during the data capture stage.

Collecting data in the field

Some GIS data is directly captured in the field using a Global Positioning System (GPS) device. GPS units calculate their position using signals from satellites (and sometimes base stations). They vary in capability and accuracy, so be sure to use a GPS that is as accurate as the data with which it will be used. GPS units can be connected to handheld computers, laptops, or Tablet PCs to record data in the field.

Workflow for creating features in ArcMap

Before you create or edit features in ArcMap, you need to have an existing feature class to edit. If you do not have one, you can create a new geodatabase feature class or a shapefile in the Catalog window.

The Editor toolbar and Create Features window contain the most frequently used feature editing tools.

Once you have added the data you want to edit to ArcMap, you'll follow a basic workflow.

1. Choose the workspace and data frame you want to edit.
2. Start an edit session (start editing).
3. Choose a feature template and construction tool from the Create Features window.
4. Set up additional editing properties or options, such as snapping.
5. Create the new feature (such as by digitizing it on the map).
6. Add or edit attributes of the feature.
7. Save edits and stop editing.

You can also edit existing features and attributes in an edit session in ArcMap.

Starting an edit session

Editing occurs in an edit session. During an edit session, you can create or modify vector features or tabular attribute information. When you want to edit, you need to start an edit session, which you end when you’re done. Editing applies to a single workspace in a single ArcMap data frame, where a workspace is a geodatabase or a folder of shapefiles. If you have more than one data frame in your map, you can only edit the layers in one data frame—even if all data is in the same workspace. Although you can edit data in different coordinate systems, it is generally best if all the data you plan to edit together has the same coordinate system as the data frame.

There are two ways to start an edit session: by clicking the Editor menu on the Editor toolbar or by right-clicking a layer in the table of contents. If you use the Editor menu to start editing on a data frame that contains data from multiple workspaces, you are prompted to choose a workspace to edit. If you right-click a layer in the table of contents, you automatically start an edit session on the entire workspace containing that layer.

Most of the time you edit data in data view, since it shows only the data in your map and hides the layout elements. You can also edit in layout view, although editing is typically easier and more accurate in data view. However, editing in layout view is useful when you want to make minor additions to your map in the context of your map layout.

Edits are temporary until you choose to save and apply them permanently to your data. You can also quit an edit session without saving your changes. Just saving a map document does not save the edits to the features—you need to specifically save the edits in your edit session. When you save edits, you write
them to the data source, or a database.

When you are working with data in a database, making edits and saving them are transactions against the database. Versions allow multiple users in a multiuser geodatabase to edit the same data without applying feature locks or duplicating data. When users are ready to apply their edits, they merge their changes through a process of reconciling edits, resolving conflicts, and posting their changes to the parent version of a database.

Some types of data, such as CAD drawings or coverages, can be viewed but not edited inside ArcMap and must be edited in the data's native application. For example, while you can view coverages in ArcMap, you can only edit them in ArcInfo Workstation. You can import these display-only formats into geodatabase feature classes or shapefiles and edit them in ArcMap.

Creating features with feature templates

Creating features is accomplished through the use of feature templates. Feature templates define all the information required to create a feature: the layer where a feature will be stored, the attributes a feature is created with, and the default tool used to create that feature. Templates also have a name, description, and tags that can help you find and organize them. If templates are not present when you start editing, they are automatically created for each layer in the current editing workspace. Templates are saved in the map document (.mxd) and the layer file (.lyr).

A layer can have multiple templates associated with it, where each template has different default settings. For example, if you have a roads layer with classifications of freeway, major highway, and local road, you could have three different templates with each one having a different default attribute for the type of road. This makes it easier for you to create the new type of road you want from the start. To create a local road feature, simply click the local road template, and new features are automatically created as a local road and attributed and symbolized properly. You still need to add other, nondefault attribute values after you create the feature.

Anytime you create features on the map, you start with the Create Features window. Choosing a feature template on the Create Features window sets up the editing environment based on that feature template's properties; this action sets the target layer in which your new features will be stored, activates a feature construction tool, and prepares to assign the default attributes to the feature you create. To reduce clutter, templates are hidden on the Create Features window when layers are not visible.

The top panel of the Create Features window shows the templates in the map, while the bottom panel of the window lists the tools available to create features of that type. The availability of the feature creation tools, or construction tools, depends on the type of template you have selected at the top of the window. For example, when a line template is active, you can see a set of tools for creating line features. If you choose an annotation template instead, the available tools change to those that can be used to create annotation.

Each template has a default construction tool, which you can set in the template's properties. Setting the default tool can help you avoid an extra click to choose a different tool to create new features. For example, when you are drawing rectangular building footprints, set that template's default construction tool to the Rectangle tool so that tool automatically becomes active when creating building footprints. You can always override the default tool and choose a different one in the Create Features window.

To create feature templates, open the Organize Feature Templates dialog box from the Create Features window and start the Create New Templates wizard. The wizard steps you through the quick process of making a template: first, you choose the layer or layers, then, if applicable, choose any or all classes within that layer to make into individual templates. Once the templates are created, you can change their default properties, copy and paste them, or delete them.
Templates are used anytime you are creating features. When creating features with an editing command, such as Buffer or Union, you choose a template on the dialog box that opens for those commands. If you are editing an existing feature, you do not need to specify a template.

Using snapping while editing

Snapping allows you to create features that connect to each other so that your edits are more accurate and have fewer errors. With snapping, your pointer will jump, or snap to, edges, vertices, and other geometric elements when it nears them. This enables you to position a feature easily in relation to the locations of other features. As you move your pointer around the map, it snaps automatically to points, endpoints, vertices, and edges. All the settings you need to work with snapping are located on the Snapping toolbar, including enabling and disabling snapping types and setting snapping options. The main snap types are buttons on the toolbar, but additional ones are available on the Snapping menu.

Creating points

Points are the simplest features to create. Simply click a point template in the Create Features window and the Point tool is automatically activated. Click the map where you want to add the point. You can right-click the map or use snapping to help you create points at exact locations.

Creating lines and polygons (segments)

To create segments in lines or polygons, you will most commonly use the Line tool (with line templates) and the Polygon tool (with polygon templates). While these tools are used with different template types, they behave similarly. To create segments, simply click the map where you want to place vertices.

You digitize a new line or polygon feature's shape by drawing an edit sketch, which is the underlying representation of the feature's geometry. As you sketch, you see a WYSIWYG preview with the actual symbology used for that template, with vertices symbolized as green and red squares.

A sketch is composed of all the vertices and segments of the feature. Vertices are the points at which the sketch changes direction, such as corners; segments are the lines that connect the vertices.

When you want to create features, you'll most commonly use the Create Features window's construction tools and the construction methods on the Editor toolbar. With those tools, for example, you can create lines, arcs, tangent curves, vertices at intersections or midpoints, vertices based on distances and directions from other features, or new segments by tracing along existing ones.

By default, the Line and Polygon tools create straight segments between the vertices you click. These tools have additional ways to define a feature's shape, such as creating curved lines or tracing existing features. These are construction methods, which are located on the Editor toolbar. To create a curved segment, click that construction type from the palette on the Editor toolbar and draw the curve on the map. You can even switch among construction types after each segment, allowing you to build the exact shape you want. For example, if you are drawing a road with a bend in it, you may want some of it to be straight and some to be curved. To do this, start with Straight Segment, digitize the straight segment, then click a curved segment construction method and create the curve.

Once you are satisfied with the shape of the sketch, you need to finish the sketch to complete the feature's geometry and actually create the feature with the attributes specified in the template. There are several ways that you can finish a sketch, including double-clicking with your mouse, choosing the command from...
Creating text features

You can store map text as annotation in a geodatabase. Annotation provides flexibility in the appearance and placement of your text because you can select individual pieces of text and edit them. Dimension features are a form of annotation designed to express distance measurements. Like other types of features, geodatabase annotation and dimension features are created inside an edit session, using feature templates and the tools on the Create Features window.

Some annotation feature classes, such as standard annotation, stand alone in the geodatabase. Standard annotation is not formally associated with features in the geodatabase. For example, you might have a piece of standard annotation that represents a mountain range, an ocean, or an administrative boundary—the
annotation simply marks the general area on the map.

Another kind of annotation, feature-linked annotation, is associated with the feature it is describing through a relationship class. The text reflects the value of a field or fields from the feature to which it is linked. You might use feature-linked annotation to identify features such as parcels, streets, rivers, roads, or cities. With feature-linked annotation, as you create parcels or street features, for example, using the editing tools in ArcMap, annotation is created automatically.

![Feature-linked annotation](image)

**Defining new types of features to create**

Sometimes you may want to create features of a certain type in an existing layer, but the layer is not set up to capture those features. For example, you want to add features to a roads layer to represent an unpaved road, but you currently only have categories in your data for freeway, major highway, and local road.

Through a wizard, you can define everything about the unpaved road category at one time—making it easy to prepare your data to display and store the new types of features. ArcMap automatically adds a symbol for the new category, any required geodatabase information (such as subtype value or coded domain value) for that layer, and a feature template to use when creating an unpaved road. The wizard saves you from having to stop your work to open multiple dialog boxes to set up the data on your own.

![Define New Feature Type](image)

**Editing attributes**

Attributes are descriptions of a geographic feature in a GIS, usually stored as a row in a table. For example, attributes of a river might include its name, length, and average depth. You can enter new attribute values when you create features, and you can edit existing values. When you create a feature, it starts with only the default attribute values as specified in the template used to create the feature.

![Template Properties showing the default attributes for a feature template. These values will be assigned to new features created with this template.](image)

You input attributes after you create a feature. There are two main ways of adding or updating attributes in ArcMap: the Attributes window and the table window.

The Attributes window displays attributes of selected features and allows you to edit the values. The top panel of the window shows the layer (by its display expression) to which the selected feature or features belong, while the bottom panel shows the attribute values of that feature—including any related or joined information. The properties and order of fields reflect the settings on the Fields tab of the Layer Properties. For example, if you turn off the visibility for a field, set a field alias name, or change how numbers display in a field, these changes will all be reflected in the Attributes window. You can also set a field to be read-only, which means that you can view but cannot edit that field, regardless of the file or database permissions.
You can also open a table window to see all the tabular information about a layer or table. To add or change a value in the table window, simply click a cell and type the new value. The table window also allows you to use the Field Calculator, which helps you to update multiple values in a particular field and to use advanced statements when editing field values. While you do not have to be in an edit session to calculate field values, an edit session is recommended because it allows you to undo your edits.

Editing existing features

Once you have created features, you can also edit their shapes with the tools on the Editor toolbar. For example, to split a polygon into two polygons, select the feature, click the Cut Polygons tool on the Editor toolbar, then draw a line where you want to split the feature. To draw in a new shape for a line or polygon, select it, click the Reshape Feature tool on the Editor toolbar, and sketch in how you want the feature to appear.

If you use the Edit tool to click a location on the map with overlapping features, a small icon pops up with a dialog box previewing the selectable features where you clicked so you can distinguish the correct feature from the overlapping ones.

To work with the individual vertices and segments of a feature, select the feature with the Edit tool and click the Edit Vertices button on the Editor toolbar, or simply double-click the feature with the Edit tool. You can select multiple vertices at once by dragging a box around them with the Edit tool, then move or delete them as needed. In addition, you can right-click a segment and change it to another type, such as making a straight segment into a curve. To reshape curves, drag the curve, set a specific radius, or reposition the Bézier handles. When you use a sketch to modify an existing feature, you complete the update by finishing the sketch.

The Edit Vertices toolbar provides quick access to some of the most commonly used commands when editing vertices. It appears on-screen whenever either the Edit tool or the Topology Edit tool is active and you are editing the vertices of a feature or topology edge. The toolbar floats the first time it appears but can be docked after that.

The Edit tool, Reshape Feature tool, and Edit Vertices command on the Editor toolbar only update a single, selected line or polygon. However, if you need to update the shapes of multiple features that share an edge, you can use the topology editing tools to do this. The Topology Edit tool, Reshape Edge tool, and Modify Edge command on the Topology toolbar update the shape of all features that share the selected edge or border, which makes them ideal for reshaping coincident features. For example, if you have a forest that shares its boundary with other kinds of forests, build either a map topology or a geodatabase topology on the data and you can modify the border of all features at the same time.
A quick tour of editing

The primary pieces of the editing user interface include the Editor toolbar and several windows and dialog boxes that are opened from it.

Editor toolbar

The Editor toolbar contains the various commands you will need to edit your data. From the Editor toolbar, you can start and stop an edit session, access a variety of tools and commands to create new features and modify existing ones, and save your edits. To edit data, you need to add the Editor toolbar to ArcMap by clicking the Editor Toolbar button on the Standard toolbar.

Create Features window

Anytime you create features on the map, you start with the Create Features window. Choosing a feature template on the Create Features window sets up the editing environment based on that feature template's properties; this action sets the target layer in which your new features will be stored, activates a feature construction tool, and prepares to assign the default attributes to the feature you create. To reduce clutter, templates are hidden on the Create Features window when layers are not visible.

The top panel of the Create Features window shows the templates in the map, while the bottom panel of the window lists the tools available to create features of that type. The availability of the feature creation tools, or construction tools, depends on the type of template you have selected at the top of the window. For example, when a line template is active, you can see a set of tools for creating line features. If you choose an annotation template instead, the available tools change to those that can be used to create annotation.

Template Properties dialog box

Feature templates define all the information required to create a new feature: the layer where a feature will be stored, the attributes a new feature will be created with, and the default tool used to create that feature. Templates also have a name, description, and tags that can help you find and organize them. You can specify and review these and other settings on the Template Properties dialog box.
Snapping toolbar

Snapping allows you to create features that connect to each other so that your edits are more accurate and have fewer errors. With snapping, your pointer will jump, or snap to, edges, vertices, and other geometric elements when it nears them. This enables you to position a feature easily in relation to the locations of other features. As you move your pointer around the map, it snaps automatically to points, endpoints, vertices, and edges. All the settings you need to work with snapping are located on the Snapping toolbar, including enabling and disabling snapping types and setting snapping options. The main snap types are buttons on the toolbar, but additional ones are available on the Snapping menu.

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Edit Sketch Properties window

Vertices can store additional attributes besides x,y locations. The attributes include m-values and z-values, which are often used to store information about route measures and elevation. These attributes are added and modified using the Edit Sketch Properties window. You can open the window by selecting a feature with the Edit tool, double-clicking it, then clicking the Sketch Properties button on the Editor toolbar.
Editing Options dialog box
You can set preferences for editing in ArcMap on the Editing Options dialog box, which is opened by clicking the Editor menu and clicking Options. For example, you can set the units and number of decimal places used for entering measurements, which symbols and toolbars are displayed while editing, and so on.

Related Topics
Essential editing vocabulary
Preparing a map for editing
What is editing?

Essential editing vocabulary
Below are some of the most common terms you will encounter when editing in ArcMap.

Edit session
Editing occurs in an edit session. During an edit session, you can create or modify vector features or tabular attribute information. When you want to edit, you need to start an edit session, which you end when you're done. Editing applies to a single workspace in a single ArcMap data frame, where a workspace is a geodatabase or a folder of shapefiles. If you have more than one data frame in your map, you can only edit the layers in one data frame—even if all data is in the same workspace. Although you can edit data in different coordinate systems, it is generally best if all the data you plan to edit together has the same coordinate system as the data frame.

There are two ways to start an edit session: by clicking the Editor menu on the Editor toolbar or by right-clicking a layer in the table of contents. If you use the Editor menu to start editing on a data frame that contains data from multiple workspaces, you are prompted to choose the workspace to edit. If you right-click a layer in the table of contents, you automatically start an edit session on the entire workspace containing that layer.

Feature template
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The terms "feature template" and "template" are used interchangeably in the Editing help.

Construction tool
The top panel of the Create Features window shows the templates in the map, while the bottom panel of the window lists the tools available to create features of that type. The availability of the feature creation tools, or construction tools, depends on the type of template you have selected at the top of the window. For example, when a line template is active, you can see a set of tools for creating line features. If you choose an annotation template instead, the available tools change to those that can be used to create annotation.
Construction method
By default, the Line and Polygon tools create straight segments between the vertices you click. These tools have additional ways to define a feature's shape, such as creating curved lines or tracing existing features. These are construction methods, which are located on the Editor toolbar. To create a curved segment, click that construction type from the palette on the Editor toolbar and draw the curve on the map. You can even switch among construction types after each segment, allowing you to build the exact shape you want. For example, if you are drawing a road with a bend in it, you may want some of it to be straight and some to be curved. To do this, start with Straight Segment, digitize the straight segment, then click a curved segment construction method and create the curve.

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You digitize a new line or polygon feature's shape by drawing an edit sketch, which is the underlying representation of the feature's geometry. As you sketch, you see a WYSIWYG preview with the actual symbology used for that template, with vertices symbolized as green and red squares. A sketch is composed of all the vertices and segments of the feature. Vertices are the points at which the sketch changes direction, such as corners; segments are the lines that connect the vertices.

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Snapping allows you to create features that connect to each other so that your edits are more accurate and have fewer errors. With snapping, your pointer will jump, or snap to, edges, vertices, and other geometric elements when it nears them. This enables you to position a feature easily in relation to the locations of other features. As you move your pointer around the map, it snaps automatically to points, endpoints, vertices, and edges. All the settings you need to work with snapping are located on the Snapping toolbar, including enabling and disabling snapping types and setting snapping options. The main snap types are buttons on the toolbar, but additional ones are available on the Snapping menu.

SnapTip
A SnapTip is a small piece of text that pops up to indicate the layer you are snapped to and with which snap type (edge, end, vertex, and so on). You can set the text symbol (font, color, size, and so on) for SnapTips and whether the text includes the layer name, snap agent type, or both.

Snapping tolerance
The snapping tolerance is the distance within which the pointer or a feature snaps to another location. If the element being snapped to—such as a vertex or edge—is within the distance you set, the pointer automatically snaps to the location. You set the default snap tolerance value in pixels.

Related Topics
A quick tour of editing
Preparing a map for editing
What is editing?

Preparing a map for editing
When you are building a map to edit, there are several items to consider that will make your editing experience easier and more successful.

Preparing the layers
All the layers you want to edit together should be in the same workspace, where a workspace is a single geodatabase or a folder of shapefiles. If the feature classes are not stored together, you will not be able to edit them at the same time. When you add the layers to the map, all the layers you want to edit together should be within the same data frame, since editing only occurs in one data frame at a time.

The coordinate systems of all the layers should match each other and should match the coordinate system of the data frame. If layers are being projected on should be within the same data frame, since editing only occurs in one data frame at a time. If the feature classes are not stored together, you will not be able to edit them at the same time. When you add the layers to the map, all the layers you want to edit together should be within the same data frame, since editing only occurs in one data frame at a time.

A data frame maintains its own x,y tolerance, resolution, and domain values, which are taken from the first layer added to the map. Certain edits may fail, or features may collapse unexpectedly, because of the differences in these values between the data frame and the layers you are editing. The map tolerance is not exposed in the user interface, but you can reset the spatial reference properties of the data frame to match those of a particular layer. When you do this, the data frame takes on the coordinate system of the layer as well as the other properties.

Name your layers clearly and accurately, since feature templates are grouped under the layer name by default. You can rename a layer in the table of contents.

Preparing the symbology
You should symbolize your layers as you want them before you start editing for the first time on a map (a time when feature templates are created automatically for you), or when you go to create feature templates yourself. If you change the symbology often, you may end up with templates that no longer reflect the features you want to create. In that case, simply delete the templates and re-create them.

Prior to starting editing for the first time or creating feature templates, you should look on the Layer Properties dialog box > Symbology tab to make sure the labels for your symbols are meaningful, as the symbol labels become the names for the feature templates. If you edit the symbol labels first, it reduces the amount of cleanup you need to do on your templates after they are created and helps other editors understand which features they are creating.

For example, you have a layer of land uses with symbol categories taken from the raw attributes of AGR, COM, IND, RES, and UNK, which are shortened versions of various types of land uses. By default, these are also the symbol labels, and therefore, the feature template names. To help clarify the feature template names, you should enter better label names for the symbol, such as Agricultural, Commercial, Industrial, Residential, and Unknown. The symbol labels are also used in the entries in the table of contents and the map layout legend, so there are additional reasons to do this.

The symbols on the Symbology tab on the Layer Properties dialog box
Creating your own new feature templates

Cases wherein ArcMap creates feature templates automatically

Authoring feature templates

Simplifying the attribute fields

Effective use of feature templates can make your editing experience more productive. Feature templates define all the information required to create a feature: the layer where a feature will be stored, the attributes a feature is created with, and the default tool used to create that feature. Feature templates also have a name, description, and tags that can help you find and organize them. When creating new features, you should ensure that you have set the appropriate properties for your feature templates.

Cases wherein ArcMap creates feature templates automatically

When you start editing either a saved map document or a brand new map, ArcMap checks to see if you have any existing feature templates in the map. If no templates are found, ArcMap automatically creates them to help you get started adding features. If you have layers from several different geodatabases or folders of shapefiles in a data frame or multiple data frames in a map document, ArcMap creates templates the first time you start editing in each workspace or data frame if there are no existing templates.

When templates are created automatically, they are generally created for all types of symbology. However, templates work best when creating features symbolized by categories, as a single symbol, or by representations, rather than with quantities or charts.

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Creating your own new feature templates

To create feature templates, open the Organize Feature Templates dialog box from the Create Features window and start the Create New Templates wizard. The wizard steps you through the quick process of making a template: first, you choose the layer or layers, then, if applicable, choose any or all classes within that layer to make into individual templates. Once the templates are created, you can change their default properties, copy and paste them, or delete them.

You can make a copy of an existing template to use as the basis of a new template. For example, if you want a different default attribute for one of the fields in the layer, copy and paste the template, then change the new template’s properties. This saves you from going through the wizard to make just a slight change to a template.
If you add a layer to your map, significantly change the symbology used to draw the features, or add a symbology category (such as for a layer drawn with unique values), you need to create new templates to be able to add features in that layer.

Setting feature template properties

The default attribute values are some of the most important properties you can set for a feature template. The attributes set on the Template Properties dialog box are assigned to new features created with that feature template. Setting the appropriate default values saves you time and improves accuracy, since the attributes are populated automatically in the new features.

Each template has a default construction tool, which you can set in the template’s properties. Setting the default tool can help you avoid an extra click to choose a different tool to create new features. For example, when you are drawing rectangular building footprints, set that template’s default construction tool to the Rectangle tool so that tool automatically becomes active when creating building footprints. You can always override the default tool and choose a different one in the Create Features window.

You can create multiple templates for a layer even if you are symbolizing with a single symbol. You might do this when you have a layer that should all be displayed the same way but the features you want to create have different attribute values. For example, if you are creating lines to represent pipeline features, you could create several feature templates with different default attributes for the common types of material or diameter sizes.

Managing feature templates

The Organize Feature Templates dialog box allows you to author and manage the templates in your map, such as by creating, deleting, copying, and renaming templates and setting template properties.

If you had many layers that you will never edit in your map the first time you started editing (so templates were created automatically), you can delete the templates you are not using. For example, if you have 10 layers in your map but are only creating new features in two of them, delete the other templates so it makes it easier for you to find the templates you need.

If you have changed the rendering of several layers since the templates were initially created, it may be best just to delete all your templates and start again so the templates are synchronized better with your current symbology. Once you delete them, simply start the Create New Templates wizard and make templates for only the layers in which you want to create features.

A better practice, however, is to spend some time preparing the map and its symbology prior to actually starting editing and creating templates.

Creating maps to share with other editors

If you are creating a map that other editors will use, you should ensure that all the elements necessary to create features are easy to understand by all the editors. This involves clearly naming layers and symbol labels, since these are used to identify the feature templates in the Create Features window. This also applies when you are serving the map through ArcGIS Server, as editors who edit the contents of the map through the Web or by downloading the data locally also receive the feature templates from the map.

General recommendations for ArcMap

Any suggestions that improve performance when working in ArcMap in general can also help when editing. For example, set visible scale ranges on your layers so they will display only at the appropriate map scales. Use simple symbology when you can, such as the symbols from the ESRI_Optimized style that look similar to default ESRI symbols but are designed to perform better.

Utilizing ArcGIS basemap layers is another way to improve display performance. This layer type provides optimized display logic that provides fast map navigation and screen refresh. As the name implies, you could consider creating a basemap layer from any layers that would normally be a basemap in your map—terrain, imagery, or static parcel features. To create a basemap layer, right-click the data frame name in the table of contents, click New Basemap Layer, then drag your layers into the basemap layer in the table of contents.

In terms of the data sources, access data locally or use the feature cache when working with features across the network. Consider using file geodatabases rather than shapefiles or personal geodatabases, since file geodatabases are faster (in addition to the format’s other benefits).

Related Topics

A quick tour of editing
Best practices for using feature templates
Essential editing vocabulary
What is editing?

Ways to enhance productivity while editing

Many editing operations can be made more efficient and accurate using some of the functions in the editing environment.

Snapping

Snapping is one of the easiest ways to more accurately position new vertices and segments, as well as when you’re moving features. Snapping can help establish exact locations in relation to other features. When snapping is turned on, your pointer will jump, or snap to, edges and vertices when your pointer is near them. This means the pointer is within the snapping tolerance. Snapping can help you with many editing operations; for example, creating polygons that do not overlap or have gaps between them or placing a point exactly along an existing line.
Mini toolbars

The Feature Construction and Edit Vertices mini toolbars provide quick access to some of the most commonly used commands when editing.

The Feature Construction toolbar appears near your pointer when you are digitizing segments once you have placed the first vertex in a sketch. The toolbar is semitransparent so you can see the map under it, although it becomes opaque when you rest your pointer over the toolbar.

The Edit Vertices toolbar appears on-screen whenever either the Edit tool or the Topology Edit tool are active and you are editing the vertices of a feature or topology edge. It contains tools for selecting vertices, adding and deleting them, and working with an edit sketch.

Shortcut menus and keyboard shortcuts

The shortcut (context) menus for many tools, especially the feature construction tools, provide commands that help you place vertices and segments more easily and accurately. You open a shortcut menu by right-clicking the map with a particular tool.

Many editing functions have keyboard shortcuts associated with them, including those on the shortcut menus. If you learn some of the most common shortcuts, you can minimize the use of your mouse and speed up your edits. For example, with a construction tool active, you can press the F6 key to quickly enter the coordinate location of the point or vertex you want to place. You can also switch to a different editing tool or quickly change to a navigation tool to zoom or pan the map by pressing different keys.

Entering measurements in units different from the map units

Sometimes you might need to enter lengths or other measurements in units different from your map units. In many dialog boxes throughout the editing environment that require you to enter a distance value, you can specify values in different units of measure by simply typing a unit abbreviation after the number. For example, if your map units are feet, by default, ArcMap will assume any distance values you enter are in feet. However, you can simply add m after your input value so ArcMap knows the value you entered is actually in meters.

Distance unit abbreviations only work when your data frame uses a projected coordinate system rather than a geographic coordinate system.

Caching data for better performance

When you are editing data in a geodatabase, especially an ArcSDE geodatabase, you might want to turn on the feature cache, which allows temporary storage of geodatabase features from a given map extent in the desktop computer's memory. Building a feature cache can reduce the load on your network and the geodatabase since ArcMap accesses this information from your computer's RAM, reducing the number of queries the client needs to execute on the server.

Opening additional windows

You can also use additional windows in ArcMap—magnifier, overview, and viewer windows—to get different views of your data, which can help when editing. You can get a closer view of a small area without changing the map extent (magnifier window), see the full extent of your map (overview window), or get an independent view onto the map (viewer window). For example, a magnifier window can be turned on before or during the creation of new features and modification of existing features. You can click the heading of the magnifier window and drag it while holding on to the same sketch or modification already in progress. Viewer windows can be used on computers with dual monitors, so you can open and maximize the viewer window on the second monitor to provide a large-scale view of the area currently being edited. Editing can be performed in both displays and graphic feedback shown while your edits appear simultaneously on both displays.

Related Topics

Keyboard shortcuts that can be used while editing

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Keyboard shortcuts that can be used while editing

You can use keyboard shortcuts to perform certain functions from within the editing environment. The following sections list the shortcuts available for each editing tool and which functions they perform from within that tool.
There are two ways to start an edit session: by clicking the Editor menu on the Editor toolbar or by right-clicking a layer in the table of contents. If you use the Editor menu to start editing on a data frame that contains data from multiple workspaces, you are prompted to choose the workspace to edit. If you right-click a layer in the table of contents, you automatically start an edit session on the entire workspace containing that layer. Edits are temporary until you choose to save and apply them permanently to your data. You can also quit an edit session without saving your changes. Just saving a map document does not save the edits to the features—you need to specifically save the edits in your edit session. When you save edits, you write them to the data source, or a database.

Errors you might receive when you start editing

When ArcMap encounters problems starting an edit session on the data you chose, a dialog box appears providing additional information. You can receive errors, warnings, or information messages.

- **Errors** prohibit you from starting an edit session. You are unable to edit any data until you resolve the issue. You can receive an error message if you have no data sources that are editable, there is a licensing issue (such as attempting to edit certain types of geodatabase features while using ArcView), or you have certain layers inside a basemap layer.
- **Warnings** allow you to start an edit session but prohibit you from editing certain items in the map. You need to resolve the issue with that particular layer or table before you can edit it.
- **Information messages** provide additional suggestions to improve performance when editing. You are not required to correct the issue to edit that layer or table, but it is recommended that you do so. For example, if the data you chose to edit is in a different coordinate system than the data frame, an information message appears informing you of this. You can edit data that is in a different coordinate system than the data frame in which it is displayed. However, some editing tasks may give you unexpected alignment or accuracy problems.

If you are using an ArcView license of ArcGIS, you can edit any data that was created using ArcView in a file or personal geodatabase. However, you cannot edit data from connections to ArcSDE geodatabases, feature classes that participate in geometric networks or geodatabase topologies, feature-linked annotation, relationship classes, dimension feature classes, or parcel fabric layers. If you need to create or edit these types of data, you should upgrade your ArcGIS license to ArcEditor or ArcInfo.

Caution: A shapefile supports one person editing it, but many people can read it at the same time. Attempting multiuser editing of a shapefile may cause data corruption.

Related Topics

- Starting an edit session (Start Editing)
- Stopping an edit session (Stop Editing)

Starting an edit session (Start Editing)

There are two ways to start an edit session: by clicking the Editor menu on the Editor toolbar or by right-clicking a layer in the table of contents. When you use the Editor menu to start editing and have multiple workspaces in the map, you need to choose the one you want to edit. The dialog box that appears lists the layers in the map and the workspaces they are from and provides information on which other layers are also part of that workspace.

Another way of starting editing is to right-click a layer in the table of contents, point to Edit Features, then click Start Editing. This starts an edit session on the workspace containing that layer. For example, if you right-click a layer from a geodatabase and start editing it, you are able to edit all the other layers from that same geodatabase.

**Steps:**

1. Click the Editor menu on the Editor toolbar and click **Start Editing**.
2. If your map contains editable data from more than one geodatabase or folder, choose the workspace that you want to edit and click **OK**. The top of the window shows a list of editable layers in the active data frame, and the bottom of the window shows the workspaces containing those layers. Only layers that can be edited are listed.
   - Click a layer to view its data source at the bottom of the window. When you click a layer at the top, any other layers in that workspace are also highlighted (the database symbols change color).
   - Click a data source at the bottom of the window to view the layers in that data source. If you click a data source at the bottom of the window but no layers are listed, this means there are no editable layers in that data source.

Related Topics

- About edit sessions
- Stopping an edit session (Stop Editing)

Stopping an edit session (Stop Editing)

When you end an edit session, you can save any changes you have made back to the data source, or you can quit editing without saving.
Warning: Not licensed to edit geometric networks

This layer participates in a geodatabase geometric network and cannot be edited with an ArcView license.  
**Solution:** Upgrade your license to ArcEditor or ArcInfo.

Warning: Not licensed to edit this data

This layer or table requires additional ArcGIS licensing to edit.  
**Solution:** Upgrade your ArcGIS license or install and register an extension product.  
**More information:** In some cases, this message is displayed in conjunction with a more specific licensing warning, such as not being able to edit topology, dimensions, or geometric networks. You also can receive this error if you attempt to edit data in an ArcSDE geodatabase when using an ArcView license since you need an ArcEditor or ArcInfo license to edit data in ArcSDE.

Information: Spatial reference does not match data frame

The spatial reference of the layer does not match the projection of the data frame.  
**Solution:** Ensure that the projection information of the layer matches the other layers and the data frame. This may mean that you need to reproject a layer to match the data frame or change the projection of the data frame to match the layer.  
**More information:** This warning occurs whenever the data frame's projection is different from the layers in the map. You often see it when you have added layers from multiple workspaces, as the data frame takes on the spatial reference of the first layer added to the map. You may not be aware that some data is being projected on the fly until you see this warning.  
While you can still edit the layers in the map, be aware that you may create or modify data that is inaccurate once saved. For examples of the effects of editing while projecting on the fly, see About editing data in a different projection (projecting on the fly).

Information: Layer has time enabled. Time will be disabled on the map.

Time will be disabled for the map when you are editing.  
**Solution:** After you stop editing, you can enable time again.  
**More information:** When time is enabled, you may only see a subset of features in a layer. However, when editing, all features will be shown on the map since time is disabled. You need to be aware of the temporal context of your edits to avoid introducing inaccuracies and inadvertently editing features that exist in different time periods.  
You can update the time properties for a layer while time is disabled on the map, but the changes will not take effect until you stop editing and enable time on the map.

About distance units and editing

When editing, the map units of your data frame are used when reporting and entering measurements and distances. The map units are the units in which the spatial data in the data frame is drawn. The map units are determined by the coordinate system of the data frame. When editing, all the values you enter will be in map units by default. You can find out the map units used by your coordinate system on the Data Frame Properties dialog box > General tab.  
Sometimes when creating features, you need to enter values that were recorded in different distance units than the coordinate system of your data. When you input measurements, in many cases it is possible to enter values in units other than map units by specifying a units abbreviation with the value.  
For example, suppose your data is in a State Plane coordinate system and the linear units are U.S. survey feet. You are given measurements in meters. Rather than convert all the measurements to U.S. survey feet, you can type the abbreviation for meters, m, after the measurements, and the tools will convert the distance correctly.  
Whenever you are typing a distance into one of the editing tools, you have the option to specify the linear units or simply type a number, which the tool will interpret as being in map units. Unit abbreviations only work when your data frame uses a projected coordinate system rather than a geographic coordinate system.  
The following sections outline all the unit abbreviations supported when editing and describe how to implement them.

### Metric units

<table>
<thead>
<tr>
<th>Distance units</th>
<th>Abbreviation</th>
<th>Meters per unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilometer</td>
<td>km</td>
<td>1,000</td>
<td>1,000 meters exactly</td>
</tr>
<tr>
<td>Meter</td>
<td>m</td>
<td>1</td>
<td>International meter</td>
</tr>
</tbody>
</table>
Metric units

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
<th>Meters per unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centimeter</td>
<td>cm</td>
<td>.01</td>
<td>1/100 meters exactly</td>
</tr>
<tr>
<td>Millimeter</td>
<td>mm</td>
<td>0.001</td>
<td>1/1000 meters exactly</td>
</tr>
</tbody>
</table>

**Imperial or international units**

<table>
<thead>
<tr>
<th>Distance units</th>
<th>Abbreviation</th>
<th>Meters per unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot</td>
<td>ft</td>
<td>0.3048</td>
<td>Standard foot used in the United States. Also known as international foot or imperial foot that was used in most non-U.S. countries before the metric system.</td>
</tr>
<tr>
<td>Mile</td>
<td>mi</td>
<td>1,609.344</td>
<td>Also referred to as a statute mile, equal to 5,280 international feet.</td>
</tr>
<tr>
<td>Nautical mile</td>
<td>nm</td>
<td>1,852</td>
<td>The nautical mile is a unit of distance used primarily in sea travel and aviation. The nautical mile is defined as the average distance on the earth's surface represented by one minute of latitude. In 1929, the nautical mile was defined as exactly 1,852 meters, or 6,076.11549 feet, a distance known as the international nautical mile.</td>
</tr>
<tr>
<td>Chain</td>
<td>ch</td>
<td>20.1168</td>
<td>66 international feet.</td>
</tr>
<tr>
<td>Yard</td>
<td>yd</td>
<td>0.9144</td>
<td>3 international feet.</td>
</tr>
<tr>
<td>Rod</td>
<td>rd</td>
<td>5.0292</td>
<td>1/4 chain, or 16.5 international feet.</td>
</tr>
<tr>
<td>Link</td>
<td>lk</td>
<td>0.201168</td>
<td>1/100 international chain, or 66/100 international feet.</td>
</tr>
</tbody>
</table>

| Inch           | in           | 0.0254          | 1/12 international feet. |

**U.S. survey units**

<table>
<thead>
<tr>
<th>Distance units</th>
<th>Abbreviation</th>
<th>Meters per unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey foot</td>
<td>ftUS</td>
<td>0.3048006096</td>
<td>The U.S. survey foot is used in the state plane coordinate systems. In the United States, fundamental survey units, such as rods, chains, statute miles, acres, sections, and townships, all depend on the U.S. survey foot. An exact conversion to meters can be accomplished by multiplying U.S. survey feet by the fraction 1,200/3,937.</td>
</tr>
<tr>
<td>Survey mile</td>
<td>miUS</td>
<td>1,609.3472186944</td>
<td>5,280 survey feet.</td>
</tr>
<tr>
<td>Survey chain</td>
<td>chUS</td>
<td>20.1168402337</td>
<td>66 survey feet.</td>
</tr>
<tr>
<td>Survey rod</td>
<td>rdUS</td>
<td>5.0292100584</td>
<td>1/4 survey chain.</td>
</tr>
<tr>
<td>Survey link</td>
<td>lkUS</td>
<td>0.2011684023</td>
<td>1/100 survey chain.</td>
</tr>
<tr>
<td>Survey yard</td>
<td>ydUS</td>
<td>0.9144018288</td>
<td>3 survey feet.</td>
</tr>
</tbody>
</table>

**Entering specific locations (DD, DMS, DDM, MGRS, USNG, and UTM)**

In commands that require you to enter a specific location when editing, you can specify the location as a longitude-latitude coordinate pair, a Military Grid Reference System (MGRS) grid location, a U.S. National Grid (USNG) location, or a Universal Transverse Mercator (UTM) coordinate. Map units are the default, but you can click the Units button to choose the units in which to enter coordinates.

These are the same formats used by the Go To XY command. Below are some guidelines for specifying these values. These apply to Absolute XY and commands such as Move To that allows you to move a vertex or topology element to an exact location.

- Remember that x is longitude (East/West), and y is latitude (North/South)—the same order in which coordinates are listed in the status bar. Spherical coordinates aren't always specified in this order, so make sure you enter longitude first in this dialog box. For example, if someone asks you to plot 17.1325, -60.666 on the map, ask them if these coordinates are in longitude-latitude or latitude-longitude order. The only way to tell the order from the coordinates themselves is if they contain E, W, N, S characters to signify the hemisphere.
- When you are using decimal degrees (DD), degrees minutes seconds (DMS), or degrees decimal minutes (DM), coordinates can be entered by using a minus sign before the numeric value to signify the western or southern quadrants or using E, W, N, S characters before or after the numeric values.
- Values in DMS and DM coordinates can be separated with spaces or the °, ′, ″ special characters (such as when you paste coordinates that you have copied from other dialog boxes or applications that use those characters) or both.
- Regardless of whether you are using DD, DMS, or DM in the dialog box, coordinates can be entered in any of these three longitude-latitude formats and are automatically converted to match your chosen format.
- When you are using DD and DM, coordinates you input are always converted to use a minus sign to signify W or S.
- When you are using DMS, coordinates you input are always converted to use E, W, N, S to signify quadrants and are given the °, ′, ″ special characters.
- When using MGRS, USNG, or UTM locations, make sure there are no spaces in the coordinate string.

**Valid longitude-latitude inputs**

-45 45
45 W 45 S
45.50W 45.50S
W45 545
45 30.5W 44 30.5S
45° 30′30″W 45°30′30″N
45 30 W 45 30 30 N
-45 30 30 45 30 30
45 30.50W 45 30.50
-45.50833 45.50833

**Valid MGRS and USNG inputs**
Conversion constants

You can use conversion constants to convert from one measurement system to another. The measurement system to be converted should be multiplied by the associated conversion constant. For example, to convert feet to centimeters, multiply feet by the conversion constant of 30.48 (27 feet \( \times \) 30.48 = 822.96 centimeters). For a list, refer to the PDF of conversion constants.

If this link does not work, you can open the conversion_constants.pdf from the \Documentation folder in the directory where you installed ArcGIS. To view this document, you need a copy of Adobe Reader.

About the U.S. survey foot

In 1959, the directors of the National Bureau of Standards and the United States Coast and Geodetic Survey agreed on a redefinition of the inch-centimeter relationship. This redefinition defined 1 inch as equal to 2.54 centimeters exactly, or 1 foot as equal to 0.3048 meters exactly. However, their agreement stipulated that the older value for 1 meter equaling 39.37 inches exactly be retained for identifying the U.S. survey foot.

One of the reasons for this retention was that the state plane coordinate systems, which are derived from the national geodetic control network, are based on the relationship of 1 meter equaling 39.37 inches exactly.

The difference between these two values for the foot is very small, two parts per million, which is hardly measurable, but not trivial when computational consistency is desired. Fundamental survey units, such as rods, chains, statute miles, acres, sections, and townships, all depend on the relationship of 1 meter equaling 39.37 inches exactly.

The U.S. survey foot table represents the corrected values (or U.S. survey values), using the 39.37-inch conversion value.

Related Topics

About direction measuring systems and units
Setting the direction type and units used when editing
Setting the number of decimal places displayed for measurements

About direction measuring systems and units

Some editing tools allow you to enter an angle, direction, or deflection when creating features. You can change the direction measuring system and units these tools use on the Units tab of the Editing Options dialog box. When you change the direction measuring system and units, the editing tools will all recognize inputs in the new system and units.

Sometimes when creating features using the coordinate geometry tools in ArcMap, you need to convert angles and distances measured in the field so they match the coordinate system of your data. This is known as a ground to grid correction. To learn more, see Applying a ground to grid correction.

Direction measuring systems

You can choose from the following direction measuring systems: north azimuth, south azimuth, quadrant bearing, and polar. By default, the tools accept angular measurements in the polar direction measuring system.

- Polar angles are measured counterclockwise from the positive x-axis.

- In the north azimuth system, the azimuth of a line is the horizontal angle measured from a meridian to the line, measured in the clockwise direction from north.

- In the south azimuth system, the angles are measured clockwise from south.
In the quadrant bearing system, the bearing of a line is measured as an angle from the reference meridian, either the north or the south, toward the east or the west. Bearings in the quadrant bearing system are written as a meridian, an angle, and a direction. For example, a bearing of N 25 W defines an angle 25 degrees west measured from north. A bearing of S 18 E defines an angle 18 degrees east measured from the south.

There are three valid input formats for quadrant bearing measurements:
- [NS] dd.dddd [EW], where the first letter is an N or S, indicating the meridian of origin, and the last letter is an E or W, indicating the direction of the angle.
- [NS] dd-mm-ss [EW], where the first letter is an N or S, indicating the meridian of origin; the string dd-mm-ss indicates whole degrees, minutes, and seconds with hyphen separators; and the last letter is an E or W, indicating the direction of the angle. Note that this option requires you to set the angular units to quadrant bearing direction type and degrees/minutes/seconds direction units.
- dd.dddd-[1234], where the second-to-last character is a hyphen (-) and the last digit indicates the quadrant in which the bearing is. The quadrants are numbered 1—NE, 2—SE, 3—SW, 4—NW.

Direction measuring units
The editing tools use decimal degrees as their default units of angular measure. You can choose from the following direction measurement units: decimal degrees, degrees/minutes/seconds, radians, gradians, and gons.
- Degrees are the standard unit of angular measurement, where one degree represents 1/360 of a circle and fractions of a degree are represented as decimal values.
- Degrees/Minutes/Seconds also use the degree, but fractions of a degree are represented in minutes and seconds, where one minute equals 1/60 of a degree and one second equals 1/60 of a minute. Valid input formats for degrees/minutes/seconds values include these:
  - dd-mm-ss
  - dd.mmssss
  - dd^mm'ss.ss"
- Radians are the International System of Units (SI) unit of plane angular measure. There are 2pi, approximately 6.28318, radians in a circle. One radian is equivalent to approximately 57.296 degrees. The length of a circular arc with an angle of one radian is equal to the radius of the arc.
- Gradians are a unit of angular measure where the right angle is divided into 100 parts. One gradian equals 1/400 of a circle.
- Gons are the same as gradians. One gon equals 1/400 of a circle. The term gon is primarily used in German, Swedish, and other northern European languages where the word grad means degree.

Setting the ground to grid correction
When you read the COGO descriptions for boundaries on a survey plan or other legal document, the directions and distances are measured on the surface of the earth. These are referred to as ground measurements. However, the directions and distances in your GIS data are based on the spatial data's coordinate system, or the grid measurements.

Ground and grid measurements are often different. You set constants (the ground to grid correction) for directions and distances so that the software can correctly convert between the ground and grid measurements.

For details, see Applying a ground to grid correction.

Related Topics
About distance units and editing
Setting the direction type and units used when editing
Setting the number of decimal places displayed for measurements

Setting the direction type and units used when editing

You can change the direction measuring system and angular units the editing tools use on the Units tab of the Editing Options dialog box.

Steps:
1. Click the Editor menu and click Options.
2. Click the Units tab.
3. Click the Direction Type drop-down arrow and choose a direction measuring system.
4. Click the Direction Units drop-down arrow and click the type of direction measurement unit you want to use.
5. Type the number of decimal places used when displaying angles.
6. Click OK.

Related Topics
About direction measuring systems and units
About distance units and editing
Setting the number of decimal places displayed for measurements

Setting the number of decimal places displayed for measurements
By default, ArcMap displays measurements and other numbers with three decimal places while editing. These measurements include the values reported when you are creating new features, such as the distance between two vertices or the current coordinate location of the pointer, and the values shown on the Edit Sketch Properties window.

**Note:** The number formatting settings on the **Fields** tab of the Layer Properties dialog box are used when displaying numeric values on the Attributes window and the table window.

**Steps:**
1. Click the **Editor** menu and click **Options**.
2. Click the **General** tab.
3. Type the number of decimal places you want to use.
4. Click **OK**.

**Related Topics**
- About direction measuring systems and units
- About distance units and editing
- Setting the direction type and units used when editing

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**Common errors that may occur during editing**

Following are some common errors that may occur during editing.

**Errors that may occur when you start editing**

When ArcMap encounters problems starting an edit session on the data you chose, a dialog box appears providing additional information. You can receive errors, warnings, or information messages.

- **Errors** prohibit you from starting an edit session. You are unable to edit any data until you resolve the issue. You can receive an error message if you have no data sources that are editable, there is a licensing issue (such as attempting to edit certain types of geodatabase features while using ArcView), or you have certain layers inside a basemap layer.

- **Warnings** allow you to start an edit session but prohibit you from editing certain items in the map. You need to resolve the issue with that particular layer or table before you can edit it.

- Information messages provide additional suggestions to improve performance when editing. You are not required to correct the issue to edit that layer or table, but it is recommended that you do so. For example, if the data you chose to edit is in a different coordinate system than the data frame, an information message appears informing you of this. You can edit data that is in a different coordinate system than the data frame in which it is displayed. However, some editing tasks may give you unexpected alignment or accuracy problems.

**Coordinates or measures are out of bounds**

This error occurs when a coordinate of a feature is beyond the extent of the feature class domain. It can happen when you are creating a new feature or editing the coordinates of an existing one.

Coordinates must fall within the range of the feature class x,y domain, as well as z- or m-domain, if the feature class can store those values. The domain is set when the feature class is created and cannot be edited later. If you need to create a new feature at that x,y location or with those z- or m-values, export the feature class to a new feature class and increase the domain values.

**The spatial index grid size is invalid**

The spatial index is used to improve performance when working with data in file geodatabases or ArcSDE geodatabases. If you attempt to perform an edit that will result in the new feature being spread across too many spatial index grids, a message appears indicating the spatial index grid size is invalid, and your edit fails. You are most likely to see this if you attempt to create a feature that greatly differs in size from the features that are already in the feature class. If you need to create a very large feature, for example, you should either delete the spatial index altogether or increase the grid size and number of grids. You can add the grid back when you are done editing.

Some examples where you might encounter this error when editing include digitizing a large feature; merging or unioning features across a large area; scaling a feature; editing, reshaping, or moving vertices so that a feature increases in size; or buffering with a large offset.

**When the software crashes**

You should save your edits periodically so they can be recovered in case a software error occurs. To prevent crashes, ensure that you have installed the latest ArcGIS service packs and patches and that any add-ons or extensions are compatible. In addition, when editing, you may want to run the Check Geometry and Repair Geometry tools to find and fix any data problems that could cause software issues.

If ArcGIS exits unexpectedly, send the automatic error report to ESRI and consider contacting ESRI Support Services with your data and the steps you performed immediately prior to the crash.

For additional information on how to resolve software crashes, see Knowledge Base article 32797: *ArcMap.exe has encountered an error and needs to close. We apologize for the inconvenience*.

**Related Topics**
- About edit sessions
- Starting an edit session (Start Editing)

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**How to enable editing tools and commands**
To enable editing tools and commands, you must be in an edit session, with editable feature layers, and have the data frame active that contains the edit session. When working with the topology tools, you need to have either a map topology or a geodatabase topology in the map.

Once you are in an edit session, the primary editing tools on the Editor toolbar are generally enabled. If a tool cannot be used because certain criteria are not met, a message appears and provides information about the tool's requirements and intended usage. This makes it easier for you to remedy the situation and be able to use the tool successfully.

Some of the common conditions required by tools include these:

- Having an appropriate current selection
- Having the correct feature template when creating new features

**Required selections**

Most tools require a single feature of a certain geometry type to be selected, although some need two or more features. If you attempt to use a tool and do not have the proper selection, the active tool automatically switches to the tool you need to use to make the selection. For example, the Reshape Feature tool requires a single line or polygon to be selected. Without a feature selected (or when more than one is selected), the Edit tool is activated as soon as you close the error message box, allowing you to make the proper selection.

Similarly, the tools on the Topology toolbar generally require a single topology edge to be selected with the Topology Edit tool. For example, when using Reshape Edge without a topology edge selected, the Topology Edit tool is activated.

Following are some examples of required selections for the more common editing tools and menu commands:

<table>
<thead>
<tr>
<th>Required selection</th>
<th>Example tool or command name</th>
</tr>
</thead>
<tbody>
<tr>
<td>One line feature</td>
<td>Split tool, Split command, Copy Parallel (requires one or more lines)</td>
</tr>
<tr>
<td>One polygon feature</td>
<td>Clip, Cut Polygons (requires one or more polygons)</td>
</tr>
<tr>
<td>One line or one polygon</td>
<td>Reshape Feature</td>
</tr>
<tr>
<td>One feature</td>
<td>Edit Vertices</td>
</tr>
<tr>
<td>One geodatabase annotation feature</td>
<td>Many commands on the Edit Annotation tool shortcut menu that appears when you right-click</td>
</tr>
<tr>
<td>Two features of the same geometry type</td>
<td>Merge (requires features be from the same layer), Union</td>
</tr>
</tbody>
</table>

Other buttons on the Editor toolbar are always enabled and open new windows when you click them, but the content of the window is blank until certain conditions are met. The Attributes window requires you to select one or more features from an editable layer, and Edit Sketch Properties requires that you are editing the geometry of a feature (double-click it with the Edit tool). The Create Features window contains separate buttons allowing you to add feature templates to the window. However, feature templates are hidden for layers that are turned off and for layers or feature templates that have been filtered from view, so check those settings before going to create new feature templates.

**Required feature templates**

Feature templates are used when creating new features. Having the required feature template in the map generally is prompted by an editing command, such as Union or Buffer, that outputs new features.

If you have no templates at all for any of the layers in your map, you can choose from a list of available layers in which to create the new features. However, if you have templates for only certain layer types, a message appears if you attempt to use a command that requires templates for a different type. For example, when using Copy Parallel, if you have a template in the map for a polygon but no line templates, a message tells you to create line templates to use the command.

**Editing features that have z-values**

A z-value typically represents elevations or heights and can be used to display features in three dimensions. Each vertex of a feature can store a z-value along with its x,y positional information. While ArcMap and its editing environment are two dimensional, they provide the ability to input, edit, and maintain z-values.

The assignment of z-values when editing in ArcMap is determined by the general function the editing tool or command performs: whether it creates a new feature or edits an existing feature. Most operations that result in a new feature being created assign all the vertices the same default z-value. When an existing feature is modified, new z-values are interpolated, and updated values are assigned to the edited vertices. Some editing operations, however, simply maintain existing z-values.

You can view or change a feature's z-values on the **Edit Sketch Properties window**. The z-values are listed in the **Z** column. To change the z-values for multiple vertices, check the boxes to the left of the vertices you want to update, then click the **Z** button and type the new values.

To store z-values in a feature, you must specify that the feature class has z-values when you create it. This makes the feature class z-aware. To determine if a feature class is z-aware, open its properties in ArcCatalog or the Catalog window, click the General tab, then look under Geometry Properties for a check next to **Coordinates include Z values**. There is also a Z in the **Shape** field in the attribute table in ArcMap, as in **Polyline Z**.
If your existing feature class is not z-aware, you need to create a new feature class capable of storing z-values, then load or copy and paste features from the existing feature class into the new one and edit the z-values. You do not need an ArcGIS 3D Analyst license to create z-aware feature classes or edit z-values in ArcMap. However, if you do have ArcGIS 3D Analyst, you can also edit features in ArcGlobe or ArcScene.

The following sections describe the behavior when editing features in ArcMap.

### How ArcMap assigns z-values to new features

ArcMap assigns z-values to new features in one of two ways:

- When copying and pasting an existing feature with z-values, ArcMap also copies those z-values to the new feature.
- With all other methods of feature creation, ArcMap assigns a default z-value to all vertices.

When you copy and paste features or use the Copy Features tool on the Advanced Editing toolbar, the existing z-values from the original feature are also copied to the new features. If the original feature is from a different layer that is not z-aware, the pasted features are assigned the default z-value.

### How ArcMap assigns z-values when existing features are edited

When editing existing features, ArcMap assigns z-values to the edited feature in one of two ways:

- The existing z-values are maintained because they are not affected by the edit.
- The z-values are updated with interpolated values.

When you move, rotate, scale, or spatially adjust an existing feature, the existing z-values are maintained. While the x,y values may change, the z-values do not. Similarly, if you simply move a vertex, the existing z-values are also maintained. If you need to modify the z-values, you can do so on the Edit Sketch Properties window.

On the other hand, operations that add, modify, or delete actual vertices in existing features typically assign new z-values for the modified vertices. Because these actions modify geometry with known z-values, ArcMap has a good starting point from which to interpolate (or extrapolate) and logically update z-values.

Operations that perform splitting, extending, trimming, smoothing, generalizing, merging, unioning, clipping, and intersecting on existing features interpolate z-values.

For example, if you trim a line that has z-values, the z-values of the other vertices in the segment are used to interpolate a z-value for the vertex at the point where the line was trimmed. If the z-value for the start vertex is 10 and the z-value for the end vertex is 20, the vertex at the trim point is assigned a z-value of 16 if you trim the line at 60 percent from the start point.

With functions such as union and intersect where the inputs can be from different layers, the output has interpolated values if all the inputs are z-aware. Current Z is used when the input layers lack z-values.

When you perform an edit that manipulates multiple vertices, only the affected vertices are reassigned z-values. In most cases, z-values are assigned through interpolation. However, Reshape Feature, Cut Polygons, and Auto Complete Polygon, which use a sketch to edit an existing feature, apply the sketch’s z-values to the inserted vertices.

### Examples of z-value assignment

The following examples show common edits being performed and the resulting z-values after the operation is completed.

Note that the Current Z value is assumed to be 0 (the default). To specify a different value for the Current Z, enter it into the Current Z text box.

<table>
<thead>
<tr>
<th>Editing scenario</th>
<th>How z-values are assigned</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating a new feature</td>
<td>Vertices are assigned the Current Z.</td>
<td><img src="image" alt="Example" /></td>
</tr>
<tr>
<td>Copying and pasting a feature</td>
<td>When copying from a z-aware feature class, the existing z-values are copied to the new feature. If the copied feature is not z-aware, then the pasted feature is assigned the Current Z value.</td>
<td><img src="image" alt="Example" /></td>
</tr>
<tr>
<td>Moving a feature</td>
<td>The existing z-values are maintained and not changed.</td>
<td><img src="image" alt="Example" /></td>
</tr>
<tr>
<td>Feature Type</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Rotating a feature</td>
<td>The existing z-values are maintained and not changed.</td>
<td></td>
</tr>
<tr>
<td>Moving a vertex</td>
<td>The existing z-values are maintained and not changed.</td>
<td></td>
</tr>
<tr>
<td>Inserting a vertex</td>
<td>The new vertex is assigned an interpolated z-value.</td>
<td></td>
</tr>
<tr>
<td>Extending a line</td>
<td>The new vertex is assigned an interpolated (extrapolated) z-value.</td>
<td></td>
</tr>
<tr>
<td>Trimming a line</td>
<td>The new vertex is assigned an interpolated z-value.</td>
<td></td>
</tr>
<tr>
<td>Splitting a line</td>
<td>The new vertex is assigned an interpolated z-value. Each feature has the same z-value for the vertex at the split point.</td>
<td></td>
</tr>
<tr>
<td>Reshaping a feature</td>
<td>Vertices that are inserted by the reshape sketch are assigned z-values from the sketch. The z-values for the other vertices are maintained and not changed.</td>
<td></td>
</tr>
<tr>
<td>Cutting a polygon</td>
<td>New vertices along the cut are assigned z-values from the sketch. The z-values for the existing vertices are maintained and not changed.</td>
<td></td>
</tr>
<tr>
<td>Auto Complete Polygon</td>
<td>Z-assignment for the new polygon: The new polygon's vertices are assigned z-values from the sketch. Z-assignment for the existing polygon: To maintain the boundary between the existing polygon and the new polygon, ArcMap inserts vertices on the existing polygon where the new polygon intersects it. Those vertices have z-values assigned from the new polygon.</td>
<td></td>
</tr>
</tbody>
</table>
### About editing in layout view

Most of the time you edit data in data view, since it shows only the data in your map and hides the layout elements. You can also edit in layout view, although you might experience unexpected results if you do not work in a focused data frame, especially if you have any layout graphics. The reason for this is that the ArcMap editing tools always work inside the data frame; however, the ArcMap graphic tools and keyboard shortcuts can work in both the layout and inside the data frame. When editing in layout view, it is recommended that you work inside (focus) the data frame. To focus a data frame, double-click it with the context of your map layout.

Features that are stored in layers with unknown coordinate systems cannot be projected by ArcMap. Regardless of the current data frame coordinate system, any edits made to these features occur in the native coordinate system. It is important to understand that coordinate systems have an area of use. The area of use defines where it is appropriate to use a particular coordinate system. Features that are stored in layers with unknown coordinate systems cannot be projected by ArcMap. Regardless of the current data frame coordinate system, any edits made to these features occur in the native coordinate system. Beyond these issues, mismatched coordinate systems between the data frame and layers in that data frame may cause certain edits to fail because of differences in tolerances. Setting the coordinate system of the data frame to match a layer resets the data frame's tolerance to match the layer. To do this, stop editing, then follow the instructions in Specifying a coordinate system.

#### Examples of z-value assignments while editing

<table>
<thead>
<tr>
<th>Feature A</th>
<th>Feature B</th>
</tr>
</thead>
</table>
| ![Feature A with z-values](image)
| ![Feature B with z-values](image) |

The z-values of the sketch used to draw the new polygon (Feature B) are 5, as all of its z-values are 5. However, the vertices inserted on the existing polygon (Feature A) have z-values of 5 and 7 because they are interpolated from Feature A's other vertices.

### About editing data in a different projection (projecting on the fly)

If you have collected data from a variety of sources, chances are that not all layers contain the same coordinate system information. The coordinate system of a data frame in ArcMap can be different from the native coordinate system of the data sources represented by the layers shown in the data frame. In this case, ArcMap projects (on the fly) the features in these layers to the data frame's coordinate system. ArcMap also lets you edit features while they are projected.

If you start editing and any of the layers in the database or folder that you plan to edit are in a different coordinate system from the data frame, you receive an information message. You have two choices:
- Continue with your edit session and start editing features in projected space.
- Choose not to continue editing if you want to change the coordinate system used by the data frame to match the native coordinate system of the layer or layers you want to edit.

### About editing projected features

When a projected feature is edited, all edits occur in the data frame's coordinate space and are projected back to the feature's native coordinate system as the feature is stored. For most editing operations and most coordinate system transformations, the integrity and accuracy of the feature is maintained. However, it is important to note that certain editing operations may produce unexpected alignment or accuracy problems, depending on the coordinate systems being used. Specific editing operations that may cause issues include changing the shapes of features, snapping to the edge or boundary of features, or extending and trimming features. These problems are more likely to occur when the features you are editing are close to the edge or beyond the area of use of the coordinate system. It is important to understand that coordinate systems have an area of use. The area of use defines where it is appropriate to use a particular coordinate system. You need to ensure that your data is located within these limits. Another reason problems occur is due to the distortions that affect features covering a large geographic extent.

Features that are stored in layers with unknown coordinate systems cannot be projected by ArcMap. Regardless of the current data frame coordinate system, any edits made to these features occur in the native coordinate system. Beyond these issues, mismatched coordinate systems between the data frame and layers in that data frame may cause certain edits to fail because of differences in tolerances. Setting the coordinate system of the data frame to match a layer resets the data frame's tolerance to match the layer. To do this, stop editing, then follow the instructions in Specifying a coordinate system.

#### Example projected editing scenario and results

Extending lines is a common case where you may see unexpected results when you are editing data that is being projected on the fly. For example, while editing in a different projection, you extend a dangling line to make it connect to another line. While the lines appear to be snapped together in this projection, you may find that the line has been extended too far (or not far enough) when you display the line again in the native coordinate system.

In another example, a new point is added on the state border between New York and Pennsylvania by snapping the point to the boundary. To illustrate the problem, the point is added in the native coordinate system (left) and again when the features are projected to a different coordinate system (right).
As the point in the projected coordinate system is created, it is projected to a location in its native coordinate system. The graphic below shows both points that were added. The green square represents the point feature that was added in the native coordinate system, and the red circle represents the one added in a different coordinate system. Even though the red circle was snapped to the straight line between the two states, due to distortions caused by projection, the feature will never be exactly on the border and is approximately 500 meters from the border.

**Editing features in a topology**

**Geodatabase topology:** When you edit features that participate in a geodatabase topology, note the following:

- Any fixes that you apply to topology errors occur in the data frame's coordinate system.
- Any validation of the topology and discovery of topology errors occur in the layers' native coordinate system.

You should fix topology errors in the layers' native coordinate system by making sure that the coordinate system of the data frame is the same as the one used by the layers you are editing. Fixing errors in projected coordinate space could result in a recursive problem of using topology to fix an error, validating the results of the fix, then discovering that the error reappears. This is not a problem with the fix that you apply; rather, it is due to inaccuracies introduced when the feature is projected back to the native coordinate system.

**Map topology:** You cannot edit layers that are projected on the fly using a map topology. To create a map topology, all the layers must have the same coordinate system, which must match the coordinate system of the data frame.

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**Using the editing geoprocessing tools**

The **Editing toolbox** contains a set of geoprocessing tools to perform bulk edits to your data. These tools are useful for performing data cleanup, especially on data that was imported from another source, such as CAD.

Effective use of the Editing toolbox geoprocessing tools can improve your productivity because the tools apply edits in bulk, such as to all features or all selected features. In most cases, the similar editing function applies to only one feature at a time.

For example, you have imported some CAD data into a feature class. A typical workflow with these tools might include running Trim Line, Extend Line, or Snap to ensure the lines connect. In fact, you could perform these tasks in a semiautomated manner by running the Editing toolbox geoprocessing tools in a model to fix many of the spatial integrity issues, applying a geodatabase topology with the Must Not Have Dangles rule to find additional lines that do not connect, then using the ArcMap editing tools to address any remaining errors.

Because these tools modify input data rather than creating new output feature classes, you might want to run the tools on a copy of the data to ensure that you are using appropriate tolerance values. This way, you can avoid editing the data beyond the level of cleanup you intended. In addition, if you run the geoprocessing tools during an edit session, you can undo the result.

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**About editing ArcSDE geodatabases**

This topic applies to ArcEditor and ArcInfo only.

When you need a large multiuser geodatabase that can be edited and used simultaneously by many users, the ArcSDE geodatabase provides a good solution. ArcSDE geodatabases work with a variety of DBMS storage models (DB2, Informix, Oracle, PostgreSQL, and SQL Server), taking full advantage of the underlying database architecture. The ArcSDE technology provides the ability to manage a shared, multiuser geodatabase, as well as support for a number of critical version-based GIS workflows involving simultaneous multiuser editing, distributed geodatabases, and historical archiving.

Data in an ArcSDE geodatabase can be either versioned or nonversioned. If the geographic data is versioned, it can be edited in a specific version of the geodatabase. On the other hand, editing nonversioned data is the equivalent of performing standard database transactions. When you edit nonversioned data in an ArcMap edit session, you edit the data source directly.
Editing versioned data in an ArcSDE geodatabase

Versioning allows multiple users in a multiuser geodatabase to edit the same data without applying feature locks or duplicating data. As you edit the ArcSDE geodatabase, you work within your own view or geodatabase state; no one else sees your edits until you save them. In other words, two editors who edit simultaneously see only their own edits.

When you start editing, you are working with your own representation of the version. Other users who are connected to the same version cannot see any of your changes until you save the edits. When you are ready to apply your edits to a different version of the geodatabase, you will merge your changes through a process of reconciling edits, resolving conflicts, and posting your changes to the parent version of the geodatabase.

The general workflow for editing a versioned ArcSDE geodatabase is as follows:

1. Establish a connection with the geodatabase.
2. Register the data as versioned.
3. Add the data to ArcMap.
4. Start editing and make your edits.
5. Review and reconcile any conflicts between the version being edited and the target version.
6. Post changes to the parent database.

The version editing process is described in more detail in A quick tour of the version editing process.

Editing nonversioned data in an ArcSDE geodatabase

Editing nonversioned data is the equivalent of performing standard database transactions. You perform a transaction within the scope of an ArcMap edit session. You can then make edits to the local copy in ArcMap and synchronize the edits back to the service. Edits can be made to the local copy without having to be connected to the server. Access to the server is only required when creating the local copy or applying changes from the local copy to the server. This workflow can be useful when your organization has disconnected employees and provides a common method for editing the same data using multiple clients, such as through the Web or to the server.

The general workflow for editing nonversioned data is as follows:

1. Make sure the data is not registered as versioned.
2. Use the Editing Options dialog box to configure ArcMap to perform nonversioned editing.
3. Add the data to ArcMap.
4. Start editing and make your edits.
5. Save edits and stop the edit session.

The nonversioned editing process is described in more detail in A quick tour of working with nonversioned data.

About editing data from ArcGIS Server

This applies to ArcEditor and ArcInfo only.

ArcMap allows you to edit data from ArcGIS Server by creating a local copy of data from a map service with an associated feature service or geodata service. You can then make edits to the local copy in ArcMap and synchronize the edits back to the service. Edits can be made to the local copy without having to be connected to the server. Access to the server is only required when creating the local copy or applying changes from the local copy to the server. This workflow can be useful when your organization has disconnected employees and provides a common method for editing the same data using multiple clients, such as through the Web or using desktop applications. The functionality is built into ArcMap and does not require any customizations.

By default, the data is copied to a new file geodatabase that is created for you automatically. You can also choose to store the data in an existing ArcSDE geodatabase. If you plan on making many updates to the data, consider using ArcSDE since it allows you to make edits and synchronize multiple times.

Making a local copy of a service

To create a local copy, first add data from an ArcGIS Server map service with an associated feature service or geodata service. Then, pan and zoom to the area you want to edit. The extent of the map defines the data that will be in the local copy. To create the local copy, right-click the map service group layer (or individual sublayers), point to Edit Features, then click Create Local Copy for Editing. If the service is not editable for some reason, you will receive an error message when you attempt to create the local copy.

Once the local copy is made, new layers referencing the local copy are added to a new group layer in the map. Layer properties, including the symbology and feature templates from the service layers, are preserved in the new layers. You can now make edits to the data in the new layers. The service layer is still present in the map, but it is unchecked in the table of contents so it does not display. If you plan to make edits over several ArcMap sessions, save the map document to make it easier to work with the local layers again.

Keep in mind that once a local copy is created, you cannot later expand the area that it covers. If you find that you need to edit a different area or a larger area, pan and zoom to the area in the service and create another local copy. You can have multiple local copies on the same machine.

Synchronizing the local edits with the server

When you are finished editing the local layers, you can synchronize the edits with the server. To do this, right-click the group layer containing the local layers, point to Edit Features, and click Synchronize Local Edits with Server. Once the synchronization process completes, you can turn on the service layers and see the edits applied in the service.

You can only synchronize edits one time if a file geodatabase is being used to store the local data. If you want to apply more edits in the future, you need to create a new local copy. However, if you use an ArcSDE geodatabase to store the local copy of the data, you can perform multiple synchronizations. In addition, when ArcSDE is used, the synchronization process applies the latest changes from the service back to the local copy. Note that if the data in the service is from a nonversioned ArcSDE geodatabase, you will not be able to store the local copy in ArcSDE. If you attempt this, an error stating that you cannot replicate nonversioned data will be displayed with you run Create Local Copy for Editing. To run the command successfully, do not set ArcSDE as the target geodatabase.

See Setting options for editing server layers locally for steps on how to do this.

When you no longer need to synchronize edits, you should disconnect the local copy from the server to clean up metadata on the client and server. The metadata cleanup process is important in that it aids server maintenance. If a file geodatabase is used to store the data locally, synchronizing also cleans up the metadata.

Related Topics

Making a local copy of a service for editing
Making a local copy of a service for editing

This topic applies to ArcEditor and ArcInfo only.

To create a local copy, first add data from an ArcGIS Server map service with an associated feature service or geodata service. Then, pan and zoom to the area you want to edit. The extent of the map defines the data that will be in the local copy. To create the local copy, right-click the map service group layer (or individual sublayers), point to Edit Features, then click Create Local Copy for Editing. If the service is not editable for some reason, you will receive an error message when you attempt to create the local copy.

Once the local copy is made, new layers referencing the local copy are added to a new group layer in the map. Layer properties, including the symbology and feature templates from the service layers, are preserved in the new layers. You can now make edits to the data in the new layers. The service layer is still present in the map, but it is unchecked in the table of contents so it does not display. If you plan to make edits over several ArcMap sessions, save the map document to make it easier to work with the local layers again.

The local layers and the new file geodatabase are stored in a folder in the map document's home location. To find this location, open the Catalog window and click make it easier to work with the local layers again.

The feature templates from the service layers, are preserved in the new layers. You can now make edits to the data in the new layers. The service layer is still present in the map, but it is unchecked in the table of contents so it does not display. If you plan to make edits over several ArcMap sessions, save the map document to make it easier to work with the local layers again.

The local layers and the new file geodatabase are stored in a folder in the map document's home location. To find this location, open the Catalog window and click make it easier to work with the local layers again.

Steps:
1. Add the feature service to ArcMap from a user connection, since these commands are disabled with administrator connections.
2. Pan and zoom to the extent you want to edit.
3. Right-click the map service group layer or sublayers within the service, point to Edit Features, then click Create Local Copy For Editing. The data is copied locally, the new layers referencing the local data are added to the map, and visibility for the original source layers are turned off.
4. Click the Editor menu on the Editor toolbar and click Start Editing.
5. Edit the data as you would edit any other geodatabase data, then save your edits and stop editing when you are done.

Related Topics
About editing data from ArcGIS Server
Setting options for editing server layers locally
Synchronizing local edits with the server

Synchronizing local edits with the server

This topic applies to ArcEditor and ArcInfo only.

When you are finished editing the local layers, you can synchronize the edits with the server. To do this, right-click the group layer containing the local layers, point to Edit Features, and click Synchronize Local Edits with Server. Once the synchronization process completes, you can turn on the service layers and see the edits applied in the service.

Conflicts are handled using a "last in, wins" policy. For example, if more than one editor is making edits to the same features, the synchronization process overwrites changes applied previously to these features by other editors.

When you no longer need to synchronize edits, you should disconnect the local copy from the server to clean up metadata on the client and server. The metadata cleanup process is important in that it aids server maintenance. If a file geodatabase is used to store the data locally, synchronizing also cleans up the metadata.

Steps:
1. Right-click the local copy group layer, point to Edit Features, then click Synchronize Local Edits With Server.
2. If you are storing the local data in ArcSDE and are done synchronizing edits, right-click the local copy group layer again, point to Edit Features, then click Disconnect Local Copy From Server.

Related Topics
About editing data from ArcGIS Server
Making a local copy of a service for editing
Setting options for editing server layers locally

Setting options for editing server layers locally

This topic applies to ArcEditor and ArcInfo only.

Options for making the local copy are available on the Distributed Geodatabase toolbar by clicking the Distributed Geodatabase menu and clicking Options. The options on the Local Editing tab can be set before creating the local copy.

When making a local copy, the options include the following:

- **Store data in the following ArcSDE geodatabase:** By default, the data in the local copy is stored in a file geodatabase. Edits made to the file geodatabase can only be synchronized once. If you wish to make edits and apply changes more than once, as well as get updates from the server, use an ArcSDE geodatabase. ArcSDE for SQL Server Express can be used to do this with a personal or workgroup license.

- **Include related data:** When Include related data is checked (default), the local copy includes data that is related to the layers in the map document. For example, if a layer from a geometric network or topology is in the map document, the other feature classes in the geometric network or topology are also copied when this option is checked.
The first portion of the tutorial (Exercises 1–3) uses data from Utah’s Zion National Park, which contains such geologic wonders as red and tan sandstone rocks, steep cliffs, and multitudes of canyons. You will use the editing environment in ArcMap to create and edit features.

**Steps:**

1. Click the Distributed Geodatabase menu on the Distributed Geodatabase toolbar.
2. Click Options.
3. On the Local Editing tab, specify the options for the local copy.
   - To store data in an ArcSDE geodatabase, check that option and browse to the ArcSDE geodatabase.
   - Check whether to include related data, such as data related to the source layers through a geometric network, topology, or relationship class.
   - Check to show a dialog box when you make a local copy so you can set the advanced options.
4. Click OK.

**Related Topics**

- About editing data from ArcGIS Server
- Making a local copy of a service for editing
- Synchronizing local edits with the server
- Understanding distributed data
- Working with geodatabase replication

**Reverting to the ArcGIS 9 editing environment**

By default, the ArcMap editing environment uses feature templates and the Create Features window when adding new features. Feature templates define all the information required to create a new feature: the layer where a feature will be stored, attributes new features will be created with, and the default tool used to create that feature. In addition, the tools on the Editor and Topology toolbars contain easy-to-use tools to create and edit features.

Due to the usability benefits that feature templates provide, it is recommended that you learn to use them when editing. However, for organizations that are unable to adopt the template-based workflow, there is an option available to revert to the ArcGIS 9 editing environment. This allows organizations that rely on extensive editing customizations to transition at their own pace to the feature template workflow. You can return to using feature templates once you are ready to migrate to that workflow.

The setting is found in the Advanced ArcMap Settings utility, located in the Utilities directory where you installed ArcGIS. This option prevents you from taking advantage of many of the capabilities for feature creation, since the user interface and editing methods revert to how they appeared and were used in ArcGIS 9.

Any user interface element used with feature templates is removed from ArcMap. For example, the Editor toolbar displays the Sketch tool palette, target layer list, and task list. Edit tasks are used in conjunction with the target layer to create and edit features. The Annotation and Dimension toolbars are used to create those feature types rather than the tools in the Create Features window.

**Note:** The steps presented in this help system describe the use of feature templates. In general, only the first few steps will be different between the methods; however, for additional details on how to create features using ArcGIS 9 methods, refer to the Web-based help for ArcGIS 9. In addition, context-sensitive help is available for the tools.

**Differences in the editing environments**

The following are some of the differences you will find when you revert to the ArcGIS 9 editing environment:

- The Editor toolbar contains the Sketch tool and palette. The contents of the toolbar are returned to how they appeared in ArcGIS 9.
- Any user interface element used with feature templates, such as the Create Features window, is removed from ArcMap.
- Edit tasks are used to specify whether features are being created or edited. The Cut Polygons, Reshape Feature, Edit Vertices, Reshape Edge, and Modify Edge tools are removed from the Editor and Topology toolbars, and the Editor toolbar Task list is used to access that functionality.
- The active layer in the Target drop-down list is the layer in which new features will be created. The exception is when using Copy and Paste and certain feature-creation commands—Buffer, Copy Parallel, Union, and so on. In those cases, a dialog box will appear allowing you to choose the target layer rather than requiring you to set the Target layer on the Editor toolbar prior to accessing the command.
- The Annotation toolbar and Dimension toolbar contain the tools used to create those feature types.

**Introduction to the Editing tutorial**

The easiest way to learn how to edit in ArcMap is to complete the exercises in this tutorial. Most of these exercises can be completed with an ArcView license—the exception is the geodatabase topology exercise, which requires an ArcEditor or ArcInfo license.

The first portion of the tutorial (Exercises 1–3) uses data from Utah’s Zion National Park, which contains such geologic wonders as red and tan sandstone rocks, steep cliffs, and multitudes of canyons. You will use the editing environment in ArcMap to create and modify spatial features to represent various natural and human-made phenomena in the park. After completing these exercises,
The remaining exercises (Exercises 4–5) show you how to edit data. You will learn how to maintain spatial integrity through topology and how to integrate new data with existing datasets using spatial adjustment. You should complete the tutorial in sequence, since the software methods build on those introduced in earlier exercises and assume you understand those concepts. For exercises 1–3, you should complete all subparts (such as a, b, c, and d) at the same time, then only stop after completing a whole exercise. For exercises 4–5, you can restart the tutorial again on either the next exercise or subpart without any difficulty since the maps and data are independent in these exercises.

Overview of the tutorial exercises

The tutorial is divided into a series of exercises and subparts:

- **Exercise 1** introduces the editing environment, including the terminology and ArcMap user interface. You learn how to create new points, digitize lines and polygons on the map, change editing tools, utilize snapping while creating features, and use feature templates.
- **Exercise 2** builds on these skills. You learn how to create features from existing features and how to edit existing features.
- **Exercise 3** is all about text on your map. You convert labels to geodatabase annotation, place the text on the map, and create new annotation features using the editing tools.
- **Exercise 4** shows you how to edit features to maintain spatial integrity. You use map topology to edit shared features and geodatabase topology to ensure that your line features connect properly. An ArcEditor or ArcInfo license is required to complete exercise 4b on geodatabase topology.
- **Exercise 5** uses spatial adjustment to transform and align your spatial data and transfer attributes among features.

**Note:** The tutorial assumes that you are using the default settings for the editing environment. If you have customized your options, you may need to reset them to match the steps in the tutorial. For example, by default, angular measurements are entered in degrees using the polar system, which is the format of the values provided in the tutorial. You can change the settings for the editing environment on the Editing Options dialog box, which is opened by clicking the Editor menu on the Editor toolbar and clicking Options.

Data credits

Zion National Park datasets are courtesy of the National Park Service and the United States Geological Survey.

Map topology datasets are courtesy of the United States Geological Survey.

The world imagery is a Web-based layer being served from ArcGIS.com.

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Exercise 1a: Creating new points

About creating new points

In this exercise, you will use an aerial photograph to create a new point feature representing a park ranger station in Zion National Park. Once the feature is created, you will then add attribute values to the point. You are introduced to the Editor toolbar, the Create Features window, and the Attributes window, which are the main elements of the ArcMap user interface when editing.

To start this exercise, you first need to zoom the map to your area of interest. A spatial bookmark, which is similar to a bookmark in a Web browser, is a way to save frequently used locations on your map so you can easily access them. A bookmark has been created for you containing the map extent in which you will be working.

**Note:** This exercise requires an active Internet connection since it uses imagery served from the Web. If you do not have an Internet connection or if the imagery is loading slowly, you can still perform the tutorial using an image that is installed with the tutorial data. You need to turn on the DOQQ imagery (local) layer in the table of contents, then you can turn off the World Imagery (Web) layer.

Prerequisite:

Start ArcMap.

Steps:

1. Click the **Open** button on the **Standard** toolbar.
2. Navigate to the **Exercise1.mxd** map document in the Editing directory where you installed the tutorial data. (C: \ArcGIS\ArcTutor is the default location.)
3. If the **Getting Started** window opens, choose to browse for an existing map and navigate to **Exercise1.mxd**.
4. Click the map and click **Open**.
5. If you are prompted to enable hardware acceleration to improve performance, click **Yes**.
6. Click the **Bookmarks** menu and click **Visitor center** to zoom you to the area around a visitor center ranger station at the south entrance of Zion National Park.
7. Click the **Editor Toolbar** button on the **Standard** toolbar.
8. Click the **Editor** menu on the **Editor** toolbar and click **Start Editing**.
9. In the **Create Features** window, click the **Ranger stations** point feature template. This sets up the editing environment so that you will be creating new point features in the Ranger stations layer. These feature templates were created for you and saved in the tutorial map document. In a later tutorial exercise, you will create feature templates yourself and modify their properties.
10. Using the aerial imagery, click the map to place a point directly over the visitor center building in the center of the display. Since you are creating points, clicking the map once adds the feature. If you were drawing lines or polygons, however, you would need to use more than one click so you could create segments in between vertices.
Notice that the center of the symbol contains a solid, cyan-colored (light, bright blue) circle. By default, as soon as you create new features when editing, they are selected. This allows you to easily identify the new feature and add attribute values to it.

11. Click the Attributes button on the Editor toolbar.
   Using the Attributes window is a quick way of updating the attribute values of one or more selected features when you are editing. The top of the window shows a hierarchy of the name of the layer and, underneath it, an identifier for the individual feature from that layer. The bottom of the window shows the field (a column in a table) names and the attribute values (a row in a table) for the feature.

12. Click inside the box for the Location property value, which is currently <Null>.
13. Type Visitor Center and press ENTER. This action stores the attribute values for that feature. Notice that the entry for the feature on the top of the window is no longer a generic number but has been replaced with the more descriptive Visitor Center.

14. Close the Attributes window.
15. To continue to the next exercise, click Exercise 1b: Digitizing lines and snapping.

You have now completed the first exercise and created a new point feature. In the next exercises, you will learn how to create new lines and polygons.

Exercise 1b: Digitizing lines and snapping

About digitizing with snapping
In the first exercise, you digitized a point over an aerial photograph; in this one, you will trace over the image to create a new line representing a road.

Because part of the road has already been created, you should use snapping to help ensure the new road feature connects to the existing roads. When snapping is turned on, your pointer will jump, or snap to, edges, vertices, and other geometric elements when it is near them. This enables you to position a feature easily in relation to the locations of other features. All the settings you need to work with snapping are located on the Snapping toolbar.

Note: This exercise requires an active Internet connection since it uses imagery served from the Web. If you do not have an Internet connection or if the imagery is loading slowly, you can still perform the tutorial using an image that is installed with the tutorial data. You need to turn on the DOQQ imagery (local) layer in the table of contents, then you can turn off the World imagery (Web) layer.

Setting options for snapping
Prerequisite:
The Exercise1.mxd is open and you are in an edit session.

Steps:
1. Navigate to the Digitizing roads bookmark. The extent is just south of the point feature you created in the previous exercise.
2. Add the Snapping toolbar to ArcMap. You can add a toolbar by clicking the Customize menu, pointing to Toolbars, then clicking the toolbar’s name in the list. You can also add the Snapping toolbar by clicking the Editor menu, pointing to Snapping, the clicking Snapping Toolbar.
3. On the Snapping toolbar, click the Snapping menu and confirm that Use Snapping is checked. If it is already checked, do not click it again, since that will turn off snapping. If Use Snapping is not checked, click it to enable snapping.
4. Look on the Snapping toolbar and confirm that End, Vertex, and Edge snapping types are active. When enabled, the buttons are highlighted. If they are not enabled, click each button to enable those agents.
5. Click the Snapping menu and click Options. From this dialog box, you can specify settings for snapping in ArcMap.
6. Ensure the snap tolerance is at least 10 pixels.
The snapping tolerance is the distance within which the pointer or a feature is snapped to another location. If the element being snapped to—such as a vertex or edge—is within the distance you set, the pointer automatically snaps to the location.

7. Check the boxes for **Show Tips**, **Layer Name**, **Snap Type**, and **Background**. Most likely, you only need to check on **Background**, as the others are turned on by default. A SnapTip is a small piece of text that pops up to indicate the layer you are snapped to and with which snap type (edge, end, vertex, and so on). The background is useful to help you see the SnapTip when working over an image.

8. Optionally, you can change the color used for the snap symbol and set SnapTip display options, such as the size or font of the tip.

9. Click **OK** to close the **Snapping Options** dialog box.

**Digitizing a line**

**Steps:**

1. You are now ready to begin digitizing the new road. In the **Create Features** window, click the **Local road** line template, which is grouped under Roads. The feature template was created for you and saved in the tutorial map document. The list of available construction tools at the bottom of the window changes to those used to create lines. Since the **Line** tool is the default tool for this template, it is activated automatically.

2. Rest your pointer over the endpoint of the existing line in the western portion of the map display, but do not click yet. Notice that the pointer icon changes to a square snap symbol and a SnapTip appears with the name of the layer (Roads) and the snap type (Endpoint) in use. You can zoom or pan closer if you need to do so.

3. Click once.

You digitize, or sketch, a new line or polygon by defining the feature’s shape. You see a preview with the actual symbology used for that feature, with vertices symbolized as green and red boxes. As you are digitizing, the Feature Construction toolbar appears near your pointer. It is a small, semitransparent toolbar that allows quick access to some of the most common tools and commands used when editing. If you find that the toolbar gets in the way of where you want to add a vertex, press the TAB key to reposition it. You will use the Feature Construction toolbar more in a later exercise.

4. Using the aerial photo as a guide, digitize the new line by clicking the map each place you want to add a vertex.

5. Once you have digitized the new line, snap to the end of the existing feature and click to place a vertex there.

6. Press the F2 key, which finishes the sketch to turn your shape into an actual feature in the geodatabase. You can finish a sketch in one of several ways: pressing F2, double-clicking, or using the right-click shortcut menu or the pop-up Feature Construction toolbar.

7. To continue to the next exercise, click **Exercise 1c: Creating new feature templates**.
In this exercise, you learned how to set up snapping and use it to help you digitize a new road that connects to existing roads.

Exercise 1c: Creating new feature templates

About creating feature templates

In the first exercises, you used feature templates that were already created for you. Now, you will make your own template using a wizard. You will create a template for a polygon layer representing private landownership.

Prerequisite:
The Exercise1.mxd is open and you are in an edit session.

Steps:

1. Click Organize Templates on the Create Features window.
2. Click Tracts on the left side of the Organize Feature Templates dialog box. If this layer had any existing templates, they would be listed on the right.
3. Click New Template. The Create New Templates Wizard opens. The first page shows you a list of all the layers in your map that are currently being edited.
4. Because the Tracts polygon layer was selected when you started the wizard, only this layer should be checked. Otherwise, check it and uncheck any other layers.
5. Click Finish. When layers are symbolized by categories, you are able to click Next and choose the categories for which you want to make feature templates. Since the Tracts layer is symbolized as a single symbol, the wizard is finished in one step.
6. A template for Tracts appears in the Organize Feature Templates dialog box. Click the Tracts template and click Properties.

   The Template Properties dialog box allows you to review and change the template settings. For example, you can rename a template, provide a description, set the default construction tool, and specify the attribute values that should be assigned to new features created with this template.

7. In the Description box, type Private lands in Zion. The description appears when you rest your pointer over a template in the Create Features window.

   You can also use tags to identify and help search for templates in the future. A tag representing the layer type—Polygon—is added automatically.

8. Click in the Tags box immediately after Polygon, type a semicolon (;), add a space, then type Zion. Type another semicolon, add a space, and type landownership.

   The Tags box should look like this when the tags are entered: Polygon; Zion; landownership.

9. The default tool should be Polygon. If it is not, click the Default Tool arrow and click Polygon. This ensures that the Polygon tool activates each time you choose the Tracts template.

10. Click the Ownership field in the grid. System information about the field is listed at the bottom of the dialog box.

11. Click <Null> for the value on the right side to clear the text and type Private, which will assign the attribute value Private. This sets Private as the default attribute value for that field for all new features created with this template.
12. Click OK.

13. Close the Organize Feature Templates dialog box. Notice that the new template is listed in the Create Features window. When you rest your pointer on the template, you see the text you entered for the description.

You can also access the properties of a template by double-clicking it in the Create Features window. By default, the templates are grouped and sorted by layer name. If you want to group them differently or filter to hide some of them, you can do so from the Arrange menu at the top of the Create Features window.

14. To continue to the next exercise, click Exercise 1d: Creating new polygon features.

You are now ready to create features using the properties specified in this feature template.

Exercise 1d: Creating new polygon features

About creating polygons
Since you have been exposed to the basic concepts and user interface elements of editing and creating features, you are now ready to learn advanced feature creation techniques. You will use several different methods to construct the polygon tract boundaries, including snapping, entering measurements, and drawing rectangles. You also will use keyboard shortcuts and right-click menus to improve productivity while creating features.

When Zion National Park became a protected area in the early 1900s, multiple owners held the land that became the park. Although Zion is mostly United States federal government land now, there are some areas within the park that are still owned privately. In this exercise, you will create some boundary lines representing the privately held features.

Creating polygons using different construction methods

Prerequisite:
The Exercise1.mxd is open and you are in an edit session.

Choosing a template sets up the editing environment for the settings in that template. This action sets the target layer in which your new features will be stored, activates a feature construction tool at the bottom of the Create Features window, and prepares to assign the default attributes to the new feature. Since the layer's template is set up so the Polygon tool is the default feature construction tool, the Polygon tool becomes active.

By default, the Line and Polygon tools create straight segments between the vertices you click. These tools also have additional ways to define a feature's shape, such as creating curved lines or tracing existing features. These are known as construction methods and are located on the Editor toolbar.

Steps:
1. Turn off the World Imagery (Web) layer in the table of contents.
2. Zoom to the Tracts bookmark.
3. In the Create Features window, click the Tracts template. This activates the Polygon construction tool, which you set as the default tool using the Template Properties.
   Since the tracts share an edge with the park boundary and an adjacent tract, you can use them to help you construct the shape of the polygon.
4. Click the Straight Segment construction method on the Editor toolbar.
   With the Straight Segment construction method, a vertex is placed each time you click, with the segments between vertices being straight lines.
5. Snap to the intersection of the park boundary polygon and the tract line feature and click once.

Note: The values, shapes, measurements, and attributes in this exercise are for demonstration purposes only and do not reflect the actual property records.
6. Move your pointer up (to the north), snap at the corner of the tract and the park boundary, then click again. You now have created two vertices with a straight line connecting them to define the eastern boundary of this tract.

7. Click **Midpoint** on the palette on the **Feature Construction** mini toolbar, which appeared on-screen near your pointer after you placed the first vertex of the polygon. This changes the active segment construction method from **Straight Segment** to **Midpoint**, which creates a vertex in the center of two locations you click. You will use **Midpoint** to create a vertex between two corners of the existing tract.

The buttons to choose a segment construction method on the Feature Construction toolbar are also found on the Editor toolbar, but it is often easier to access them on the Feature Construction toolbar since it is closer to your pointer. If you click a segment construction method on the Feature Construction toolbar, it then becomes active on the Editor toolbar, and vice versa. Two of the most common segment construction methods, **Straight Segment** and **Endpoint Arc Segment**, are located directly on the toolbar, but there is a palette to the right of these buttons containing additional methods.

8. Move the pointer to the right and click the eastern corner of the tract (the previous vertex you added). As you move the pointer, notice a black line with a small square in the middle. The square indicates where the new vertex will be added.

9. Move your pointer to the left and click the western corner of the existing tract. The new vertex is added where the square was located as soon as you click the second point.

10. Click the **Straight Segment** construction method on the **Feature Construction** mini toolbar. This changes the active segment construction method back to **Straight Segment** rather than **Midpoint**.

11. To enter the final measurement for the corner, you need to type a specific coordinate.

12. Press the F6 key. This is the keyboard shortcut for **Absolute XY**, which allows you to type an exact x,y coordinate for the next vertex. By default, the values you enter are in map units, which are meters for this map. If you want to enter values in decimal degrees or other formats, you can click the arrow to change the input boxes.
Type 314076.3 in the X: box, type 438384.9 in the Y: box, then press ENTER. A new vertex is automatically created in that location.

Click Finish Sketch on the Feature Construction mini toolbar.

You have created the first polygon lot feature. You could also use the F2 key, double-click the map, or right-click to finish the sketch.

Click the Identify tool on the Tools toolbar.

Click the new feature and notice that the attribute value for the Ownership field is Private, which is the default value you set in the template's properties.

If you identified a different layer, click the Identify from arrow, click the Tracts layer, then try clicking the feature again.

Close the Identify window.

Creating rectangular polygons

Sometimes you need to create rectangular polygons. Rather than clicking each vertex individually as you have been doing, you can use the Rectangle construction tool. The first click with the Rectangle tool creates the first vertex, then the second click establishes the "angle" of the rectangle, and the final click adds the remaining corner vertices. In addition, the Rectangle tool allows you to enter x,y coordinates for the vertices, as well as directions and lengths for the sides.

Steps:

1. Click the Pan tool on the Tools toolbar and pan the map slightly to the west so the J-shaped polygon is centered in the display.
2. Click the Tracts template, then the Rectangle tool on the Create Features window to make it the active construction tool.
3. Snap to the upper left corner of the J-shaped polygon and click to set the first corner of the rectangle.
4. Press the D key, type 179 (as in 179 degrees), then press ENTER. This establishes the angle for the rectangle. As you move your pointer around the map, you see a rectangle preview of the feature.
   By default, angles are entered in degrees using the polar system, which is measured counterclockwise from the positive x-axis. You can specify a different direction measuring system or unit on the Editing Options dialog box > Units tab.
5. Press the W key, type 400, then press ENTER. This is the shortcut to set a width of 400 meters, which are the map units.
6. Move your pointer up and to the left so the rectangle is created in the correct position in relation to the existing feature. Press the L key, type 800, then press ENTER. This is the shortcut to set a length of 800 meters.

Tip: In addition to using these keyboard shortcuts, you can right-click to access a menu containing commands for the direction, length, width, and other settings for creating a rectangle.

Creating adjoining polygons

You now need to create one more polygon to fill in the space between these two polygons. You could snap to every vertex, but an easier way is to use the Auto-Complete Polygon tool, which uses the geometry of existing polygons to create new adjacent polygons that do not overlap or have gaps.

Steps:

1. Click the Tracts template, then the Auto-Complete Polygon tool on the Create Features window to make it the active construction tool.
2. Snap to the lower left corner of the rectangle you just created and click.
3. Move southward, snap to the corner of the original existing J-shaped polygon, and click to add a vertex.
4. Click Finish Sketch on the Feature Construction mini toolbar.

When using the Auto-Complete Polygon tool, ArcMap automatically uses the shapes of the surrounding polygons in that layer to create the geometry for the new polygon.

5. Click the Editor menu on the Editor toolbar and click Stop Editing.
6. Click Yes to save your edits.
7. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.
8. To continue to the next exercise, click Exercise 2a: Defining new types of features to create.

The new features have been created with the default attribute values (Private) specified in the template. If you wanted to add other information, such as ID numbers, select the features and type the values into the Attributes window.

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About the Define New Feature Type wizard

Sometimes you may want to create features of a certain type in an existing layer, but the layer is not set up to capture those features. For example, you want to add features to a roads layer to represent an unpaved road, but you currently only have categories in your data for freeway, major highway, and local road. Through a wizard, you can define everything about the unpaved road category at one time—making it easy to prepare your data to display and store the new types of features. ArcMap automatically adds a symbol for the new category, any required geodatabase information (such as subtype value or coded domain value) for that layer, and a feature template to use when creating an unpaved road. The wizard saves you from having to stop your work to open multiple dialog boxes to set up the data on your own.

The park contains several areas of natural, cultural, or historical significance that are designated for research and education purposes only and are not open for public recreational use. In this exercise, you will define a new category of features to represent buffer regions around areas in the park that have been proposed for research-only use. This new category can show the area where travel is not recommended but is not prohibited.

The Research areas layer is symbolized by unique values, so the Define New Feature Type wizard allows you to define the symbol and create a feature template containing the default attributes for the new buffer zones category. You will use an existing feature to create the new buffer around it in a later exercise.

Steps:

1. Click the Open button on the Standard toolbar.
2. Navigate to the Exercise2.mxd map document in the Editing directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)
3. Click the map and click Open.
4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes.
5. If you are prompted to enable hardware acceleration to improve performance, click Yes.
6. Right-click the Research areas layer in the table of contents, point to Edit Features, then click Define New Types Of Features. The Define New Feature Type wizard starts.
7. Click Change Symbol to choose a different symbol to be used for the new buffer areas.
8. Click the Color drop-down arrow and click Gray 30% to change the fill color to gray.
9. Click OK on the Symbol Selector dialog box.
10. Click in the Name box and type Buffer zones.
11. Click in the Description box and type Buffer zones around Zion research areas.
12. Click Next.
13. For Value and Label, type Buffer zones. They should be populated automatically from the name you set on the previous panel of the wizard. The label is used to display the symbol category in the table of contents and legend.
14. Click Next.
   The next panel in the wizard allows you to set the default attribute values that will be used for new features created with the new Buffer zones feature template. This panel should be familiar to you from the exercise where you set the default attribute values for the landownership tracts.

15. Notice that Buffer zones is already set as the default attribute value for the Name field. You could also set defaults for the Comment field; however, you will leave it blank since any comments will be specific to each feature you create, rather than a universal default.

16. Click Finish.

17. A message appears that the new feature type was added successfully. Click No to quit adding new types.

18. Click the Editor menu on the Editor toolbar and click Start Editing.
   Notice that the Create Features window lists a new feature template for the Buffer zones.

19. To continue to the next exercise, click Exercise 2b: Creating features from existing features.

Now that you have added a feature template for the new type, you are ready to start creating features.

Exercise 2b: Creating features from existing features

About buffering features

You are provided with a polygon feature showing one of these research-only locations in the park and will use it to create another feature representing a buffer zone around it. You will select the original research-only polygon and use the Editor menu > Buffer command to create the new feature.

When you click the Buffer command, a dialog box opens allowing you to specify a feature template and buffer distance. Like other measurements when editing, the buffer distance is specified in map units, but you can also give the value in other units by specifying a distance units abbreviation with the value that you enter.

Prerequisite:
The Exercise2.mxd is open and you are in an edit session.

Editing commands that create new features automatically from existing features, such as Buffer, require you to choose the feature template to use when creating the new feature. Similar to clicking a feature template in the Create Features window, choosing a template on these dialog boxes defines the layer where a feature will be stored and the default attributes for the new feature. A buffer feature can be created as either a line or a polygon, so you could see both line and polygon templates listed but no templates for any other types of features.

Steps:
1. Navigate to the Research-only area bookmark. The map zooms to the Goose Creek area of the park. The polygons depict research-only areas.
2. Turn off the Streams layer in the table of contents. This makes it easier for you to see and select the correct features.
3. Click the Edit tool on the Editor toolbar.
4. Select the southernmost Research areas polygon—the tan-colored one.
5. Click the **Editor** menu and click **Buffer**.
6. Click the **Template** button on the **Buffer** dialog box.
7. Click the **Buffer zones** polygon template on the window.
   The Select Feature Template window shows only templates that are valid output types for the particular command rather than all the templates listed on the Create Features window. In the case of Buffer, polygon and line templates would be listed, if available, since both these geometry types can store the new buffer feature. On the other hand, when using a command, such as Copy Parallel, that creates line features, only line feature templates are listed for that command. If you want to find a template by name, you can enter it into the <Search> box.
8. Click **OK** on the Select Feature Template window.
9. Type **300** in the **Buffer Distance** text box. This means a buffer will be created 300 meters (the map units) from the border of the selected polygon.
10. Click **OK**.

   The new 300-meter polygon buffer feature is created using the properties of the **Buffer zones** feature template. The new feature is selected and is drawn on top of the existing feature.

11. To continue to the next exercise, click **Exercise 2c: Editing polygon features**.

In this exercise, you used an editing command, Buffer, to generate a feature from an existing feature and chose the feature template to use when creating the new feature.

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**Exercise 2c: Editing polygon features**

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**About editing polygons**

In the previous exercise, the Buffer command created a feature that is the extent of the original feature plus the buffer distance. Since this feature should just be the buffer, you need to remove the shape of the original inner feature from the current buffer feature. You can use the Editor menu > Clip command to cut a hole in the polygon feature.

You will also use the Cut Polygons tool to split a polygon by an overlapping line feature.

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**Cutting a hole in a polygon**

**Prerequisite:**

The Exercise2.mxd is open and you are in an edit session.

The new feature is drawn on top of the existing one. To use Clip, you need to select the underlying existing feature. The Edit tool has special capabilities to help you select the correct feature from overlapping ones.

**Steps:**

1. Click the **Edit** tool on the **Editor** toolbar.
2. Click the center of the buffer feature. Since there are multiple selectable features where you clicked, the selection chip appears. Click the arrow to the right of the icon to view a list of the features from which you can select. Features are listed in the selection chip by their display expression, which is set on the Layer Properties > Display tab.

3. Rest your pointer over a feature in the list to flash it on the map. Click the Isolated Mesa Tops feature to select it. You will use this feature to clip a hole in the Buffer zone polygon.

4. You can check that the correct feature is selected by clicking the List By Selection button in the table of contents and noting that only the Isolated Mesa Tops is listed in the Research areas layer in the Selected category. The Editor > Clip command only clips polygon features that are within a buffer distance of a selected feature—in this case, the Isolated Mesa Tops research area.

5. Click the Editor menu and click Clip.

6. Ensure the Buffer Distance is 0. This way, you will be clipping to the exact border of the selected feature rather than at a distance from it.

7. Click Discard the area that intersects. This removes the overlapping area from the feature that is being clipped.

8. Click OK. The overlapping area is clipped and now the original Research areas feature is visible through the hole in the buffer feature.

9. Click the List By Selection button in the table of contents, if you are not already listing layers this way, then click each feature on the map and note that the selected feature changes in the list in the table of contents. The 1 to the right of the selection icons indicates that there is one selected feature.

Since the buffer feature has a hole in it, its geometry is represented in ArcGIS as a multipart polygon. Multipart features either contain holes in them or are composed of more than one physical part that only references one set of attributes. For example, the individual islands that make up Hawaii are often represented as a multipart polygon feature. You can view the list of parts in a feature by double-clicking it with the Edit tool and opening the Edit Sketch Properties window.

Cutting a polygon

The neighboring research area needs to be divided into two polygons based on the river that runs through the middle. You can use the Cut Polygons tool to split the polygon.

To use the Cut Polygons tool, you need to select the polygon, then digitize a line where you want to cut the polygon. To change the shape of the line used to cut the polygon, click a construction method type on the Editor toolbar or on the Feature Construction mini toolbar. Segments can be created using a variety of methods, for example, as straight lines, with curves, or traced from the shapes of other features.

If you are cutting a polygon along a simple line, you can click to draw the line using the Straight Segment construction method. However, in this case, the river feature you want to use to cut with is long and curved, so it will be easier to trace around the border to create the line.

Steps:

1. Click the Edit tool on the Editor toolbar.
2. Click the Goose Creek research area, the blue polygon just to the west of the polygons you were previously editing. You may need to zoom in or pan to this feature so you can see it better.
3. In the table of contents, click the gray layer icon to the left of the Streams layer to make the streams visible again so you can trace along them. When you do this, the layer icon becomes colored.
4. Click the Snapping menu on the Snapping toolbar and click Intersection Snapping. This turns on snapping to intersections between features, which will help you ensure that the line used to cut the polygon starts and stops at the intersection of the polygon and line edges.
5. Click the Cut Polygons tool on the Editor toolbar.
6. Click Trace on the Editor toolbar palette.
7. Snap to the intersection of the polygon edge and the stream line near the buffer polygons, then click to start tracing the line through the polygon. Follow along the stream line to trace it.

8. Once you have traced all the way across the polygon, snap to the intersection of the polygon and line at the northern edge of the polygon, and click the map to place vertices.

9. Right-click anywhere on the map and click Finish Sketch.
10. You are finishing the sketch used to cut the polygon. The polygons flash on the map as the cut is made and the new features are selected. If an error occurs, ensure that you have the correct feature selected, try the trace again, then make sure your line goes completely across the polygon. It may help to zoom in when you start and end the trace.

11. Click the Edit tool on the Editor toolbar.
12. Click each new feature and notice that you now have two polygons.
13. Click the Editor menu on the Editor toolbar and click Save Edits.
14. Click the Editor menu on the Editor toolbar and click Stop Editing.
15. To continue to the next exercise, click Exercise 2d: Editing vertices and segments.

In this exercise, you learned how to clip polygons and split them by tracing along an overlapping line feature.

Exercise 2d: Editing vertices and segments

About editing vertices and segments

In the previous exercise, you edited whole features. In this exercise, you will be editing the vertices and segments that make up a feature. You can double-click a feature with the Edit tool to edit its shape. When you do this, the Edit tool pointer changes from a black arrow to a white arrow to show you can directly select vertices and modify segments.

The Edit Vertices toolbar provides quick access to some of the most commonly used commands when editing vertices. It appears on-screen whenever either the Edit tool or the Topology Edit tool is active and you are editing the vertices of a feature or topology edge. The toolbar floats the first time it appears but can be docked after that.

**Note:** This exercise requires an active Internet connection since it uses imagery served from the Web. If you do not have an Internet connection or if the imagery is loading slowly, you can still perform the tutorial using an image that is installed with the tutorial data. You need to turn on the DOQQ imagery (local) layer in the table of contents, then you can turn off the World imagery (Web) layer.

Editing vertices and segments

You will drag the vertices and handles to edit the shape of a line that was poorly digitized on a trailhead that starts at a road and ends near a stream.

**Steps:**

1. Make sure you have stopped editing from the previous exercise.
2. In the table of contents, click the List By Drawing Order button.
3. Right-click the Editing features data frame name and click Activate to make this the active data frame.
4. Click the Editor menu on the Editor toolbar and click Start Editing.
5. Close the Create Features window. You will not need it in this exercise.
6. Navigate to the Trail bookmark.
7. Click the Edit tool on the Editor toolbar.
8. Select the trail line (the dashed line) that connects to the road and click the Edit Vertices button on the Editor toolbar. When you are viewing the sketch geometry of a feature, the Edit Vertices toolbar appears, giving you quick access to commands used when editing a feature's vertices and segments.

When compared to the aerial photograph, notice that this line is straight when it should be curved, and it also has some extra vertices. You can easily
change a straight segment into a circular arc or Bézier curve, and vice versa, and delete the extra vertices. A Bézier curve is smooth and has on each of its two endpoints handles that can be moved to change the direction and the steepness of the curve. You can create Bézier curves by digitizing them using the Bézier Curve sketch construction method or by using certain editing commands, such as Smooth on the Advanced Editing toolbar.

9. Move your pointer over the middle of the segment closest to the road and notice that the pointer changes to indicate you are working with a segment. Right-click, point to Change Segment, then click Circular Arc.

10. The segment changes to an arc. Click the arc, drag it, and drop it over the trail on the aerial photograph. You can hold down the SPACEBAR key to turn off snapping temporarily if you are having difficulty placing the curve where you want it.

11. Click the map away from the feature to update its shape, then double-click the feature, which accomplishes the same thing as using Edit Vertices.

12. Click the Delete Vertex tool on the Edit Vertices toolbar. The Delete Vertex tool looks like the white Edit tool with a minus sign (-) next to it.

13. Drag a box around the three vertices that form a zigzag shape between the previous segment and the horizontal segment. This deletes those vertices, as they are in the incorrect locations and are not needed to maintain the shape of the line in this area.

14. Click the Modify Sketch Vertices tool (the white Edit tool) on the Edit Vertices toolbar. This allows you to continue working with the segments and vertices.

15. Right-click the northernmost segment, point to Change Segment, then click Bézier. A new set of Bézier curve handles is added, and the segment changes into an S-shaped curve. You can see the locations of the vertices and handles, which are displayed in blue. Rest your pointer over a green vertex, then rest it over a blue handle. You get different pointer icons depending on the type of point you are over.

16. Drag the handles to reshape the curve to match the aerial photograph.

17. Click the map to update the changes you made to the shape. If you need to refine the line's shape further, double-click it again with the Edit tool and modify the segments. If you want to insert or delete a vertex, use the tools on the Edit Vertices toolbar.
18. Click the Editor menu on the Editor toolbar and click Save Edits.

19. Click the Editor menu on the Editor toolbar and click Stop Editing.

20. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.

21. To continue to the next exercise, click Exercise 3a: Converting labels to annotation.

You changed segments into different types and edited vertices.

Exercise 3a: Converting labels to annotation

About annotation features

Annotation is a way to store text to place on your maps. With annotation, each piece of text stores its own position, text string, and display properties. Dynamic labels, based on one or more attributes of features, are the other primary option for placing text on maps. If the exact position of each piece of text is important, you should store your text as annotation in a geodatabase. Annotation provides flexibility in the appearance and placement of your text because you can select individual pieces of text and edit them. You can convert labels to create new annotation features.

In this exercise, you will convert labels into geodatabase annotation so you can edit the text features.

Preparing the labels for conversion

The map you will use in this exercise contains roads and water features in Zion National Park. The layers in the map have dynamic labels, but some of the map features could not be labeled due to space constraints. When you convert the labels to annotation, you can position each piece of text manually.

Steps:

1. Click the Open button on the Standard toolbar.

2. Navigate to the Exercise3.mxd map document in the Editing directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)

3. Click the map and click Open.

4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes. Each feature layer has dynamic labels, and the Streams layer has label classes based on the layer’s symbology. Label classes let you create different labels for different types of features in a given layer, so for example, intermittent streams can be given smaller labels than perennial streams.

5. Click Customize, point to Toolbars, then click Labeling.

6. To view which labels do not fit, view the unplaced labels. Click the View Unplaced Labels button.

The labels that could not be placed are displayed in red. It might be possible to fit these labels by adjusting their size, changing the feature and label weights, or making the map larger. However, for this exercise, you will convert the labels to annotation and place or delete the unplaced annotation.

7. Click the View Unplaced Labels button again to hide the unplaced labels.

Annotation features have a fixed position and size, so when you zoom in to the map, they appear to get larger. Labels are dynamically drawn according to their layer’s label properties. If the map does not have a reference scale, they are drawn at their specified font size regardless of the map scale. To
make labels behave more like annotation, you can set a reference scale for the map. The labels are drawn with their specified font size scaled relative to the reference scale. When converting labels to annotation, you should specify a reference scale. If you do not, the current map scale is used as the reference scale for the annotation.

8. Type 170000 in the Map Scale box on the Standard toolbar and press ENTER.

9. In the table of contents, click the List By Drawing Order button if it is not already the active way to sort layers. Then, right-click Layers (the name of the data frame), point to Reference Scale, then click Set Reference Scale. Now if you zoom in or out, the labels become correspondingly larger or smaller. You are ready to convert these labels to annotation.

Converting labels to annotation

Annotation can be stored in a map document or in feature classes in a geodatabase. You will convert these labels to annotation stored in a geodatabase. The Convert Labels to Annotation dialog box allows you to specify what kind of annotation to create from the labels, which features to create annotation for, and where the annotation will be stored.

Steps:

1. In the table of contents, right-click Layers and click Convert Labels to Annotation.

   ArcView users can view feature-linked annotation, but they cannot create it or edit datasets that contain it. If you have an ArcView license, the Feature Linked column of check boxes is unavailable. In this exercise, you will create standard annotation features. Skip the next step if you have an ArcView license.

2. Uncheck the check boxes in the Feature Linked column.

   Small folder icons, the browse buttons, appear beside the annotation feature class names as you uncheck the Feature Linked check boxes. Feature-linked annotation must be stored with the feature class that it is related to in the geodatabase. Standard annotation feature classes can be stored in other geodatabases; after unchecking the boxes, you have the option to specify a new location for your annotation. Standard annotation feature classes are stored in the same dataset as their source feature class by default. If a feature layer on the map was based on a shapefile or coverage feature class, the browse button would have been visible and you would need to browse to a geodatabase to store the new annotation feature class.

3. Verify that Convert unplaced labels to unplaced annotation is checked. This gives you a chance to manually place the annotation for the features that could not be labeled.

4. Click Convert.

   The labels are converted to annotation. The process should take less than a minute, though the speed depends on your computer. When the annotation feature classes are created, they are added to ArcMap.

   Each layer's label classes are stored as separate annotation classes within a single annotation feature class. For example, the two label classes for streams become two annotation classes, Intermittent and Perennial, within the StreamsAnno annotation feature class. These annotation classes can be turned on and off independently, and they can have their own visible scale ranges.

5. To continue to the next exercise, click Exercise 3b: Editing annotation features.

   You have converted labels to annotation features. Next, you will place them on the map and edit their positions.

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**Exercise 3b: Editing annotation features**

**About editing annotation features**

Now that the labels have been created, you will start an edit session and add the unplaced annotation features to the map. The Unplaced Annotation window lets you view unplaced annotation features in a table that can show all the unplaced annotation in the annotation feature classes on your map. You can filter the table to show annotation for a specific annotation class and choose whether to show annotation for the whole extent of the data or for the current visible extent. You can sort the table alphabetically by the unplaced annotation's text content or annotation class by clicking either the Text or Class column heading.

**Placing unplaced annotation features**

Prerequisite:

- The Exercise3.mxd is open.

Steps:

1. Click the Editor menu on the Editor toolbar and click Start Editing.

2. Click the Editor menu on the Editor toolbar, point to Editing Windows, then click Unplaced Annotation.

3. On the Unplaced Annotation window, check the Draw box to display the unplaced annotation features on the map.
4. Click **Search Now**. A number of annotation features are listed in the table. If you scroll through the table, you can see there are unplaced annotation features from several annotation classes represented. You can also see some new annotation features outlined in red on the map. You see these unplaced annotation features because the Draw box is checked.

5. Click the **Edit Annotation** tool on the **Editor** toolbar.

6. Click the map, press and hold down the Z key, then click and drag a box around the small cluster of unplaced annotation features at the east side of the park. The Z key is the keyboard shortcut to zoom in. To pan to this area, you can press the C key. You can also navigate to the **Zion Canyon** bookmark.

![Map with annotation features](image)

The Hillshade background layer has a visible scale range; when you zoom in closer than 1:85,000, it is no longer displayed. Setting a visible scale range is also a good idea for annotation feature classes, as they are most useful within the range of scales where they are legible. There is no need to spend time on—especially for multiuser geodatabases—network and database resources drawing annotation features when they cannot be read. You can set a visible scale range for a layer in ArcMap, or you can change the properties of the annotation feature class itself. The second method has the advantage that the annotation feature class will always be drawn within its visible scale range when it is added to a map.

7. Now that you have zoomed in to the cluster of unplaced annotation in the east side of the park, you are ready to start placing the unplaced annotation features. Click **Search Now**.

8. Right-click **Birch Creek** in the **Text** column and click **Place Annotation**. The Birch Creek annotation feature is placed. It is selected, so it has a blue outline instead of a red outline.

### Making annotation follow along the edge of a feature

The annotation feature is straight and placed parallel to a segment of the stream feature. The other stream annotation features curve to follow the streams, so you will make this newly placed annotation feature follow the stream. You can make an annotation feature follow a line feature or the boundary of a polygon feature. The Follow Feature Options dialog box allows you to specify how annotation will behave when it follows a feature.

**Steps:**

1. With the **Edit Annotation** tool, right-click the **Birch Creek** annotation feature, point to **Follow**, then click **Follow Feature Options**.
2. For **Make annotation**, click **Curved**.
3. For **Constrain Placement**, click the **Side cursor is on** button to constrain the placement of the annotation.
4. Type 100 in the **Offset from feature** text box. The annotation will be offset 100 meters from the stream.
5. Click **OK**.
6. Move the pointer over the stream feature just south of the Birch Creek annotation feature, right-click, then click **Follow This Feature**. The stream feature flashes, and the annotation feature bends to follow the stream. The selected annotation feature follows any line feature that you right-click and tell it to follow using the Edit Annotation tool.
7. Place the pointer over the middle of the **Birch Creek** annotation feature. The pointer changes to the four-pointed Move Annotation pointer.

![Follow Feature Options dialog box](image)

8. Drag the **Birch Creek** annotation feature along the stream feature. Press the L key as you drag the annotation if you need to flip its reading direction.

### Stacking and rotating annotation

You have placed an annotation feature and made it follow another feature with the Edit Annotation tool. The Edit Annotation tool also allows you to make other edits to annotation features. Now that you have placed the annotation feature from the StreamsAnno feature class, you will place the other nearby annotation features.

**Steps:**

1. On the **Unplaced Annotation** window, click **Grotto Springs**, then right-click it and click **Pan to Annotation**.
2. Press the SPACEBAR, which is the keyboard shortcut to place a selected annotation feature. The Grotto Springs annotation feature is placed.

3. Right-click the feature on the map and click Stack. The Grotto Springs annotation feature is split at the space in the text, and the word Grotto is placed above the word Springs.

4. Move the pointer over the middle of the Grotto Springs annotation feature. The pointer will change to the four-pointed Move Annotation pointer. Click the middle of the Grotto Springs annotation feature and drag it toward the southwest so it is between the spring features.

5. On the Unplaced Annotation window, click Zion Canyon Scenic Drive and press the P key, which is the keyboard shortcut to pan to a selected annotation feature.

6. Right-click Zion Canyon Scenic Drive and click Place Annotation.

7. Right-click the Zion Canyon Scenic Drive annotation feature on the map and click Stack.

8. Click the middle of the Zion Canyon Scenic Drive annotation feature with the four-pointed Move Annotation pointer and drag it toward the southwest until the south end of the annotation feature is near the intersection with the road that branches off to the east, Highway 9.

9. Move the pointer over the blue, wedge-shaped rotate handle on the northeast corner of the Zion Canyon Scenic Drive annotation feature until the pointer becomes the Rotate pointer. Click the corner and drag it counterclockwise until the annotation feature follows the general trend of the road.

10. If you wanted, you could continue to place and edit the annotation features. When you are done, close the Unplaced Annotation window.

11. To continue to the next exercise, click Exercise 3c: Creating new annotation features.

You have placed, moved, stacked, and rotated annotation features with the Edit Annotation tool. Next, you will create new annotation features and edit them.

Exercise 3c: Creating new annotation features

About creating and editing annotation

With the completion of the exercises so far, you have learned how to create feature templates and set their properties. You created point, line, and polygon features by digitizing over an image, snapping to existing features, entering exact measurements, and using various construction tools and editing commands. In this exercise, you will learn how to create and edit annotation on your map, which has a similar workflow to creating other types of features. There are several different tools you can use to add annotation to the map; you will use two of them, Straight and Follow Feature.
Creating straight annotation

Prerequisite:
The Exercise3.mxd is open and you are in an edit session.
You will use the Straight annotation construction tool, which allows you to place annotation that has a straight baseline but may be rotated at an angle, to add some text to your map to identify canyons in the park.

Steps:
1. In the Create Features window, click the Canyons annotation feature template in the CanyonsAnno layer. When you activate an annotation template, the Annotation Construction window appears so you can enter the text and change the formatting of the feature you are going to create.
2. Click the Straight construction tool on the Create Features window.
3. Type Zion Canyon in the Annotation Construction window. As you type, the text on your pointer changes as well.
4. Click the map to the left of the road near Grotto Springs. The location you click is the center point of the new feature.
5. Rotate the annotation sketch counterclockwise to create annotation that is aligned with the road, stream, and canyon.
6. Click to place the annotation.
7. Press the E key until you have activated the Edit Annotation tool. The E key switches among the construction tools, the Edit tool, and the Edit Annotation tool.
8. Place the pointer over the red triangle on the edge of the Zion Canyon annotation feature. The pointer changes to the two-pointed Resize Annotation pointer, allowing you to resize interactively so the feature fits better.
9. Drag the resize handle toward the middle of the annotation feature. The feature shrinks as you drag it.
10. Drag the annotation feature if you need to reposition it again.

Creating annotation that follows the edge of a line

The next style of annotation you will create is follow feature annotation, which is designed to follow along or match the shape of lines or polygon edges. You will use the Follow Feature construction tool to create annotation that follows the shape of the road and use the road’s attributes as the text for the annotation.

Steps:
1. In the Create Features window, click the Default annotation feature template in the RoadsAnno layer.

2. Click the Follow Feature construction tool on the Create Features window.

3. On the Annotation Construction window, click Follow Feature Options to set options for how the annotation will be placed as it is dragged along the stream. The options should still be set from when you constructed follow feature annotation. If not, make the annotation curved and constrained to be placed on the side the cursor is on at a 100-meter offset. Click OK when you are done.

4. Click Find Text on the Annotation Construction window. Find Text allows you to click a feature and populate the annotation string with an attribute from another feature.

5. Move the pointer over the road feature that branches off toward the east from the intersection with Zion Canyon Scenic Drive and snap to and click the road. Highway 9 should appear in the Text box on the Annotation Construction window and on the tool's pointer. If Zion National Park or Clear Creek appear, click Find Text, move the pointer over the road feature, then try again.

6. Click the road feature, which becomes highlighted, and drag the Highway 9 annotation feature along the line. Press the L key if you need to flip the reading direction.

7. Click to place the annotation. You could continue to place unplaced annotation, edit annotation, create new annotation features, and delete unwanted annotation until the map suits your needs. This annotation is stored in geodatabase annotation feature classes, each of which can be reused on other maps. When you have completed your edits, stop editing and save them.

8. Click the Editor menu on the Editor toolbar and click Stop Editing.

9. Click Yes to save your edits.

10. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.

11. To continue to the next exercise, click Exercise 4a: Editing shared features with a map topology.

In this exercise, you created new annotation features, edited their size and position, set the text string for a new annotation feature using attributes from another feature, and placed annotation features along a line.

Exercise 4a: Editing shared features with a map topology

About map topology

Many vector datasets contain features that share geometry. Features can share edges—for example, line segments—or nodes, the points at the ends of segments. For example, watershed polygons might have common edges along ridgelines, and lake polygons might share their shoreline edges with land-cover polygons. Three watersheds might share a single node at a mountain peak, and three river-reach features might share a node at a confluence. The Topology toolbar contains tools for working with topologically related features.

A map topology creates topological relationships between the parts of features that are coincident. You can specify the feature classes that you want to participate in the map topology. You can also choose the distance, or cluster tolerance, that defines how close together edges and vertices must be in order to be considered coincident. You can simultaneously edit shared edges and nodes with the Topology Edit tool when you create a map topology.

ArcView users can create and edit a map topology, which is the type used in this exercise. ArcEditor and ArcInfo users also can edit geodatabase topology, which defines a set of rules about the relationships between feature classes in a feature dataset. You will edit a geodatabase topology in another exercise.

Creating a map topology

Prerequisite:

Start ArcMap and display the Editor, Snapping, and Topology toolbars.

In this exercise, you will update multiple watershed features in two feature classes by creating a map topology.

Steps:

1. Click the Open button on the Standard toolbar.
2. Navigate to the MapTopology.mxd map document located in the \Editing\Topology directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)

3. Click the map and click **Open**.

4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes.

The map opens to the following view:

![Map View](image)

This map contains two feature classes. Hydro_region contains polygon features representing three large hydrologic regions in the southwestern United States. Note that part of the Great Basin regional watershed has been omitted from the tutorial dataset. Hydro_units contains polygon features representing smaller watersheds within these regions. You can see the features in the Hydro_units feature class because the Hydro_region features are partly transparent.

The regional data was derived by dissolving the smaller hydrologic units, so the boundaries of the features in Hydro_region are already coincident with the boundaries of the smaller watersheds. In this exercise, you will create a map topology to allow you to edit the vertices that make up a shared edge and move a node that defines the intersection of multiple features.

5. Click the **Editor** menu on the **Editor** toolbar and click **Start Editing**.

6. Close the **Create Features** window. You will not need it in this exercise.

Before you create the map topology, zoom in to the area that you want to edit. Zooming in to an area reduces the number of features that the map topology analyzes when building the topology cache.

7. Click **Bookmarks** and click **3 Region Divide**.

The map zooms to the bookmarked area. Now you can see labels for the smaller watersheds.

8. Click the **Map Topology** button on the **Topology** toolbar.

The **Map Topology** dialog box appears. You can select the feature classes that will participate in the topology and choose a cluster tolerance. The cluster tolerance defines how close together parts of features must be before they are considered coincident.

9. Click **Select All**. You want all the features on the map from both feature classes to participate in the map topology.

   The default cluster tolerance is the minimum possible cluster tolerance and is given in coordinate system units. In this case, the dataset is in the universal transverse Mercator coordinate system, and the units are meters. Accept the default cluster tolerance.

10. Click **OK**.

**Finding shared features**

Now you will start editing the map topology using the Topology Edit tool to select an edge and determine which features share it. You can use the Show Shared Features dialog box to investigate which features share a given topology edge or node and control whether edits that you make to a given topology element will be shared by certain features.

**Steps:**

1. Click the **Topology Edit** tool on the **Topology** toolbar.

2. Click the edge that is shared by the **East Fork Sevier, Utah. polygon (#16030002)** and **Kanab, Arizona, Utah. polygon (#15010003)**.

   The edge is selected and changes color. This edge is also shared by the larger regional polygons. To check this, you will use the Show Shared Features command.

3. Click **Show Shared Features** on the **Topology** toolbar.

   The names of both feature classes in the map topology, Hydro, region and Hydro_units, are listed with check marks on this dialog box. The checks mean that the selected topology element is shared by features in these feature classes and are affected by any edits you make to the shared edge. Next, you will see which features share this edge.
4. Double-click Hydro_units. The plus sign changes to a minus, and two more branches expand below Hydro_units. Each of these represents a hydrologic unit feature that shares this edge.

5. Click East Fork Sevier, Utah. Feature number 51 in the Hydro_units feature class, the East Fork Sevier hydrologic unit, flashes on the map.

6. Double-click Hydro_region and click Great Basin Region. Feature number 1 in the Hydro_region feature class, the Great Basin region, flashes on the map.

7. Close the Shared Features dialog box.

Editing a shared edge in a map topology

Now that you have seen that the features you need to update share this edge, you’ll update the boundary of the watersheds to better fit the terrain.

Steps:

1. Check Hillshaded_terrain.sid in the ArcMap table of contents to turn on the image.

This is a small area of hillshaded terrain extracted from the National Elevation Dataset Shaded Relief Image Service, published by the United States Geological Survey. You will use this image, and the guidelines that have been added to it, to update your watershed data.

2. Press and hold the Z key. The pointer becomes the Zoom In tool.

3. While pressing the Z key, drag a box around the selected edge.

4. Double-click the edge. Now you can see the vertices (in green) that define the shape of this edge.
5. Move the pointer over the second vertex from the eastern end of the edge. When the pointer changes to a box with four arrows, click the vertex, drag it toward the northwest, then drop it on the blue guideline.

You could continue reshaping this edge vertex by vertex, but there is a faster way to update it.

6. Click once on the map, off the edge, to deselect it. Then click the edge again to reselect it.

Reshaping a shared edge in a map topology

Steps:

Now you'll use an edit sketch to reshape the shared edge. You'll need to use the Reshape Edge tool and snap to the watershed edges.

1. Ensure edge snapping is enabled. If it is not, click Edge Snapping on the Snapping toolbar.
2. Click the Reshape Edge tool on the Topology toolbar.
3. Move the pointer over the edge where the selected topology edge and the blue guideline begin to diverge.

4. Click the edge to begin an edit sketch.
5. Continue adding vertices along the guideline. You can hold down the SPACEBAR key to turn off snapping temporarily if you are having difficulty placing the reshape line where you want it along the blue line.
6. Make sure that the last vertex you add to the sketch snaps to the edge near the vertex you moved.
7. Right-click anywhere on the map and click Finish Sketch.
   The edge looks like this once you finish the sketch:
Moving a shared node in a map topology

Now that you've adjusted the edge shared by the watershed boundaries, another problem with the existing data needs to be fixed. The node at the east end of the edge is the point where the Great Basin, Upper Colorado, and Lower Colorado region watersheds come together. You'll move this shared node by a specified number of meters.

**Steps:**
1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. Click once on the map, off the edge, to deselect it.
3. Press and hold the N key. This temporarily limits the selectable topology elements to nodes.
4. Drag a box around the node while holding down the N key.

The node is selected. Now you'll move it to the correct location.

5. Right-click and click **Move**.

You will move this node 460 meters in the x direction (east) and 410 meters in the y direction (north).

6. Type **460** and **410** in the x and y boxes, respectively, and press ENTER.

The node is moved to the new location, and all the features that share it in the map topology are updated. You can also move the node by dragging it as you move the vertex of the topology edge.

7. Click the **Editor** menu on the **Editor** toolbar and click **Stop Editing**.
8. Click **Yes** to save your edits.
9. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.
10. To continue to the next exercise, click **Exercise 4b: Using geodatabase topology to fix line errors**.
In this exercise, you learned how to create a map topology and how to use the Topology Edit tool to edit multiple features that share edges and nodes. The map topology allowed you to maintain the common boundary between the features while simultaneously editing four, then six, features in two different feature classes. The Topology Edit tool and the topology editing tasks can also be used to edit the edges and nodes in a geodatabase topology.

Exercise 4b: Using geodatabase topology to fix line errors

About geodatabase topology

Geodatabase topology is a set of rules that define how the features in one or more feature classes share geometry. Geodatabase topology is created in the Catalog window or ArcCatalog and can be added to ArcMap as a layer, just like any other data. After editing has been performed on the feature classes, you validate the geodatabase topology to see if the edits break any of the topology's rules. An ArcEditor or ArcInfo license is required to create, edit, or validate geodatabase topology.

In this exercise, you will create a simple geodatabase topology rule to help you find digitizing errors in lot line data that has been imported from CAD, then use the topology and editing tools to fix these errors.

Creating a geodatabase topology

Prerequisite:

Start ArcMap and display the Editor and Topology toolbars.

Steps:

1. Click the Open button on the Standard toolbar.
2. Navigate to the GeodatabaseTopology.mxd map document located in the \Editing\Topology directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)
3. Click the map and click Open.
4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes.
5. If the Catalog window is not already open, click the Catalog Window button on the Standard toolbar to display it. The Catalog window allows you to manage your datasets and is where you will add the topology. You can dock the window to the ArcMap user interface by clicking the pin in the upper righthand corner.
6. If necessary, expand the Home - Editing\Topology folder, which displays the contents of the Topology folder installed with the tutorial data.

7. Expand the Topology geodatabase, if needed, and click the StudyArea feature dataset. Now you will create a geodatabase topology to help you find errors in the lot lines data. The topology will be simple, involving one feature class and one topology rule.
8. Right-click the StudyArea dataset, point to New, then click Topology.
9. Click Next on the introduction. On the next panel of the wizard, you can set the cluster tolerance. The cluster tolerance is the minimum distance that separate parts of features can be from each other. Vertices and edges of features that fall within the cluster tolerance are snapped together. By default, the wizard gives the smallest possible cluster tolerance, which is determined by the precision of the spatial reference of the dataset. The precision of a dataset defines how many system units can be stored per unit of linear measure and controls how precisely coordinates are stored in the dataset.
10. Accept the default name and cluster tolerance and click Next.
11. Now you can choose which feature classes in the dataset to include in the topology. Check LotLines and click Next. When you have more than one feature class in a topology, you can give them different ranks. When vertices or edges of features fall within the cluster tolerance of each other, the feature class rank controls which is moved to the other's location. Feature classes of a lower rank will be snapped to feature classes of a higher rank. The highest rank is 1; the lowest is 50. Parts of features of the same rank that fall within the cluster tolerance are geometrically averaged.
12. Accept the default ranks and click Next.
13. When you build a topology, you can pick the rules that will govern the allowable spatial relationships between features.
14. Click Add Rule.
15. Click the Rule arrow and click Must Not Have Dangles.
Dangles are the endpoints of lines that are not snapped to other lines in the feature class. You will want to find the dangles in the LotLines feature class, because they represent places where the imported CAD line work is not connected properly.

15. Click **OK**.

16. The rule is added to the list of topology rules. Click **Next**.

17. Review the summary and click **Finish**.

   A message appears informing you that the topology is being built, then another asks whether you want to validate the topology now. Validation discovers errors in the layer.

18. Click **Yes**.

   A message appears informing you that the topology is being validated, and the new topology appears in the StudyArea dataset.

### Adding the topology to the map

Now you’ll use the topology to help you find the dangle errors in the lot lines data. In the future, you may need to build polygon lot features from these lines. Therefore, it is important to clean up this data first because only one lot polygon will be created if a line dividing two lots does not completely separate them.

**Steps:**

1. In the **Catalog** window, expand the **StudyArea** feature dataset, if needed, then click **StudyArea_Topology** and drag it onto the map.

2. Click **No** when you are asked whether to add all the layers that participate in the topology, since the layers are already in the map.

3. Close the **Catalog** window.

   The topology layer shows all the topology errors. Notice that in the ArcMap table of contents, the topology layer can show area, line, and point errors. This topology only has one feature class and one rule, so all the topology errors relate to that rule. The topology rule specifies that lot lines must not have dangles. The error geometry for dangles is a point, located at the dangling end of a line feature. All the red error features on the map are dangles.

### Finding topology errors

The next step to make this data useful is to identify the topology errors that are present. Lot lines that have a dangle, where one end of the line is not connected to another lot line, are errors that you need to find to clean up this data so you can create lot polygons. Some dangles need to be extended to close a polygon; others overshoot the line that they should snap to and need to be trimmed. You will find some of these errors now.

**Steps:**

1. Click **Bookmarks** and click **Dangle errors**.

   The map zooms to the bookmarked area. Now you can see three dangle errors, which you will fix in this exercise.

2. Click in the **Feature 1** column on the **Error Inspector** window until the northernmost feature on the map flashes and turns black to show that it is selected.

3. Zoom in to the error until you can see where the lot line with the error crosses the other lot line.
This is an overshoot error, a type of error that is often found in line work imported from CAD programs or digitized without using snapping to control the connectivity of the line features.

3. Right-click the error on the Error Inspector window and click Trim.
4. Type 3 in the Maximum Distance text box and press ENTER.

The dangling segment is trimmed back to where the lines intersect, and the error disappears. The Error Inspector shortcut menu provides a list of potential fixes for this error. You trimmed the line feature to fix this error. You also could have marked the error as an exception or snapped or extended the line until it reached another feature.

### Correcting an undershoot error

**Steps:**

1. Click the Go Back To Previous Extent button on the Tools toolbar until you can see the two remaining errors in this area of the data. Now you'll correct another type of dangle error.

2. Zoom in to the westernmost of the two remaining errors.

3. Zoom in again, if necessary, until you can see where the lot line with the error fails to connect to the other lot line.

   This is an undershoot error, another type of error that is often found in line work imported from CAD programs or digitized without using snapping to control the connectivity of the line features. The end of this line fell short by a little more than half a meter. You'll fix this error by extending the undershoot until it meets the line to which it should have been snapped.

4. Click the Fix Topology Error tool on the Topology toolbar. This tool lets you interactively select and apply predefined fixes to topology errors on the map.

5. Drag a box around the error.

6. Right-click the map and click Extend.
7. Type 3 in the Maximum Distance text box and press ENTER.
You have corrected the undershoot by extending the line with the dangle to the other line. If the distance to the next line had been greater than the three-meter maximum distance you specified, the line would not have been extended.

Correcting a double-digitized line
Sometimes a given line or part of a line is digitized twice in the course of creating the data. This may happen with CAD drawings or with lines digitized on a digitizing tablet.

Steps:
1. Click the Go Back To Previous Extent button on the Tools toolbar until you can see the one remaining error in this area of the data.

2. Zoom in to the remaining error.
3. Click Search Now on the Error Inspector window.
4. Click the numeric value in the Feature 1 column.

The line feature with the dangle flashes. Notice that the whole lot line did not flash.

5. Zoom in until you can see that there are two nearly parallel lot lines, one of which has the dangle.

You'll correct this error by deleting the extra line.
6. Right-click the numeric value in the Feature 1 column, click Select Features, then press the DELETE key. This deletes the extra line.
7. Click the Go Back To Previous Extent button on the Tools toolbar until you can see the area in which you have been working.

Reviewing the areas you have edited
You have fixed three errors that resulted from violations of the Must Not Have Dangles rule. In each case, the error was corrected by editing the geometry of a lot line feature by trimming, extending, or deleting the feature.

Viewing topology errors is useful for tracking where there are problems with your data, but correcting the error requires you to correct the data—you cannot edit
the topology error feature layer directly.

When you edit features in a topology, the topology tracks where changes have been made. These places are called dirty areas because a topology rule could potentially have been violated by the edits, but the error, if it exists, cannot be found until the dirty area is validated again. When you validate the topology again, it just checks the dirty areas.

You can see the areas that have been edited by showing the dirty areas in the topology layer.

**Steps:**
1. Right-click the topology in the table of contents and click **Properties**.
2. Click the **Symbology** tab.
3. Check **Dirty Areas**.
4. Click **OK**.

Now you can see the dirty areas on the map. The dirty areas cover the features that you edited. Dirty areas optimize the validation process, as only these must be checked for errors. Zoom out, if needed, so you can see all the entire extent of the dirty area boxes.

5. Click the **Validate Topology In Specified Area** button on the **Topology** toolbar.
6. Drag a box around the northern dirty area.

The dirty area is removed, and no errors are found in the area you validated.

7. Click the **Validate Topology In Current Extent** button on the **Topology** toolbar.

The topology is validated for the other areas you edited, and the dirty area is removed.

**Creating a report of the status of the data**

**Steps:**
1. Right-click the topology in the table of contents and click **Properties**.
2. Click the **Errors** tab.
3. Click **Generate Summary**.

The summary shows the number of topology errors and exceptions; you could have a different number of errors. You can save this report to a text file to document the status of the data, but you do not need to for this exercise.

<table>
<thead>
<tr>
<th>Rule</th>
<th>Errors</th>
<th>Exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Edge Longer Than Query Tolerance</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multi-Node Node Duplicates</td>
<td>147</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>147</td>
<td>0</td>
</tr>
</tbody>
</table>

4. Click **OK**.

**Fixing multiple errors at once**

Many errors, like the double-digitized line, need to be fixed one at a time by deleting, modifying, or moving individual features. Some errors must be fixed by
creating new features. However, sometimes a feature class contains a number of errors, such as overshoots and undershoots, that are simple to fix. When this is the case, you can select multiple errors at once with the Fix Topology Error tool and apply the same fix to all of them. If you prefer, you can individually check each error using the Error Inspector window. This is a workflow and quality assurance decision that your organization should make before you begin applying topology fixes to multiple errors.

It is also a good idea to look at your data and evaluate whether the fixes are appropriate. You would not want to trim lines with dangles that actually needed to be snapped to another line, or extend a line that actually needed to be trimmed. In this case, if you extend dangling lines that are within three meters of another line, you're not likely to cause problems with your data, since the parcels and rights-of-way are larger than three meters.

Now you'll use this method to clean up several errors at one time.

**Steps:**

1. Click the Full Extent button on the Tools toolbar.
2. Click the Fix Topology Error tool on the Topology toolbar.
3. Drag a box around all the errors on the map. This selects all of the errors. Now you'll fix the undershoots.
4. Right-click the map and click Extend.
5. The maximum distance you set when you fixed the other undershoot is fine, so press ENTER. The process may take a few seconds while all the features with dangles are checked to see if there is a feature within three meters to which they can be extended. The undershoots are fixed, and a number of dirty areas appear on the map. Each dirty area marks the bounding box of a feature that was edited by the extend error fix.
6. Click Search Now on the Error Inspector window. (If you closed the Error Inspector window, you can open it again from the Topology toolbar.) The number of topology errors is displayed to the right of the Show drop-down menu. Notice that many have not been fixed. You can trim the remaining errors and continue fixing topology errors to clean up this data if you want.
7. Click the Editor menu on the Editor toolbar and click Stop Editing.
8. Click Yes to save your edits.
9. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.
10. To continue to the next exercise, click Exercise 5a: Transforming data.

In this exercise, you created a geodatabase topology with simple rules to help you clean up data. You learned how to use the Error Inspector to find errors of a particular type and how to use some of the editing tools to fix errors in your data.

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**Exercise 5a: Transforming data**

**About transforming data**

A spatial adjustment transformation is used to convert the coordinates of a layer from one location to another. This involves scaling, shifting, and rotating features based on displacement links defined by the user. Transformations are applied uniformly to all features in a feature class and are often used to convert data created in digitizer units into real-world units represented on a map.

This exercise will show you how to apply a transformation based on displacement links that you will create. This transformation will move, scale, and rotate two feature classes containing parcel and building features into alignment with another set of parcel and building feature classes. You might use this technique to adjust data that was digitized or imported into a temporary feature class in preparation for copying and pasting the features into your database. You will also learn how to specify which features to adjust, preview the adjustment, and view a link table.

Spatial adjustments are based on displacement links. These are special graphic elements that represent the source and destination locations for an adjustment.

**Setting up the data and transformation options**

Prerequisite:

Start ArcMap and display the Editor, Snapping, and Spatial Adjustment toolbars.

**Steps:**

1. Click the Open button on the Standard toolbar.
2. Navigate to the Transform.mxd map document located in the \Editing\SpatialAdjustment directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)
3. Click the map and click Open.
4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes.
5. Click the Editor menu on the Editor toolbar and click Start Editing.
6. Close the Create Features window. You will not need it in this exercise.
7. Ensure vertex snapping is enabled. If it is not, click Vertex Snapping on the Snapping toolbar.

**Applying a transformation**

Spatial adjustment allows you to adjust a selected set of features or all the features in a layer. This setting is available on the Choose Input For Adjustment dialog box. The default is to adjust a selected set of features.

**Steps:**

1. You need to choose whether to adjust a selected set of features or all the features in a layer. Click the Spatial Adjustment menu on the Spatial Adjustment toolbar and click Set Adjust Data.
2. Click All features in these layers.
3. Uncheck the SimpleBuildings and SimpleParcels layers, keep the NewBuildings and NewParcels layers checked, then click OK.
4. Now that you have determined which features will be adjusted, the next step is to choose an adjustment method. Click the Spatial Adjustment menu, point to Adjustment Methods, then click Transformation - Similarity to set the adjustment method.

Adding displacement links
Displacement links define the source and destination coordinates for an adjustment. Displacement links can be created manually or loaded from a link file. In this exercise, you will create your own displacement links from the exterior corners of the NewParcels layer to the corresponding locations in the SimpleParcels layer.

Steps:
1. Click Bookmarks and click Transform.
2. Click the New Displacement Link tool on the Spatial Adjustment toolbar.
3. Snap to a from-point in the source layer and a to-point in the target layer.
4. Continue to create additional links as shown below. For this exercise, you will have a total of four displacement links when you are finished.

Adjusting the data

Steps:
1. Click the Spatial Adjustment menu and click Adjustment Preview to examine the adjustment. The preview allows you to see an adjustment prior to actually performing it. If the results of the adjustment are not adequate, you can modify the links to improve the accuracy of the adjustment.
2. Click View Link Table on the Spatial Adjustment toolbar. The link table provides information about link coordinates, link IDs, and RMS errors. Right-clicking a link record opens a shortcut menu. You can edit link coordinates, flash links, zoom and pan to selected links, and delete links with these commands. If the RMS error for this adjustment is not acceptable, you can modify the links to increase the accuracy. The preview window and link table are designed to help you fine-tune your adjustment. The final step of the spatial adjustment process is to perform the adjustment.
3. Click the Spatial Adjustment menu and click Adjust. The adjusted data looks like this:
4. Click the Editor menu on the Editor toolbar and click Stop Editing.
5. Click Yes to save your edits.
6. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.
7. To continue to the next exercise, click Exercise 5b: Rubbersheeting data.

In this exercise, you learned how to set your data for an adjustment, create displacement links, preview the adjustment, and adjust the data.

Exercise 5b: Rubbersheeting data

About rubbersheeting

Rubbersheeting is typically used to align two or more layers. This process moves the features of a layer using a piecewise transformation that preserves straight lines.

This exercise will show you how to rubber sheet data by using displacement links, multiple displacement links, and identity links. You will rubber sheet a newly imported set of street features to match an existing feature class of street features.

Setting up the data and rubbersheeting options

Prerequisite:

Start ArcMap and display the Editor, Snapping, and Spatial Adjustment toolbars.

Steps:

1. Click the Open button on the Standard toolbar.
2. Navigate to the Rubbersheet.mxd map document located in the \Editing\SpatialAdjustment directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)
3. Click the map and click Open.
4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes.
5. Click the Editor menu on the Editor toolbar and click Start Editing.
6. Close the Create Features window. You will not need it in this exercise.
7. Ensure vertex snapping is enabled. If it is not, click Vertex Snapping on the Snapping toolbar.
8. You need to choose whether to adjust a selected set of features or all the features in a layer. Click the Spatial Adjustment menu on the Spatial Adjustment toolbar and click Set Adjust Data.
9. Click All features in these layers.
10. Make sure only the ImportStreets layer is checked. If necessary, uncheck the ExistingStreets layer. Click OK.
11. Click the Spatial Adjustment menu, point to Adjustment Methods, then click Rubbersheet to set the adjustment method.
12. Click the Spatial Adjustment menu and click Options.
13. Click the General tab.
14. Click Rubbersheet for the adjustment method so you can set additional options for rubbersheeting.
15. Click Options.
16. Click Natural Neighbor and click OK.
17. Click OK to close the Adjustment Properties dialog box.

Adding displacement links

Displacement links define the source and destination coordinates for an adjustment. Displacement links can be created manually or loaded from a link file.

In this exercise, you will create your own displacement links at several key intersections of the ExistingStreets and ImportStreets layers.

Steps:

1. Click Bookmarks and click Import streets to set the current view to the area of this exercise.
When the display refreshes, note that the ImportStreets layer is not aligned with the ExistingStreets layer. You must adjust the ImportStreets layer so it aligns with the ExistingStreets layer by using the rubbersheet adjustment method.

2. To get a better view of the adjustment area, zoom to the Intersections bookmark, which was created for you. Click Bookmarks and click Intersections.

3. Click the New Displacement Link tool on the Spatial Adjustment toolbar.

4. Snap the link to the source location in the ImportStreets layer, as shown below:

5. Snap the link to the destination location in the ExistingStreets layer, as shown below:

6. Continue to create links at the perimeter intersections of the layers in a counterclockwise direction. Look at the SnapTips to ensure you are snapping to the correct location. You will create a total of six displacement links, as shown below:

---

**Adding multiple displacement links**

**Steps:**

1. To get a better view of the adjustment area, zoom to the Curve features bookmark, which was created for you. Click Bookmarks and click Curve features.
To preserve the curved road features, you can add multiple links at critical points.

2. Click the **Multiple Displacement Links** tool on the **Spatial Adjustment** toolbar.
   The Multiple Displacement Links tool allows you to create multiple displacement links in one operation. This tool can help save time by allowing you to create more than one link simultaneously; it is especially useful for curved features.

3. Click the curved road feature in the ImportStreets layer.

4. Click the curved road feature in the ExistingStreets layer.

5. You will be prompted to enter the number of links to create. Accept the default value (10) and press ENTER.
   The multiple links now appear in the map.

6. Create multiple links for the other curved feature.

7. Click the **New Displacement Link** tool on the **Spatial Adjustment** toolbar.

8. Add the final displacement links, as shown below:
Adding identity links

Identity links are used to anchor features at specific points to prevent their movement during an adjustment. You will now add identity links at key intersections to maintain their locations.

Steps:
1. Click the New Identity Link tool on the Spatial Adjustment toolbar.
2. Zoom out and add five identity links at the intersections as shown below:

Adjusting the data

Steps:
1. Click the Spatial Adjustment menu and click Adjustment Preview to examine the adjustment. The preview allows you to see an adjustment prior to actually performing it. If the results of the adjustment are not adequate, you can modify the links to improve the accuracy of the adjustment.
2. Click the Spatial Adjustment menu and click Adjust.
3. Here is how the adjustment should appear:

Notice that all the displacement links you created have turned into identity links. The next step is to delete these links, since you no longer need them.

4. Click the Edit menu and click Select All Elements. This allows you to select the links, since they are graphic elements.
5. Press the DELETE key.
6. Click the Editor menu on the Editor toolbar and click Stop Editing.
7. Click Yes to save your edits.
8. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.
9. To continue to the next exercise, click Exercise 5c: Edgematching data.

In this exercise, you learned how to set your data for an adjustment, create displacement links, preview the adjustment, and adjust the data.
About edgematching data

Edgematching is used to align features along the edges of adjacent layers. Usually, the layer with the less accurate features is adjusted, while the other layer is used as the target layer. Edgematching relies on displacement links to define the adjustment.

In this exercise, you will edgematch two adjacent tiles of stream data by using displacement links that you will create. You will also learn how to use the Edge Match tool and set edge snap properties.

Setting up the data and edgematching options

Prerequisite:

Start ArcMap and display the Editor, Snapping, and Spatial Adjustment toolbars.

Steps:

1. Click the Open button on the Standard toolbar.
2. Navigate to the EdgeMatch.mxd map document located in the \Editing\SpatialAdjustment directory where you installed the tutorial data. (C:\ArcGIS\ArcTutor is the default location.)
3. Click the map and click Open.
4. If you still have the map document open from the previous exercise and are prompted to close it, you can do so without saving your changes.
5. Click the Editor menu on the Editor toolbar and click Start Editing.
6. Close the Create Features window. You will not need it in this exercise.
7. Ensure end snapping is enabled. If it is not, click End Snapping on the Snapping toolbar.
8. You need to choose whether to adjust a selected set of features or all the features in a layer. Click the Spatial Adjustment menu on the Spatial Adjustment toolbar and click Set Adjust Data.
9. Click Selected features.
10. Click OK.
11. Now that you have determined which features will be adjusted, the next step is to choose an adjustment method. In this exercise, you will use Edge Snap.
12. Click the Spatial Adjustment menu, point to Adjustment Methods, then click Edge Snap to set the adjustment method.
13. Click the Spatial Adjustment menu and click Options.
14. Click the General tab.
15. Click Edge Snap for the adjustment method so you can set additional options for edgematching.
16. Click Options.
17. Click Line as the method and click OK.
   The line method only moves the endpoint of the line being adjusted. The smooth method distributes the adjustment across the entire feature.
   The edgematch adjustment method requires you to set properties that will define the source and target layers as well as determine how the displacement links will be created when using the Edge Match tool.
18. Click the Edge Match tab.
19. Click the Source Layer drop-down arrow and click StreamsNorth.
20. Click the Target Layer drop-down arrow and click StreamsSouth. The StreamsNorth layer will be adjusted to match the target layer, StreamsSouth.

21. Check One link for each destination point.
22. Check Prevent duplicate links and click OK.

Adding edgematch displacement links

Steps:

1. Click Bookmarks and click West streams to set the current view to the edit area of this exercise.
Displacement links define the source and destination coordinates for an adjustment. In this exercise, you will create multiple links using the Edge Match tool.

2. Click the **Edge Match** tool on the **Spatial Adjustment** toolbar.
3. Drag a box around the endpoints of the features. The Edge Match tool creates multiple displacement links based on the source and target features that fall inside the box.

Displacement links now connect the source and target features at their endpoints.

Edgematch displacement links are created between the closest source and target features that fall within the snapping tolerance distance. If links were not created when you dragged a box around the edges, zoom out a little and try again. This should help because the snapping tolerance units are screen pixels and your display resolution may be relatively high.

Since edgematching only affects the exterior regions of the layer, you must select the features you want to adjust.

4. Click the **Edit** tool on the **Editor** toolbar.
5. Drag a box around the features that are to be edgematched, as shown below.
6. Click Bookmarks and click East streams.
7. Repeat the same steps used for creating links with the Edge Match tool for the east streams portion of the data.
8. You will need to hold down the SHIFT key while you select the stream features so the features from the west side stay selected.

**Adjusting the data**

**Steps:**

You can examine how an adjustment will appear prior to actually performing it with the preview window. You can use the standard ArcMap Zoom and Pan tools to navigate in the preview window.

1. Click the Spatial Adjustment menu and click Adjustment Preview to examine the adjustment. The preview allows you to see an adjustment prior to actually performing it. If the results of the adjustment are not adequate, you can modify the links to improve the accuracy of the adjustment.
2. Click the Spatial Adjustment menu and click Adjust.
3. Here is how the adjustment should appear:

4. Click the Editor menu on the Editor toolbar and click Stop Editing.
5. Click Yes to save your edits.
6. Close ArcMap if you are done working with the tutorial. You do not need to save the map document.
7. To continue to the next exercise, click Exercise 5d: Transferring attributes between features.

In this exercise, you learned how to set edgematch properties, use the Edge Match tool to create displacement links, preview the adjustment, and perform it.
6. Close the **Create Features** window. You will not need it in this exercise. Before you transfer attributes, set your snapping environment for your source and target layers. This will ensure that you select the correct feature when using the Attribute Transfer tool.

7. Ensure edge snapping is enabled. If it is not, click **Edge Snapping** on the **Snapping** toolbar. The first step in the Attribute Transfer process is to set the source and target layers. The Attribute Transfer Mapping dialog box allows you to define these settings.

8. Click the **Spatial Adjustment** menu and click **Attribute Transfer Mapping**.

9. Click the **Source Layer** drop-down arrow and click the **Streets** layer.

10. Click the **Target Layer** drop-down arrow and click the **NewStreets** layer.

The next step is to specify which fields to use for the attribute transfer. You will select a field in the source layer and match it to a corresponding field in the target layer. The Attribute Transfer tool uses these matched fields to determine which data to transfer.

11. Click the **NAME** field in the **Source Layer** field list box.

12. Click the **NAME** field in the **Target Layer** field list box.

13. Click **Add**. The fields are now added to the **Matched Fields** list.

14. Repeat the same steps for the **Type** fields and click **OK**.

**Using the Attribute Transfer tool**

**Steps:**

1. Click **Bookmarks** and click **New streets** to set the current view to the edit area of this exercise.

Prior to performing the attribute transfer, verify the attributes of the source and target features. This can be done using the Identify tool.

2. Click the **Identify** tool on the **Tools** toolbar.

3. Click the source feature indicated, as shown below.

4. Notice the **NAME** and **Type** field attributes. These attribute values will be transferred to the target feature.
5. With the Identify tool still active, click the target feature.

6. Notice the NAME and Type fields; attribute values for these fields will be transferred from the Streets layer. You will now use the Attribute Transfer tool to transfer the source feature attributes to the target feature.

7. Click the Attribute Transfer tool on the Spatial Adjustment toolbar.

8. Snap to an edge of the source feature, as shown below:

9. Drag the link toward the target feature.

10. Snap to an edge of the target feature and click.

To transfer the attributes of a source feature to multiple target features, hold down the SHIFT key while selecting the target features.

Verifying the results of the attribute transfer

Now that you have transferred the attributes from the source feature to the target feature, it is a good idea to verify that the target feature was updated with the proper information.

Steps:

1. Click the Identify tool on the Tools toolbar.

2. Click the target feature. The NAME and Type fields in the target feature reflect the new attributes.
3. Click the Editor menu on the Editor toolbar and click Stop Editing.
4. Click Yes to save your edits.
5. Close ArcMap.

In this exercise, you learned how to transfer attributes from a source layer to a target layer. You have now completed the editing tutorials.

Adding a point at the endpoint of a line

Sometimes it may be necessary to create point features at the endpoints of line features. In a stream network, you might want to place a point at the beginning of a stream to represent a spring. When working with a utility network, you may need to have the endpoints of secondary electric lines be capped by either a transformer or meter.

Steps:
1. Ensure end snapping is enabled. If it is not, click End Snapping on the Snapping toolbar.
2. Click a point feature template in the Create Features window.
3. Snap to the ends of an existing line and click to add the point.

Related Topics
Creating a point or vertex at the midpoint of two locations
Creating new points along a line

Creating a point or vertex at the midpoint of two locations

Midpoint allows you to place a point or vertex by clicking two points; the new point or vertex is placed at the midpoint of the line between these points. If you were creating street centerlines from parcel data, you might use Midpoint to create the vertices directly between the parcels on opposing sides of the road.

Steps:
1. These steps can be used to create either point features or vertices in lines and polygons:
   - To create a point feature: Click a point feature template in the Create Features window and click the Point tool.
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click Midpoint on the Editor toolbar construction method palette.
3. Click once to establish the first of two points. The new vertex is created between this point and the next point you click.
4. Click the second point to place the vertex or point at the midpoint of the line between the two points you clicked.

Related Topics
Adding a point at the endpoint of a line
Creating a point or vertex at a direction and distance
Creating a point or vertex at an exact x,y location (absolute x,y)
Creating a point or vertex at the intersection of two distances
Creating a point or vertex at the intersection of two segments

Creating new points along a line

Construct Points creates new point features at intervals along a selected line. For instance, you could use Construct Points to place utility poles along an electric...
line. You can create a specific number of points that are evenly spaced, or you can create points at an interval you choose based on distances or m-values.

When creating the points, you have three options:

- **Number of points**—A specific number of points are created along the selected line so they are evenly spaced. In this example, two points, evenly spaced, are created on the line.

  ![Number of points example](image)

- **Distance**—The points are created on the selected line based on an interval that is measured in map units from either the start or end of the line. Arrows are shown to indicate the direction of the selected line. In this case, the line starts at the left and ends at the right.

  ![Distance example](image)

  With a 100-meter line and an interval of 20 meters, all the points are evenly spaced along the line from the start point on the left.

  ![Distance example with 100m and 20m interval](image)

  However, with the same 100-meter line and starting direction, an interval of 30 meters results in the points being placed unevenly. The last point is placed less than 30 meters to the end of the line, since 30 does not divide evenly into 100.

  ![Distance example with 100m and 30m interval](image)

- **By measures (m-values)**—The points are created on the selected line based on an interval that is measured in m-values along the line. Click this option, type the interval, then click whether the points should originate from the start or end of the line. Arrows are drawn on the map to indicate the direction of the line.

  ![By measures (m-values) example](image)

  For any of these options, you can create additional points at the start and end of the line.

**Steps:**

1. Click the **Edit** tool on the **Editor** toolbar.
2. Click the line feature along which you want to generate points.
3. Click the **Editor** menu and click **Construct Points**.
4. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the **Template** button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
5. Choose how you want the points to be created.
   - Number of points
   - Distance
   - By measures (m-values)
6. Choose whether to place additional points at the start and end of the line.
7. Click **OK**.

**Related Topics**

- Adding a point at the endpoint of a line
- Creating new lines from points

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**Moving a vertex to an exact x,y location (absolute x,y)**

You can move a vertex (or point) by specifying new x,y locations when you obtain additional data that provides the exact coordinate location at which the vertex should be. For example, suppose a parcel is resurveyed and a new Global Positioning System (GPS) point is obtained for the parcel corner. You can move the corner of the parcel to match the location found by the GPS by specifying the equivalent location in x,y coordinates.

You can specify the location as a longitude-latitude coordinate pair, a Military Grid Reference System (MGRS) location, a U.S. National Grid (USNG) location, or a Universal Transverse Mercator (UTM) coordinate. If you are entering a coordinate pair, you see two boxes on the dialog box, compared with one box for grid locations.

For more information on valid formats when entering locations, see [About distance units and editing](#).

**Steps:**

1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Position the pointer over the vertex until it changes to the move pointer. To move multiple vertices, drag a box around them and position the pointer over one of the selected vertices.
3. Right-click and click **Move To**.
4. Click the **Units** button and click the unit you want to use to enter the location.
5. Type the coordinates or grid location of the place you want to move the vertex and press ENTER.
6. Right-click anywhere on the map and click **Finish Sketch**.

**Related Topics**

- About distance units and editing
- Moving a feature relative to its current location (delta x,y)
- Moving a vertex by dragging it
- Moving a vertex relative to its current location (delta x,y)
Moving a vertex without changing a feature's general shape

Moving a feature relative to its current location (delta x, y)

Specify x, y coordinates when you want to move a feature to a precise location. ArcMap uses the current location of the selected feature or features as the origin (0,0) and moves them from that location according to the coordinates you specify. In other words, the coordinates you enter are relative to the current position of the features. The coordinates are measured in map units. The graphic below illustrates the change in location when delta x, y coordinates of 2, 3 are specified for a building.

In the example above, the building is moved up and to the right as positive coordinate values are specified. To move the building left and down, specify negative values.

Steps:
1. Click the Edit tool \p on the Editor toolbar.
2. Click the feature or features you want to move. Hold down the SHIFT key while clicking features to select additional features.
3. Click the Editor menu and click Move.
4. Type the desired delta x, y distance and press ENTER.

Related Topics
Moving a feature and snapping it to another feature
Moving a feature by dragging it
Moving a point to a specific x, y location (absolute x, y)

Editing a vertex's m-value or z-value

Vertices can store additional attributes besides x, y locations. The attributes include m-values and z-values, which are often used to store information about route measures and elevation. These attributes are added and modified using the Edit Sketch Properties window. You can open the window by selecting a feature with the Edit tool, double-clicking it, then clicking the Sketch Properties button on the Editor toolbar.

Note: To add m- or z-values to a vertex, you must have specified that the feature class be able to store them when you created the feature class. If you did not set this property, you need to create a new feature class and import the existing features into it.

Steps:
1. Click the Edit tool \p on the Editor toolbar and double-click the feature you want to edit.
2. Click the Sketch Properties button \p on the Editor toolbar.
   When the Edit tool or a construction tool is active, you can press the P key as a shortcut to opening the window.
3. Click the cell for the m-value or z-value you want to edit and type a new value.
4. To change the m-values or z-values for multiple vertices, check the boxes to the left of the vertices you want to update.
5. Click the M button \p to edit m-values or click the Z button \p to edit z-values.
   - For m-values: Either clear the m-values (resets them to NaN) or type a new m-value and click OK.
   - For z-values: Type the new z-value and click OK.
   The m-values and z-values are applied to all the selected (checked) vertices.
6. When you are done, click Finish Sketch \p on the Edit Sketch Properties window.

Related Topics
Using the Edit Sketch Properties window

Removing points that fall inside a polygon

You have several options if you want to delete points that are within a polygon.

Selecting and deleting features while editing
If you have only a few points, you can simply select them and delete them while editing.
Creating a cul-de-sac

Steps:
1. Use Select By Location to select those features from the points layer that intersect the polygon layer.
2. If you instead want to delete the points that are outside the polygon, right-click the layer, point to Selection, then click Switch Selection.
3. Press the DELETE key.

Using the Erase Point geoprocessing tool
If you have many points or multipoint features, use the Erase Point geoprocessing tool to remove the points that are either inside or outside a polygon. This tool is most useful if you have a large dataset of multipoint features that you want to clip without making a new output feature class. For example, use the tool when you have a lidar dataset containing mass points stored as multipoint features and want to remove the points that are outside your area of interest (outside a polygon) or want to remove the points that are on water bodies (inside a polygon).

Creating lines that connect to other lines

Steps:
1. Ensure end snapping is enabled. If it is not, click End Snapping on the Snapping toolbar.
2. Ensure edge snapping is enabled. If it is not, click Edge Snapping on the Snapping toolbar.
3. Click a line feature template in the Create Features window.
4. Click the Straight Segment construction method on the Editor toolbar.
5. Snap to an existing line, then click to add a start vertex in the new line.
6. If you want the end vertex to meet at an existing line, make sure your end vertex snaps when you add the vertex and finish the sketch.

Creating a cul-de-sac

There are several ways to create a cul-de-sac line, which is the end of a dead-end street or alley that widens to provide a circular turnaround for vehicles.

Steps:
1. Use the Integrate geoprocessing tool.
2. Ensure edge snapping is enabled. If it is not, click Edge Snapping on the Snapping toolbar.
3. Click a line feature template in the Create Features window.
4. Click the Straight Segment construction method on the Editor toolbar.
5. Snap to an existing line, then click to add a start vertex in the new line.
6. If you want the end vertex to meet at an existing line, make sure your end vertex snaps when you add the vertex and finish the sketch.

Creating a cul-de-sac using COGO tools (ArcEditor and ArcInfo)
The Cul-de-sac command on the COGO toolbar creates a symmetrical or asymmetrical cul-de-sac from a street centerline. A cul-de-sac is the end of a dead-end street or alley that widens to provide a circular turnaround for vehicles.

A cul-de-sac consists of two or three circular line features, depending on your input values. The main circular feature is centered on the end of the selected centerline with a radius that you specify. Two other minor circular features (known as return or reverse curves) are created at the intersection between the main circular feature and lines parallel to the centerline. These fillet curves have a (return) radius that you specify.

You can create a cul-de-sac from either a straight or curved centerline. Sometimes a cul-de-sac is designed with the main circular feature being offset 90° from the end of the centerline. This is an asymmetrical cul-de-sac.
Steps:
1. Click the **Edit** tool on the **Editor** toolbar.
2. Click the lines you want to use for a centerline. You must select lines that form a single continuous shape. In other words, you cannot use multiple lines or multipart features that have gaps or are disjointed.
3. Click **Cul-de-sac** on the **COGO** toolbar.
4. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the **Template** button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
5. Click **Start Point of Line** if you want to add the cul-de-sac features at the first vertex, or click **End Point of Line** if you want to add the cul-de-sac features at the last vertex.
6. If you want to create an asymmetrical cul-de-sac, check **Create offset cul-de-sac**.
7. Type a radius, return radius, and street width.
8. Click **OK**. Two or three line features are created using the properties of the feature template you chose. Any COGO fields are populated.

Creating a cul-de-sac using regular editing tools
You can create a cul-de-sac using the regular editing tools with any ArcGIS license.

Steps:
1. Click a line feature template in the **Create Features** window.
2. Click the **Straight Segment** construction method on the **Editor** toolbar.
3. Draw a straight line segment, but do not finish the sketch.
4. Click **Arc** on the **Feature Construction** or **Editor** toolbar and create an arc segment. Do not finish the sketch.
5. Change back to the Straight Segment method, draw the remaining segment, then finish the sketch.

Reshaping a line

The Reshape Feature tool lets you reshape a line by constructing a sketch over a selected feature. The feature takes the shape of the sketch from the first place the sketch intersects the feature to the last.

When you reshape a line, the line takes the shape of the sketch you draw.

Tip: If you want to reshape a feature to match another one, you can use the Reshape Feature tool in conjunction with the Trace construction method. Select the feature, click the Reshape Feature tool, click Trace from the palette on the Editor toolbar, and follow along the edge to perform the reshape.

Steps:
1. Click the **Edit** tool on the **Editor** toolbar.
2. Click the feature you want to reshape.
3. Click the **Reshape Feature** tool on the **Editor** toolbar.
4. Click the map to create a line according to the way you want the feature reshaped.
   - You can snap the sketch to the selected edge or cross it to indicate where to start and stop reshaping. The sketch must cross (or touch the edge) two or more times for it to be reshaped.
5. To change the shape of the sketch segment, click a construction method type on the **Editor** toolbar or on the **Feature Construction** mini toolbar. Segments can be created using a variety of methods—for example, as straight lines, with curves, or traced from the shapes of other features. You can also use keyboard shortcuts or right-click to access a menu of commands to help you place vertices in the sketch.
6. Right-click anywhere on the map and click **Finish Sketch**.

Related Topics
Reshaping a polygon
Reshaping a line to match another feature

You can reshape a line to reflect a change, align with another line or polygon, or match an object in an image. For example, a line representing a sidewalk can be updated to match a road’s edge of pavement line after the road is widened.

Steps:
1. Click the Edit tool  on the Editor toolbar.
2. Select the line you want to reshape.
3. Click the Reshape Feature tool  on the Editor toolbar.
4. Click Trace  on the Editor toolbar palette.
5. Click the line or polygon edge you want to use to update the shape of the original line and trace along it. If you want to add an offset, right-click, click Trace Options, and enter an offset value. You might use an offset when updating road curb lines by tracing new road centerlines.
6. Make sure that the sketch intersects or completely crosses the selected line at least two times so the reshaping can be completed.
7. When you are finished tracing and creating the shape of the feature, double-click to finish the sketch.

Extending a line to an intersection with another line

The Extend tool  on the Advanced Editing toolbar lets you click a line feature and extend it to another selected line feature. To use the Extend tool, select the feature that you want to extend lines to, then start clicking the lines you want to extend.

Steps:
1. Click the Edit tool  on the Editor toolbar.
2. Select the line segment to which you want to extend a line.
3. Click the Extend tool  on the Advanced Editing toolbar.
4. Click the endpoint of the feature you want to extend. The line you clicked is extended to the selected line.

Related Topics
Extending multiple lines

Trimming a line to an intersection with another line

The Trim tool  on the Advanced Editing toolbar lets you click a line feature and trim it based on its intersection with a selected line feature. To use the Trim tool, select the feature that you want to use as a cutting line, then start clicking the intersecting line segments that you want to trim. The part of the line that you click will be removed.
Steps:
1. Click the **Edit** tool on the **Editor** toolbar.
2. Select the line segment at which you want to trim a line.
3. Click the **Trim** tool on the **Advanced Editing** toolbar.
4. Click the end of the feature that you want to trim.

The line you clicked is trimmed to the selected line.

Related Topics
- Trimming a line to a specific length
- Trimming multiple lines

Methods for splitting line features

You can easily split line features to break them into several line features. There are several methods to split lines:

- At the location where you click (Editor toolbar > Split tool)
- At a specific distance or percentage (Editor menu > Split command)
- Into an equal number of parts (Editor menu > Split command)
- At intersections, either existing or where lines are extended to meet (Advanced Editing toolbar > Line Intersection tool)
- At all intersections (Topology toolbar > Planarize Lines)
- At specific distances, with any leftover line length being apportioned among the segments (COGO toolbar > Proportion command)
- At each vertex of the line or at points along a line (Split Line At Vertices or Split Line At Points geoprocessing tools)

Splitting lines manually

The **Split** tool is used to manually split one line into two at the location you click with the mouse. For example, you can use the Split tool to divide a street centerline into two features when a new intersecting road is constructed. If the two roads cross, you can use intersection snapping to precisely locate the point to split.

The split operation updates the shape of the existing feature and creates a new feature using the default attribute values for the feature class.

Splitting lines at a specified distance or percentage

The **Split** command on the Editor menu can split a selected line from either the start point or end point of the line by using a specified distance value, a percentage of total length, or an m-value. Split updates the shape of the existing feature and creates one or more new features using the default attribute values for the feature class.

Split dialog box displays the length of the original feature in current map units to help you split it accurately. Arrows are shown on the feature to indicate the line's direction, so you can choose whether you want to split the line from the start or end point of the line. These arrows will help ensure that the line is split from the proper orientation.

Splitting a line into an equal number of parts

The **Split** command on the Editor toolbar allows you to split a line into an equal number of new features. For example, you can use this Split option to break a line into pieces that are the same length. This functionality is similar to the **Divide** command available in previous ArcGIS releases.

Splitting lines at intersections

The **Line Intersection** tool allows you to split line features at their intersections. The lines are split at the location where you click the mouse. The split operation updates the shape of the existing feature and creates a new feature using the default attributes for the feature class.

There can be many potential intersections between the lines' features, and the intersection points can be either at specific locations in the middle of both lines or at implied intersections along extensions to one or both lines. When a feature needs to be extended to a point of intersection, you can either extend the existing feature or add a new feature.

In the simplest case, there is a single intersection between the line features. In the graphics below, the line features are drawn in black, and the pointer is placed at the intersection. The graphic on the right shows red lines leading to an implied intersection. In that case, the lines will be extended to the intersection.
In more complex cases, there can be many points of intersection, although you can split only one intersection at a time. You can press the TAB key to cycle through the possible intersections. As you move your pointer, the intersection solution closest to the pointer is shown. Click at that location to perform the split.

When working with multipart lines, only one part will be split at a time. Even if more than one part intersects the same line feature, only the part that corresponds to the intersection solution you clicked will be split. Once you have split the first part, simply use the Line Intersection tool again and split the other part at the second intersection.

Splitting all lines at intersections

This section applies to ArcEditor and ArcInfo only.

You can split selected lines where they intersect using Planarize Lines on the Topology toolbar. You do not need to have a map topology or geodatabase topology to use Planarize.

When Planarize is used on a multipart line feature, it is split at the point of intersection into a new feature.

Splitting lines proportionally

This section applies to ArcEditor and ArcInfo only.

The Proportion command on the COGO toolbar splits a selected line feature into a number of segments, based on specified distance values. If there is a difference between the feature length and the entered values, this difference is proportioned between all the new segments. Proportion is useful when you are working with exact measurements, such as COGO or survey data.

For example, you have line features that need to be split into specific lengths. The example below shows a line feature that needs to be split into four parts: 13.79 feet, 48 feet, 60 feet, and 60 feet. The Proportion command is used to split this feature into the four new features.

The lengths you entered add to 181.79 feet. If the length of the input feature is either longer or shorter than this value, the difference is proportioned among the new features. So if the length of the original feature were 182 feet, it is to be proportioned into features that are as follows: 13.807 feet, 48.055 feet, 60.069 feet, and 60.069 feet long.

Splitting lines at vertices or at points on the line

You can use geoprocessing tools to split a line at its vertices or at the points on the line. The Split Line At Vertices tool splits a line at its vertices so that each segment in the original line becomes a new feature. The Split Line At Point tool splits input lines at the locations of point features on the line or within a tolerance of the line.

Tips on splitting lines

Tip: When working with geodatabase features, you can set up split policies that control the behavior of an object’s attributes when it is split.

Tip: If you are working with representations and shape overrides, learn more about how they behave in a split.

Related Topics

Splitting a line into an equal number of parts
Splitting lines at a specified distance or percentage
Splitting lines at intersections
Splitting lines at intersections with Planarize Lines
Splitting lines manually
Splitting lines proportionally

Editing shared geometry

Polygon features often form a continuous fabric and are often coincident with lines. If you are mapping parcels, soils, administrative zones, or land uses, for example, you will frequently need to modify shared edges or polygon borders. For example, you might need to edit the boundary between urban and agricultural land-use zones as development occurs.

To work with shared geometry, you will need to have a map or geodatabase topology on your data. Then you can select edges and nodes that may be shared by more than one feature, modify them, and update all the features that share the node or edge.

Steps:
1. Create either a map topology or a geodatabase topology on your data.
2. Click the Topology Edit tool on the Topology toolbar.
3. Use the Topology Edit tool to select and manipulate the shared edges and nodes. You also can use Reshape Edge to update the shape of the edge or Modify Edge to edit the segments and vertices. When you use the topology editing tools, all the features sharing the edge are updated at the same time.

Related Topics
About editing shared geometry

Flipping the direction of a line

Flipping reverses the direction of a selected line so that the last vertex of the sketch becomes the first, thereby changing the from-to direction of the feature. Flipping can be useful for editing lines in which the line orientation represents flow direction, and when using symbols, such as arrowheads, that depend on the orientation of the line. It may be helpful for you to add arrowhead symbols to a line first to determine which lines need to be reversed.

In the graphics below, the original digitized direction is left to right (since the red vertex indicates the last vertex). The flipped digitized direction is right to left, as you can tell by noting the new position of the red vertex.

The following steps describe flipping one line at a time. If you need to flip the direction of multiple lines, use the Flip Line geoprocessing tool.

Steps:
1. Click the Edit tool on the Editor toolbar and double-click the feature you want to edit.
2. Right-click any part of the sketch and click Flip.
   The sketch becomes inverted (the first vertex becomes the last, marked in red).
3. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Flip Line

Creating segments by tracing

Tracing is a quick and accurate way of creating new segments that follow the shapes of other features. You can trace directly on top of a feature or apply an offset value. To trace, use either the Line or Polygon tool in conjunction with the Trace construction method on the palette on the Editor toolbar (or the Feature Construction mini-toolbar).

Tracing is particularly useful when the features you want to follow have curves or intricate shapes, since snapping is more difficult in those cases. For example, when digitizing a forest boundary that is adjacent to a river, tracing the river is an easy way to create the forest segments shared with the river.

In another scenario, suppose you want to create new lines to represent the road centerlines through a neighborhood. By tracing, you can create new segments that follow the parcel boundaries yet constructed at an offset value to represent the road centerlines.
When tracing, you can specify several settings. To open the Trace Options dialog box, right-click while tracing or press the O key. To trace at an offset, enter a value into the Offset text box. If you enter 0, you will trace directly on top of the existing features. This is one way of duplicating segments in existing features. You also can specify to trace only a certain length or set the appearance of the corners—mitered, beveled, or rounded. In addition, you can choose to remove self-intersecting loops. If the offset distance is large enough, self-intersecting loops are created to preserve any shape attribute values. By checking this option, you automatically remove these loops and drop the associated vertices.

By default, the trace can follow along any feature near your pointer. If you want to trace only features that are selected, hold down the CTRL key while tracing. There is also an option for tracing selected features on the Trace Options dialog box. (If you turn on the option, CTRL then does the reverse, and temporarily allows you to trace any feature.)

**Steps:**

1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line
     - Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon
     - Click a polygon feature template in the Create Features window and click the Polygon tool.

2. Click Trace on the Editor toolbar palette.

3. Optionally, right-click and click Trace Options or press the O key to set an offset value and other options as desired. If you want to trace directly on top of existing features, enter a value of 0.

4. Click the map to create the first vertex and start tracing.

5. Drag to trace along a feature. If you trace too far or trace in the wrong direction, you can move the pointer backward over what you have traced. If you have clicked to stop the trace and add the vertices, you can click Undo to remove all vertices added during the trace. Press ESC if you need to cancel the trace.

6. As you are tracing, you can change which features are being traced by pointing to them and clicking or dragging. If you want to trace only selected features, hold down the CTRL key. When tracing complicated segments, you can press the SPACEBAR to suspend snapping temporarily if you find the trace is getting too slow.

7. When tracing at an offset, you can press the TAB key to trace on the opposite side of the edge. This simply makes the offset value negative on the Trace Options dialog box.

8. To pan the map while tracing, press either the C key or the middle mouse button. You can also use continuous map panning if you are using basemap layers.

9. Optionally, you can switch between tracing and other segment construction methods using the Feature Construction mini toolbar or the palette on the Editor toolbar. For example, this allows you to trace, create a straight or curved segment, then return to tracing.

10. Right-click anywhere on the map and click Finish Sketch.

**Related Topics**

- Creating a feature by drawing freehand
- Creating segments by streaming vertices
- Setting options for streaming

**Copying parallel line features**

Copy Parallel makes a copy of selected lines at a distance you specify. You can choose to copy the new lines to the left, right, or both sides of the selected lines. You can use the Copy Parallel command, for example, to create a street centerline or a gas line that runs parallel to a road. If you use Copy Parallel to copy lines on both sides of the selected line, you can create road edge of pavement lines from a street centerline. When using Copy Parallel, you need to choose a feature template, which specifies the layer that will store the new feature and the default attribute values that will be applied to the feature.

When copying, you can specify the method for how corners are created. The graphics below show the different corner options, where the blue selected line is the original line that is being copied. The beveled option (left) adds a line segment to create a beveled corner. The mitered option (center) extends line segments until they intersect. The rounded option (right) adds a curved segment at the corner.
Selecting multiple lines: Copy Parallel works with one or more selected lines. Arrows are drawn on the line feature or features to show you the direction of the selection. Various options are available to ensure the lines are copied to the side you want. If you select multiple lines and they form a single continuous line (regardless of the direction of the lines), the Treat selection as a single line option is available.

In the following example, there are two line features whose endpoints are coincident. However, the digitized direction of the lines are different, as shown by the converging arrows.

If you want to copy those lines to the left side, for example, you will get different results depending on which options you choose at the bottom of the Copy Parallel dialog box. If you uncheck the Treat selection as a single line option, you get a feature created for each line in the selection, but they will be on the left side of the original features' directions.

If you check the Treat selection as a single line option, the arrows dynamically flip so the direction of all the selected lines is the same (this does not change the lines' actual directions). Now, when you want to copy to the left, you get one feature on the left of the arrows, and the resulting lines are all on the same side.

If you also check the Create new feature for each selected line option, you will get a feature created for each line in the selection.

Self-intersecting loops: If the Copy Parallel offset distance is large enough, self-intersecting loops may occur. Maintaining these loops allows you to retain any attribute values of the features. However, if you do not want them to be created, make sure you check the option for Remove self-intersecting loops. This option must be on when you check both the Treat selection as a single line and Create a new feature for each selected line.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the line you want to copy.
3. Click the Editor menu and click Copy Parallel.
4. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
5. Type the distance in map units from the original feature where you want to copy the line.
6. Click the Side drop-down arrow and click whether you want the feature to be copied on the left, right, or both sides. (The direction of the selected line is indicated by arrows on the map.)
7. Optionally, check the boxes to treat the selection as a single line, create a new feature for each selected line, and specify the behavior of intersecting loops.
8. Click OK.

A parallel copy of the line is created at the specified distance.
If you are creating polygons of land uses, soils, counties, or property ownership, for example, you often need to create polygons next to one another. The polygons should share a border, but you want to avoid digitizing the border twice or having overlaps or spaces between polygons. You can use the Auto-Complete Polygon construction tool when creating new polygons to help ensure that your data forms a continuous fabric. With Auto-Complete Polygon, you can digitize a new polygon that adjoins an existing polygon, using the existing polygon’s geometry and the edit sketch to define the edges of the new polygon.

**Steps:**

1. Click a polygon feature template in the Create Features window.
2. Click the Auto-Complete Polygon tool on the Create Features window.
3. Starting from the boundary of an existing polygon in the same layer, digitize a boundary of the new polygon that will share a boundary with the existing polygon.
4. To change the shape of the sketch segment, click a construction method type on the Editor toolbar or on the Feature Construction mini toolbar. Segments can be created using a variety of methods—for example, as straight lines, with curves, or traced from the shapes of other features. You can also use keyboard shortcuts or right-click to access a menu of commands to help you place vertices in the sketch.
5. You can either snap the sketch to the edge of the existing polygon or finish the sketch just inside the existing polygon. The sketch must cross (or touch) the existing polygon edge at least two times for the new polygon to be created.

Creating polygons from lines

If you have line features, you can create polygon features from them. For example, you might need to create parcel polygons from lot lines, lakes from shorelines, or street polygons from pavement lines. There are several ways you can use line features to create polygon features. You can create a brand new polygon feature class, or you can interactively create polygon features in an existing feature class.

Creating a new polygon feature class

If you have an ArcInfo license, there are several geoprocessing tools you can use. The most common one is the Feature To Polygon tool, in the Data Management toolbox > Features toolset.

Creating polygon features in an existing feature class interactively

With an ArcEditor or ArcInfo license, you can use the Construct Polygons command on the Topology toolbar to create polygons from lines in ArcMap.

Creating and editing multipart polygons

Multipart features are composed of more than one physical part that only references one set of attributes. For example, the individual islands that make up Hawaii are often represented as a multipart polygon feature. You can create, edit, and work with multipart features using editing tools as well as geoprocessing tools.

Here are some of the common tasks performed when working with multipart features:

- To create a new multipart feature, create a sketch of the first part, right-click, then click Finish Part. Draw the sketch of the next part, and finish the sketch when you are done creating all the parts. (A shortcut to the Finish Part command is to hold down the SHIFT key and click.)
- To create multipart features from existing polygons by aggregating them based on attributes, you can use the Editor > Merge command (produces multipart polygons when the selected polygons are not contiguous) or the Dissolve geoprocessing tool, and specify that the output have multipart polygons.
- To add a part to an existing feature, create a new feature in the same layer, select it, then use the Editor > Merge command.
- To remove a part from an existing multipart feature, double-click the feature with the Edit tool, right-click the part you want to delete, point to Part, then click Delete. Finish the sketch when you are done.
- To separate parts into individual polygon features, you can select them and use the Explode command on the Advanced Editing toolbar. You can also run the Multipart to Singlepart geoprocessing tool.

Keep in mind that parts in a multipart polygon are spatially separated. They can touch each other at vertices, but they cannot share edges or overlap. When you are sketching a multipart polygon, any parts that share an edge will be merged into a single part when you finish the sketch. In addition, any overlap among parts will be removed, leaving a hole in the polygon.

Splitting a polygon by an overlapping feature

If you have a feature that crosses a polygon, you can use it to split the polygon—for example, if you want to divide a forest boundary at a road or river.
If you have an ArcEditor or ArcInfo license, you can use the Split Polygons command on the Topology toolbar to split polygons by overlapping features. Split Polygons allows you to split many polygons simultaneously. For example, this may be useful if you are creating new parcels from a larger tract polygon.

Steps:
1. Select the line or polygon features you want to use to split the existing polygon or polygon features. Only features that overlap the polygon are used in the split.
   
   **Note:** The selected input features must be from a different feature class than the output polygon.
2. Click **Split Polygons** on the **Topology** toolbar.
3. Click the layer in which to store the new features. When splitting features this way, you choose the layer in which to store the new feature. This allows you to retain the attribute values from the existing feature, rather than having them be overwritten with values from a feature template.
4. Optionally, type a cluster tolerance. You should use the default cluster tolerance or match the cluster tolerance of the geodatabase topology, if you are using one.
5. Click **OK**.

With ArcView, you can use the Cut Polygons tool on the Editor toolbar to perform this task. You can cut multiple polygons this way, but the cut line is based on a sketch you draw manually.

Steps:
1. Select the polygon.
2. Click the **Cut Polygons** tool on the **Editor** toolbar.
3. Click **Trace** on the **Editor** toolbar palette.
4. Click and trace along the existing line or polygon. As you are tracing, you can change which features are being traced by pointing to them and clicking or dragging.
   
   The sketch must cross (or touch the edge) at least two times for the polygon to be split.
5. Right-click anywhere on the map and click **Finish Sketch**.

Related Topics
- Constructing polygons from the shapes of other features
- Splitting a polygon
- Splitting lines at intersections with Planarize Lines

Reshaping a polygon to match another feature

You can reshape a polygon to reflect a change in an area's boundary, align with another line or polygon, or match an object in an image. For example, a polygon representing a national park's boundary can be updated and enlarged after additional land is acquired for the park.

The following steps will work when the existing feature overlaps the polygon you want to reshape:

Steps:
1. Click the **Edit** tool on the **Editor** toolbar.
2. Select the polygon you want to reshape.
3. Click the **Reshape Feature** tool on the **Editor** toolbar.
4. Click **Trace** on the **Editor** toolbar palette.
5. Click the line or polygon edge you want to use to update the shape of the original polygon and trace along it. If you want to add an offset, right-click, click **Trace Options**, and enter an offset value.
6. Make sure that the sketch intersects or completely crosses the polygon at least two times so the reshaping can be completed.
7. When you are finished tracing and creating the shape of the feature, double-click to finish the sketch.

If you have a polygon that you want to reshape based on a feature that does not overlap the polygon, you'll need to perform a few more steps. The example below describes a forest boundary (polygon) being edited to follow a river (line).
Steps:

1. Click the **Edit** tool on the **Editor** toolbar.
2. Select the polygon you want to reshape.
3. Click the **Reshape Feature** tool on the **Editor** toolbar.
4. Click the **Straight Segment** construction method on the **Editor** toolbar.
5. Click inside the polygon and digitize between the polygon and line.
6. Snap to the line and click it once. Do not finish the sketch.
7. Click **Trace** on the **Editor** toolbar palette.
8. Trace along the line and click once where you want the trace to end.
9. Without finishing the sketch, change back to the **Straight Segment** construction method and digitize the remaining shape between the line and the polygon.
10. Click inside the polygon.
11. Right-click anywhere on the map and click **Finish Sketch**.

The resulting feature should look like this:

---

Removing overlaps from existing polygons

If you have overlapping polygons that you want to make coincident or adjacent, you can clip out the overlapping portion. When using this method, keep in mind that all editable features underneath the feature you are using to clip with will be clipped. **Clip** is commonly used to remove the more significant and obvious overlaps among polygons.

If you have ArcEditor or ArcInfo, you can also use **geodatabase topology and the Must Not Overlap rule**.

Steps:

1. Select the polygon feature whose border you want to maintain. The other polygon will be clipped back to match it.
2. Click the **Editor** menu and click **Clip**.
3. Set the buffer distance to 0 and choose to discard the area that intersects.
4. Click **OK**.

---

Removing slivers or gaps between polygons

Tiny sliver polygons or gaps between polygons often result from creating new polygons without using snapping or editing shared boundaries without a topology. Slivers and gaps keep your dataset from forming a continuous fabric and should be identified and fixed as appropriate.

With an ArcEditor or ArcInfo license, you can set up a **geodatabase topology**. Geodatabase topology is the most efficient, automated, and thorough means of finding and fixing these errors. You can apply Must Not Overlap and Must Not Have Gaps rules to find polygons that either overlap each other or have gaps between them. You can also look for Must Be Larger Than Cluster Tolerance errors, which are polygons small enough to collapse during the process of validating the topology.

Without the ability to use geodatabase topology, there are several general ways you can find and fix these errors:
You can run the Check Geometry and Repair Geometry tools, which can help find and fix short segments, null geometry, and other problems that could result in sliver polygons.

You can use the Integrate geoprocessing tool to make polygon edges and vertices coincident. Integrate can help fix both slivers and gaps. However, you need to be careful that you enter the smallest cluster tolerance possible so you don't inappropriately collapse or merge features.

Use snapping to modify polygon edges and vertices manually using the editing tools.

You can perform a Select By Attributes query for polygons that have an area smaller than a certain size, depending on your dataset. You can inspect the selected polygons to see if they are slivers, then either use the Editor > Merge command or the Eliminate geoprocessing tool (requires an ArcInfo license) to merge the slivers with neighboring polygons. You could also select each polygon individually and reshape the feature by tracing along the edge of the adjacent larger polygon.

Creating new donut holes and island polygons

Sometimes you need to create a polygon with a hole in it or even a polygon with both a hole and an interior polygon. To create these kinds of polygons, you need to create a multipart feature. When you create a polygon with an island inside it, the outer and inner areas are all one feature. This means that clicking either polygon will select both of them, and the attributes of the feature are stored in just one row in a table.

Donut polygons are commonly used with administrative boundaries. For example, a city may have unincorporated areas within its limits, or school districts may have holes or discontinuities. Islands might be useful for mapping land covers or habitats, such as where two groups of similar trees are separated by a grassy area or there is land mass surrounding a water body that has islands in it.

In the graphic below, the land mass has a donut hole (where the lake is) cut in it, then an island polygon is inside the hole. The lake polygon has a donut hole (where the island is) cut in it as well.

Steps:

1. Click a polygon feature template in the Create Features window.
2. Click a construction tool and method and digitize the outer boundary of the polygon, without finishing the sketch.
3. Hold down the SHIFT key and click, or right-click and click Finish Part.
4. Click inside the polygon and sketch the inner boundary.
5. If you are creating a donut polygon, finish the sketch. To create an island, finish the part and create another sketch inside the hole, then finish the sketch.

You can cut holes in existing polygon features to create a donut polygon.

Steps:

1. Ensure point snapping is enabled. If it is not, click Point Snapping on the Snapping toolbar.
2. Click the Snapping menu on the Snapping toolbar and click Snap To Sketch.
3. Click the Cut Polygons tool on the Editor toolbar.
4. Sketch the area you want to remove. Make sure the end vertex snaps to the first one, so you end up with a closed polygon.
5. To use an existing polygon for the shape of the hole, click Trace on the Editor toolbar palette, click edge of the feature you want to use to cut, and trace around it. As you are tracing, you can change which features are being traced by pointing to them and clicking or dragging.
6. Right-click anywhere on the map and click Finish Sketch.
7. You now have two polygons. Select only the inner polygon and press the DELETE key.

The Clip command is another way of using an existing overlapping polygon to cut the shape of the hole. When using this method, keep in mind that all editable features underneath the feature you are using to clip with will be clipped.

Steps:

1. Select the inner polygon.
2. Click the Editor menu and click Clip.
3. Set the buffer distance to 0 and choose to discard the area that intersects.
4. Click OK.
5. Delete the inner polygon.

Filling in holes in polygons
If you have a polygon with a hole in it, there are several methods you can use to fill in the hole.

To fill in the hole completely by incorporating the void into the outer polygon, use the following method:

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Right-click the part you want to delete, point to **Part**, then click **Delete**.
3. Right-click anywhere on the map and click **Finish Sketch**.
   You can also click **Finish Sketch** on the **Edit Vertices** toolbar.

To create a new polygon feature where the void is, there are several methods you can use:

- You could **trace** a new feature (see the task below).
- You could turn on edge and vertex snapping for the polygon layer containing the void and use the Polygon tool to digitize a new feature inside the void.
- You could use the **Auto-Complete Polygon** tool and draw a sketch across the void. This will create two new features in the void, which you could then **merge**.
- You could copy and paste the feature, then delete the outer part of the new feature, leaving only the interior. This method works if the void is entirely contained within one polygon rather than at the border of two adjacent polygons.
- If you have many voids to fill in with new features and want to do them all at once, you could set up a geodatabase topology with a Must Not Have Gaps rule. Using the **Error Inspector** or the **Fix Topology Error tool**, select all the errors caused by voids in the polygons, right-click, then click **Create Feature**.

**Steps:**
1. Click a polygon feature template in the **Create Features** window.
2. Click **Trace** on the **Editor** toolbar palette.
3. Right-click and click **Trace Options** or press the O key and make sure the offset is set to 0.
4. Click to start tracing, then click to stop after you have traced completely around the void.
5. Right-click anywhere on the map and click **Finish Sketch**.

Common annotation editing tasks

Creating annotation that follows a feature

When you are creating annotation for a stream network, you might want the annotation feature to match the curves in the stream that it annotates. You can set options for how the text follows the feature, such as whether the annotation feature is straight or curved, parallel or perpendicular to the feature, which side of the feature it will follow, and how much of an offset there will be. Once these options are set, you can create the new annotation feature and specify which feature it is to follow.  

Moving annotation along a feature

Sometimes you have an existing annotation feature class that you want to edit so the features follow the streams in a stream network. You can set options for how the text follows the feature, such as whether the annotation feature is straight or curved, parallel or perpendicular to the feature, which side of the feature it will follow, and how much of an offset there will be. Once these options are set, you can edit the existing annotation feature and specify which feature it is to follow. Once the feature is specified, you can drag the annotation feature along the stream feature to determine its best location.

Editing the placement of individual words in an annotation feature

When working with a multiple-word annotation feature, it is sometimes necessary to edit the placement of only one of the words and not the annotation feature as a whole. This can easily be done by converting the annotation feature to a multiple-part annotation feature, then editing the individual part. If your annotation is feature-linked, it will still maintain its link to the features' attributes.

Constructing new annotation with text derived from attributes

Sometimes when you are creating new annotation for a feature class, the text that you want to use already exists in the attribute table of the feature class—for example, parcel identification numbers. You can pull this value from the feature and use it as annotation, thereby preventing any mistakes while typing. If the annotation feature class you are editing is a standard annotation feature class, the text will be based on the label expression of the layer containing the first visible and selectable features. If the annotation feature class is a feature-linked annotation feature class, the text will be pulled from a feature in the origin feature class.

Adding new annotation with a leader line

Sometimes you need to create annotation for features that are either very small or close together, and it is difficult to distinguish which annotation feature annotates which feature. This is when leader lines can be used to point to the feature that is being annotated.

Adding a leader line to an existing annotation feature

If an annotation feature is in a congested area, it is not always easy to tell which feature it is annotating. You can easily add a leader line to this annotation feature to point to the feature.

Stacking the words in an existing annotation feature

Some annotation consists of multiple words for a street name or a long legal description of a parcel feature. When editing these longer annotation features, you can stack them to make them more compact and easier to place. When the text is being stacked, it uses the spaces in the string to determine where to break
Stacking and unstacking annotation

Editing the baseline of an annotation feature

When editing annotation for stream features, it is sometimes necessary to change the curve of an annotation feature to fit the curve of the stream. You can do this by editing the baseline of the annotation feature.

Editing the shape of curved annotation

Editing the symbology of an existing annotation feature

Sometimes you may need to change the color or size of several of your annotation features but not for the entire annotation feature class. You can easily change how the annotation features look by editing their symbology on the Attributes window.

Changing annotation formatting and symbology

About snapping

Snapping allows you to create features that connect to each other so your edits are more accurate, with fewer errors. When snapping is turned on, your pointer will jump, or snap to, edges, vertices, and other geometric elements when your pointer is near them and within a certain tolerance. This enables you to position a feature easily in relation to the locations of other features.

All the settings you need to work with snapping are located on the Snapping toolbar. Snapping is not limited to being used while editing, as it is utilized in other areas of ArcGIS, such as georeferencing and the Measure tool on the Tools toolbar. By default, snapping is enabled, and the active snapping types are points, endpoints, vertices, and edges. You can turn on or off individual types from the Snapping toolbar. To turn off snapping completely, click the Snapping menu and remove the check mark next to Use Snapping.

When snapping is enabled, the pointer icon changes as you move around and pause on various features on your map. Each snapping type (vertex, edge, endpoint, intersection, and so on) has its own feedback, which matches the icons on the Snapping toolbar. For example, the cursor is a square when you are snapping to a vertex and becomes a box with diagonal lines when you are snapping to an edge. By noting the cursor appearance and the SnapTip text that pops up, you can immediately determine the layer you are snapping to and which snapping type is in use.

To help you distinguish the icons on the Snapping toolbar, rest your pointer on a button; note that a piece of text pops up (a ToolTip) near your pointer with the name of the button, and a description appears in the status bar at the bottom of the application. In addition, you can change the appearance of the buttons on the toolbar so the icons display with their names or the buttons display as text-only without any icons. To do this, click the Customize menu and click Customize Mode. While the Customize dialog box is displayed, right-click an icon on the Snapping toolbar and click either Text Only, Image Only (the default), or Text and Image. This tip applies to any toolbar in ArcGIS.

Choosing the snapping environment to use for editing

Snapping while editing

Snapping is useful with many editing operations, such as creating polygons that do not overlap or have gaps between them, drawing lines that connect to each other, or placing a point exactly along an existing line. For example, suppose you are creating a new segment of an electric line that begins from an existing transformer; you want to ensure that the vertex of the line connects precisely to the transformer. Snapping makes this type of task accurate, quick, and easy. You can snap to any feature layer in your map, not just ones you are currently editing. This allows you to snap to features in a computer-aided design (CAD) drawing, coverage, feature class from another geodatabase, and so on.

Snapping can also be used to move a feature to an exact location in relation to another feature. For example, you can move a parcel and have one of its corners jump, or snap, precisely to a corner of another parcel. Simply move the parcel's selection anchor to its corner vertex after setting the appropriate snapping properties. Then move the parcel to its new location until the selection anchor snaps to the corner vertex of the other parcel.

If you have multiple snap types active, the sequence in which the snapping occurs is determined automatically. The highest priority is given to snapping to sketch elements.

Choosing the snapping environment to use for editing
When you are editing, there are two snapping environments available to you. The default environment uses the Snapping toolbar, but you can instead choose to use the editing classic snapping environment. With classic snapping, you can set up snapping on a layer-by-layer basis.

The editing classic snapping environment refers to the snapping functionality that was available during an edit session in ArcGIS 9 and earlier using the Snapping Environment window. In classic snapping, snapping settings are specified by choosing a layer and snapping type (vertex, edge, or end) in the Snapping Environment window. This snapping functionality is off by default and has been replaced with the Snapping toolbar, which provides a flexible, easy-to-use snapping environment with more snapping types, more options, and better feedback than classic snapping. Since there may be some scenarios where you need to access the classic snapping environment, such as when performing raster snapping with the ArcScan for ArcGIS extension, you have the option to switch to classic snapping.

You enable editing classic snapping on the Editing Options dialog box and use the Snapping Environment window to turn on snapping for individual layers and snap types.

**Related Topics**
- Disabling snapping
- Enabling snapping

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### Snapping can be enabled on the Snapping toolbar.

**Steps:**
1. Add the Snapping toolbar to ArcMap.
2. Click the Snapping menu on the Snapping toolbar and click Use Snapping.
3. Click the buttons on the Snapping toolbar to perform point, end, vertex, or edge snapping. These snap types are enabled by default.
4. Click the Snapping menu to enable other snapping types.

**Related Topics**
- About snapping
- Disabling snapping

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### Disabling snapping

These steps are used to turn off snapping altogether. If you want to disable a single snapping type, such as only turning off snapping to points, click the appropriate button on the Snapping toolbar.

**Steps:**
1. Add the Snapping toolbar to ArcMap.
2. Click the Snapping menu on the Snapping toolbar and click Use Snapping.
3. If there is a check next to Use Snapping, click Use Snapping to disable snapping.
   - Snapping is disabled when there is no check next to Use Snapping.

**Related Topics**
- About snapping
- Enabling snapping

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### Turning on SnapTips

A SnapTip is a small piece of text that pops up to indicate the layer you are snapped to and with which snap type (edge, end, vertex, and so on). You can set the text symbol (font, color, size, and so on) for SnapTips and whether the text includes the layer name, snap agent type, or both.

**Steps:**
1. Click the Snapping menu on the Snapping toolbar and click Options.
2. Check the Show Tips box to turn on SnapTips.
3. Check Layer Name so the tip will include the name of the layer to which you are snapped.
4. Check Snap Type so the tip will include the active snap agent (edge, end, vertex, and so on).
5. Click the Text Symbol button to set the color, font, size, and other properties for the tip text.
6. Check Background so the SnapTip has a solid background. This can be useful when working over imagery.
7. Click OK.

**Related Topics**
Setting the snapping tolerance

The snapping tolerance is the distance within which the pointer or a feature snaps to another location. If the element being snapped to—such as a vertex or edge—is within the distance you set, the pointer automatically snaps to the location. You set the default snap tolerance value in pixels. For example, to make a new electric utility line snap to an existing electric line’s end, first make sure end snapping is enabled (in other words, the End Snap button is highlighted on the Snapping toolbar). When the pointer comes within the snapping tolerance of the existing line and you click to create the first vertex of the new line, it will be snapped to the existing line’s endpoint. Since the start point of the new line is coincident with the end of the existing line, your electric lines are modeled as being connected.

Steps:
1. Click the Snapping menu on the Snapping toolbar and click Options.
2. Type the desired number of pixels in the Tolerance box.
3. Click OK.

Related Topics
- Setting the color used for the snap symbol
- Turning on SnapTips

Setting the color used for the snap symbol

The color of the snap symbol can be changed so the pointer is easier to see.

Steps:
1. Click the Snapping menu on the Snapping toolbar and click Options.
2. Click the Snap Symbol color and choose a different one. By default, the snap symbol is black.
3. Click OK.

Related Topics
- Setting the snapping tolerance
- Turning on SnapTips

Using snapping while editing

Snapping helps you create features and perform edits more accurately.

Steps:
1. Turn on snapping and enable the snap agents you want from the Snapping toolbar.
   As you move your pointer around the map with an editing tool, such as the Line or Polygon tool, the pointer will snap to various geometric locations as you move over them. You can tell what you have snapped to by noting the cursor’s feedback appearance and the pop-up SnapTips.
2. Once the cursor has snapped, click to place a vertex or point or perform the edit as desired.

Related Topics
- Snapping to a specific feature while editing
- Snapping together multiple features
- Turning on snapping to edit sketch elements

Turning on snapping to edit sketch elements

Enabling edit sketch snapping is particularly useful when you are splitting polygons or cutting donut holes in them, since it ensures the cut operation will be completed successfully. It is also useful when you are creating a feature that intersects or connects to itself, such as a boundary line that forms a closed loop. To enable Snap To Sketch, you must be in an edit session.

Steps:
1. Make sure you are in an edit session.
2. Ensure snapping is enabled. On the Snapping toolbar, click the Snapping menu and make sure Use Snapping is checked.
3. Click the Snapping menu on the Snapping toolbar and click Snap To Sketch.
4. Turn on at least one snap type, such as edge or vertex snapping. For example, when vertex and edge snapping are enabled, you can snap to vertices and edges within the sketch in addition to other features in the map.
Related Topics
Snapping to a specific feature while editing
Snapping together multiple features
Using snapping while editing

Snapping to topology nodes

Enabling snapping to topology nodes allows you to snap to a node in a map topology or a geodatabase topology. You might do this when you need to move parts of topology edges or snap to a location that is not an actual vertex in the feature.

You can create nodes in your topology for snapping purposes, such as by splitting a topology edge. If you display unselected topology nodes on the Editing Options > Topology tab, it is easier for you to see the temporary topology nodes.

To enable topology node snapping, point snapping needs to be enabled first, and the map must contain either a map topology or geodatabase topology with the layers you want to snap to participating in it.

**Steps:**

1. Make sure you are in an edit session and have either a map topology or geodatabase topology containing the layers to which you want to snap.
2. Click the **Snapping** menu on the **Snapping** toolbar and click **Use Snapping**.
3. Ensure point snapping is enabled. If it is not, click **Point Snapping** on the **Snapping** toolbar.
4. Click the **Snapping** menu on the **Snapping** toolbar and click **Snap To Topology Nodes**.

Related Topics
Moving a shared node without stretching all connected edges (split-move)
Moving a topology edge
Moving a topology element relative to its current location (delta x,y)
Moving a topology element to an exact x,y location (absolute x,y)
Moving a topology node

Snapping to a specific feature while editing

You can snap on the fly to specific features. By specifying a feature and the part of the feature to which you want to snap, your next vertex will automatically be placed regardless of the other snapping settings.

This functionality is available with the Snapping toolbar snapping or the editing classic snapping environment.

**Steps:**

1. While digitizing on the map, right-click the feature you want to snap to; point to **Snap to Feature**; then click either **Endpoint**, **Vertex**, **Midpoint**, or **Edge**. This will place a vertex at the nearest location that matches your choice.
2. If nothing happened, move the pointer closer to the element you want to snap to, and try again.

Related Topics
Snapping together multiple features
Turning on snapping to edit sketch elements
Using snapping while editing

Snapping together multiple features

You can use the **Snap geoprocessing tool** to snap together multiple features at their ends, vertices, or edges within a specified tolerance.

This tool is useful for cleaning up features that were not digitized using snapping or were imported from another format, such as CAD. The Snap tool allows you to set up a combination of snapping types, layers, and distances between different layers. For example, you can snap features in the input layer to an edge in one layer and to a vertex in another layer—with different tolerances specified for each case. Some of the scenarios in which you might use this tool include to remove dangling lines, ensure points fall along lines, or match borders that should be shared between two layers.

This tool can operate on only the selected features and also be run inside an edit session.

Related Topics
Snap
Snapping to a specific feature while editing
Turning on snapping to edit sketch elements
Using snapping while editing

Setting the snapping environment when working on top of imagery layers
When you are working on top of imagery layers, changing the snapping symbols can make it easier for you to see the snapping pointer and SnapTips. You can access the settings for snapping appearance by clicking the Snapping menu on the Snapping toolbar, then clicking Options.

The easiest thing you can do to improve the snapping display over rasters is to show the background for the SnapTip. This adds a solid fill behind the text, so the SnapTip does not blend in with the raster. In addition, making the font size larger may help you see the SnapTip better. If you want to change the font, color, or background fill, click the Text Symbol button to open the Symbol Selector dialog box. Click the Edit Symbol button if you want to make further refinements to the snapping text symbol's properties.

You can also change the color of the SnapTip and the snap symbol that indicates whether you are snapping to an edge, end, or other element. Since the snapping elements are semitransparent, it may be easiest simply to experiment with different colors to find ones that are distinguishable over the imagery.

About the editing classic snapping environment

Note: While classic snapping is enabled, editing tools only use the classic snapping environment. However, georeferencing tools, the Measure tool, and other non-editing tools continue to use the snap settings on the Snapping toolbar.

Snapping allows you to create features that connect to each other so your edits are more accurate, with fewer errors. When snapping is turned on, your pointer will jump, or snap to, edges, vertices, and other geometric elements when your pointer is near them and within a certain tolerance. This enables you to position a feature easily in relation to the locations of other features.

The editing classic snapping environment refers to the snapping functionality that was available during an edit session in ArcGIS 9 and earlier using the Snapping Environment window. In classic snapping, snapping settings are specified by choosing a layer and snapping type (vertex, edge, or end) in the Snapping Environment window. This snapping functionality is off by default and has been replaced with the Snapping toolbar, which provides a flexible, easy-to-use snapping environment with more snapping types, more options, and better feedback than classic snapping. Since there may be some scenarios where you need to access the classic snapping environment, such as when performing raster snapping with the ArcScan for ArcGIS extension, you have the option to switch to classic snapping.

The Snapping Environment window

The Snapping Environment window is the main place for you to specify the settings for classic snapping. You can choose the part of the feature, vertex, edge, or endpoint to which you want your new feature to snap by setting the layer snapping types. For example, to make a new segment of water lateral line snap to the edge of an existing line, check the box under Edge and next to the water laterals layer in the Snapping Environment window. When the pointer comes within the snapping tolerance of the edge, the first vertex of the new line feature snaps to the edge of the existing feature.

You can also set snapping properties that apply specifically to an edit sketch or topology elements using the boxes at the bottom of the Snapping Environment window. Checking the Edit sketch vertices box allows you to snap to vertices in the sketch. With Edit sketch edges, you can snap to the edge or boundary of segments in the sketch. You can check Perpendicular to sketch to snap to a 90-degree angle from the last segment in the sketch. To snap to topology elements, check the box next to Topology nodes.

Related Topics

- Enabling snapping (classic snapping)
- Setting the snapping tolerance (classic snapping)
- Turning on SnapTips (classic snapping)

Enabling snapping (classic snapping)

Note: While classic snapping is enabled, editing tools only use the classic snapping environment. However, georeferencing tools, the Measure tool, and other non-editing tools continue to use the snap settings on the Snapping toolbar.

You enable editing classic snapping on the Editing Options dialog box and use the Snapping Environment window to turn on snapping for individual layers and snap
types.

Steps:
1. Click the Editor menu and click Options.
2. Click the General tab.
3. Check Use classic snapping.
4. Click OK.
5. Click the Editor menu, point to Snapping, then click Snapping Window.
6. Click the vertex, edge, and end boxes for the layers to which you want to snap.
When you have selection layers or other instances of multiple layers referencing the same data source, only one layer pointing to that data source will be listed in the Snapping Environment window.
7. Click and drag the layer names to arrange them in the order in which you want snapping to occur. Snapping occurs first in the layer at the top of the list, then in each consecutive layer down the list.
8. Check the boxes at the bottom panel of the window to enable snapping to edit sketch or topology elements.
9. You can close the window or leave it open while you work. The snapping settings you change are effective immediately.

Related Topics
About the editing classic snapping environment
Setting the snapping tolerance (classic snapping)
Turning on SnapTips (classic snapping)

Setting the snapping tolerance (classic snapping)

Warning: While classic snapping is enabled, editing tools only use the classic snapping environment. However, georeferencing tools, the Measure tool, and other non-editing tools continue to use the snap settings on the Snapping toolbar.

The snapping tolerance is the distance within which the pointer or a feature is snapped to another location. If the element being snapped to—such as a vertex or edge—is within the distance you set, the pointer automatically snaps to the location.
You set the snap tolerance value in pixels (the default option) or map units when working with classic snapping. When editing, press the T key to see a circle representing the snap tolerance, shown in green on the graphic below.

You can also interactively set the snap tolerance when working in classic snapping by using the Snap Tolerance tool, which you can add to the ArcMap user interface from the Customize dialog box. To set the snap tolerance with the Snap Tolerance tool, click the map and drag the pointer to draw a circle.

Steps:
1. Click the Editor menu, point to Snapping, then click Options.
2. Click the Snapping tolerance drop-down arrow and click the type of measurement unit you want to use for snapping tolerance—pixels or map units. This only updates the snapping tolerance for the classic snapping environment used with editing tools.
When the snapping tolerance is set to map units, you can also give the value in other units by specifying a distance units abbreviation with the value that you enter. For example, to specify a distance of 10 feet, type in 10ft. Distance unit abbreviations only work if your data frame is projected.
3. Type the desired number of measurement units.
4. Click OK.

Related Topics
About the editing classic snapping environment
Enabling snapping (classic snapping)
Turning on SnapTips (classic snapping)
One useful trick for working with classic snapping is to enable SnapTips, which provide pop-up text and status bar messages to indicate the layer you are snapped to and with which snap type. In the graphic below, the pointer has snapped to an end element in the arterials layer.

Once you have snapped to an element, the cursor needs to be stationary for at least one second for the tip to appear. The tip will fade after several seconds. You cannot change the formatting or contents of the classic snapping SnapTip.

**Steps:**
1. Click the Editor menu, point to Snapping, then click Options.
2. Check Show SnapTips.
3. Click OK.

**Related Topics**
- About editing classic snapping environment
- Enabling snapping (classic snapping)
- Setting the snapping tolerance (classic snapping)

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**Creating features with feature templates**

Creating features is accomplished through the use of feature templates. Feature templates define all the information required to create a feature: the layer where a feature will be stored, the attributes a feature is created with, and the default tool used to create that feature. Templates also have a name, description, and tags that can help you find and organize them. If templates are not present when you start editing, they are automatically created for each layer in the current editing workspace. Templates are saved in the map document (.mxd) and the layer file (.lyr).

A layer can have multiple templates associated with it, where each template has different default settings. For example, if you have a roads layer with classifications of freeway, major highway, and local road, you could have three different templates with each one having a different default attribute for the type of road. This makes it easier for you to create the new type of road you want from the start. To create a local road feature, simply click the local road template, and new features are automatically created as a local road and attributed and symbolized properly. You still need to add other, nondefault attribute values after you create the feature.

Anytime you create features on the map, you start with the Create Features window. Choosing a feature template on the Create Features window sets up the editing environment based on that feature template’s properties; this action sets the target layer in which your new features will be stored, activates a feature construction tool, and prepares to assign the default attributes to the feature you create. To reduce clutter, templates are hidden on the Create Features window when layers are not visible.
The top panel of the Create Features window shows the templates in the map, while the bottom panel of the window lists the tools available to create features of that type. The availability of the feature creation tools, or construction tools, depends on the type of template you have selected at the top of the window. For example, when a line template is active, you can see a set of tools for creating line features. If you choose an annotation template instead, the available tools change to those that can be used to create annotation.

Each template has a default construction tool, which you can set in the template’s properties. Setting the default tool can help you avoid an extra click to choose a different tool to create new features. For example, when you are drawing rectangular building footprints, set that template’s default construction tool to the Rectangle tool so that tool automatically becomes active when creating building footprints. You can always override the default tool and choose a different one in the Create Features window.

To create feature templates, open the Organize Feature Templates dialog box from the Create Features window and start the Create New Templates wizard. The wizard steps you through the quick process of making a template: first, you choose the layer or layers, then, if applicable, choose any or all classes within that layer to make into individual templates. Once the templates are created, you can change their default properties, copy and paste them, or delete them.

Templates are used anytime you are creating features. When creating features with an editing command, such as Buffer or Union, you choose a template on the dialog box that opens for those commands. If you are editing an existing feature, you do not need to specify a template.

Setting feature template properties

You can specify and review properties of a feature template on the Template Properties dialog box. The settings there specify how the new feature will be created: the layer where a feature will be stored, the attributes, and the default tool. You also can use the properties for name, description, and tags to help you find and organize feature templates.

The default attribute values are some of the most important properties you can set for a feature template. The attributes set on the Template Properties dialog box are assigned to new features created with that feature template. Setting the appropriate default values saves you time and improves accuracy, since the attributes are populated automatically in the new features.

Related Topics
About COGO and feature templates
Best practices for using feature templates
Creating new feature templates
Filtering feature templates in the Create Features window
Grouping feature templates in the Create Features window
Organizing feature templates
Best practices for using feature templates

Getting started with feature templates
Creating features is accomplished through the use of feature templates. Feature templates define all the information required to create a feature: the layer where a feature will be stored, the attributes a feature is created with, and the default tool used to create that feature. Templates also have a name, description, and tags that can help you find and organize them. If templates are not present when you start editing, they are automatically created for each layer in the current editing workspace. Templates are saved in the map document (.mxd) and the layer file (.lyr).

Cases wherein ArcMap creates feature templates automatically
When you start editing either a saved map document or a brand new map, ArcMap checks to see if you have any existing feature templates in the map. If no templates are found, ArcMap automatically creates them to help you get started adding features. If you have layers from several different geodatabases or folders of shapefiles in a data frame or multiple data frames in a map document, ArcMap creates templates the first time you start editing in each workspace or data frame if there are no existing templates.

When templates are created automatically, they are generally created for all types of symbology. However, templates work best when creating features symbolized by categories, as a single symbol, or by representations, rather than with quantities or charts.

Once templates are created the first time you start editing, they are not added automatically after that. You need to create the templates yourself for layers subsequently added to the map. This allows you to control the creation of templates and avoid cluttering the list of templates with templates for layers that may not be used for editing.

Creating new feature templates
To create feature templates, open the Organize Feature Templates dialog box from the Create Features window and start the Create New Templates wizard. The wizard steps you through the quick process of making a template: first, you choose the layer or layers, then, if applicable, choose any or all classes within that layer to make into individual templates. Once the templates are created, you can change their default properties, copy and paste them, or delete them.

You can make a copy of an existing template to use it as the basis of a new template. For example, if you want a different default attribute for one of the fields in the layer, copy and paste the template, then change the new template's properties. This saves you from going through the wizard to make just a slight change to a template.

If you add a layer to your map, significantly change the symbology used to draw the features, or add a symbology category (such as for a layer drawn with unique values), you need to create new templates to be able to add features in that layer.

Setting a feature template's properties
The default attribute values are some of the most important properties you can set for a feature template. The attributes set on the Template Properties dialog box are assigned to new features created with that feature template. Setting the appropriate default values saves you time and improves accuracy, since the attributes are populated automatically in the new features.

Each template has a default construction tool, which you can set in the template's properties. Setting the default tool can help you avoid an extra click to choose a different tool to create new features. For example, when you are drawing rectangular building footprints, set that template's default construction tool to the Rectangle tool so that tool automatically becomes active when creating building footprints. You can always override the default tool and choose a different one in the Create Features window.
Feature templates and the table of contents

Templates are always synchronized with the contents of the map. If you turn off a layer in the table of contents, the layer’s templates are hidden on the Create Features window. If you save a layer as a layer file (.lyr) from ArcMap, the layer’s templates are saved in it as well.

When a layer is not visible because it is turned off in the table of contents, beyond its visible scale range, or does not satisfy the current definition query, its associated templates are hidden on the Create Features window. You need to make the layer visible again before you create features in it. This way, you can choose the template, but additionally, the new features will be displayed on the map once they are created, rather than immediately disappear because the layer is not visible.

Furthermore, when working with definition queries, only feature templates with default attribute values that satisfy the query are listed in the Create Features window. For example, if you have a definition query to display just the major roads in a layer containing several different road types, you only see the feature templates that have the road type default attribute value of major roads. If you start editing and there are no feature templates in the Create Features window for a layer with a definition query, open the Organize Feature Templates dialog box, click the layer’s name, open the properties for the template, and set a default attribute value that matches the definition query—in this case, set the road type field to major roads. If you need to add features with other attributes, such as minor roads, you should first update the definition query to make the features display on the map, then you can create templates with other default attributes.

Before you create a new template for a layer, make sure the layer is visible and that the template is not hidden from view through the use of a filter in the Create Features window. In addition, when you open the Organize Feature Template dialog box, click the layer’s name to see if any templates already exist. This may save you from making new templates that are duplicates of the existing ones.

Feature templates in editing commands

Some editing commands, such as those on the Editor menu, use a dialog box to allow you to choose a template when creating new features. The template specifies the layer where a feature will be stored and the default attributes for the new features. For a template to be listed in the window, it must already exist and must be the appropriate target geometry type; other template types are filtered from the list and not shown.

Editing commands that can only output one type of geometry (such as Copy Parallel, which only produces lines) list templates just for that layer type. Commands that can output a variety of layer types list any existing templates that are the proper types. For example, the Buffer command can create either line or polygon features, so line and polygon templates may both be listed in the window. If you have created templates for a line layer but not for a polygon layer, only the line templates are listed in the window because there are no available polygon templates in the map. In that case, to choose a polygon as the output, close the command’s dialog box, launch the Create New Templates Wizard from the Create Features window, then create a template for the polygon.

If you have no templates at all for any of the layers in your map, you can choose from a list of available layers in which to create the new features. However, if you have templates for only certain layer types, a message appears if you attempt to use a command that requires templates for a different type. For example, when using Copy Parallel, if you have a template in the map for a polygon but no line templates, a message tells you to create line templates to use the command.

When copying features, however, you choose the layer in which to store the new feature. This allows you to retain the attribute values from the copied feature, rather than having them be overwritten with values from a feature template. This applies to commands such as Paste and Copy Features.

Finding and organizing feature templates

You can search for templates on the Create Features window. When you search, only the templates that satisfy your query are shown on the Create Features window. To find and identify templates more easily, give them clear and descriptive names. This also applies to the layers and symbol labels, since they provide the default template names. You can enter a description, which appears as a ToolTip pop-up text when you rest your pointer over a template. The description property allows you to provide additional information about the contents and intended use of a particular template.
To create feature templates, open the Organize Feature Templates dialog box from the Create Features window and start the Create New Templates wizard. The wizard steps you through the quick process of making a template: first, you choose the layer or layers, then, if applicable, choose any or all classes within that layer. Once the templates are created, you can change their default properties, copy and paste them, or delete them.

Updating feature template properties

If you find that you want to change the default attribute values for new features or repeatedly switch from the default tool to a different one, update the properties of the template.

**Note:** The symbol for a template is read-only on the Template Properties dialog box. This is because the template properties simply reflect the current symbology set on the Layer Properties dialog box. If you want to change the symbol used for a template, you need to change on the Layer Properties > Symbology tab. In some cases, the template cannot draw the symbol, such as for certain <All other values> entries when drawing a layer with unique values. In those cases, you need to update the Layer Properties.

Keep in mind that templates are used only at the time a feature is created. Once a feature is created, there is no link back to the template. If you update the default attribute values of a template, for example, those attribute values are not retroactively applied to existing features. Changes made to a template's properties are only reflected in new features created with that template after the change has occurred. To update the attribute values of a feature that has already been created, use the attribute table or the Attributes window.

Creating multiple feature templates for the same symbology

You can create multiple templates for a layer even if you are symbolizing with a single symbol. You might do this when you have a layer that should all be displayed the same way but the features you want to create have different attribute values. For example, if you are creating lines to represent pipeline features, you could create several feature templates with different default attributes for the common types of material or diameter sizes.

Deleting unnecessary feature templates

If you had many layers that you will never edit in your map the first time you started editing (so templates were created automatically), you can delete the templates you are not using. For example, if you have 10 layers in your map but are only creating new features in two of them, delete the other templates so it makes it easier for you to find the templates you need.

If you have changed the rendering of several layers since the templates were initially created, it may be best just to delete all your templates and start again so the templates are synchronized better with your current symbology. Once you delete them, simply start the Create New Templates wizard and make templates for only the layers in which you want to create features.

A better practice, however, is to spend some time preparing the map and its symbology prior to actually starting editing and creating templates.

Creating maps to share with other editors

If you are creating a map that other editors will use, you should ensure that all the elements necessary to create features are easy to understand by all the editors. This involves clearly naming layers and symbol labels, since these are used to identify the feature templates in the Create Features window. This also applies when you are serving the map through ArcGIS Server, as editors who edit the contents of the map through the Web or by downloading the data locally also receive the feature templates from the map.

Related Topics

- About feature templates
- Creating new feature templates
- Filtering feature templates in the Create Features window
- Grouping feature templates in the Create Features window
- Organizing feature templates
- Preparing a map for editing
- Setting feature template properties

Creating new feature templates

To create feature templates, open the Organize Feature Templates dialog box from the Create Features window and start the Create New Templates wizard. The wizard steps you through the quick process of making a template: first, you choose the layer or layers, then, if applicable, choose any or all classes within that layer to make into individual templates. Once the templates are created, you can change their default properties, copy and paste them, or delete them.

If you are in an edit session, and find that some of your layers are not listed in the Create New Templates wizard, they may not be editable or in the same workspace. When you start editing and have data from different folders or geodatabases in your map, you must choose a particular data source to edit. You can only edit one workspace in one data frame at a time; a workspace is either a folder of shapefiles or the feature classes within a single geodatabase.
When you are not in an edit session, you can create new feature templates for any layer in your map. To open the template organizer and access the wizard, right-click a layer in the table of contents, point to Edit Features, and click Organize Feature Templates.

**Steps:**

1. Click **Organize Templates** on the **Create Features** window.
2. Click **New Template** on the **Organize Feature Templates** dialog box.
3. Check the layers for which you want to create new templates.

   **Note:** If the layer is symbolized as a single symbol, the wizard is completed in one step.

4. Click **Next**.
5. If any of the layers have subtypes or are symbolized by categories, choose the classes for which to create templates.
6. Click **Finish**.

**Related Topics**

- About feature templates
- Best practices for using feature templates
- Filtering feature templates in the Create Features window
- Grouping feature templates in the Create Features window
- Organizing feature templates
- Setting feature template properties

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**Setting feature template properties**

Feature templates define all the information required to create a new feature: the layer where a feature will be stored, the attributes a new feature will be created with, and the default tool used to create that feature. Templates also have a name, description, and tags that can help you find and organize them. You can specify and review these and other settings on the Template Properties dialog box.

**Steps:**

1. Double-click a template in the **Create Features** window. You can also right-click a template in the **Create Features** window and click **Properties** or use the template organizer to open the **Template Properties** dialog box.
2. Type a name for the template.
3. Type a description, which is used when searching for templates and also appears as a text pop-up when you rest your pointer over a template in the Create Features window.
4. Type tags about the template, separating each entry with a semicolon. A tag is generally a short keyword, metadata item, or any other term to identify the template that will help when searching for templates. A tag for the type of layer (point, line, polygon, and so on) is listed automatically.
5. Click the **Default Tool** drop-down arrow and click a tool for the template. The default tool is the construction tool that automatically becomes activated as soon as you choose a template in the **Create Features** window.

   **Note:** The list of construction tools is filtered to show only the Line tool when working with line templates for layers with COGO attributes, layers participating in geometric networks, or turn feature classes in network datasets. This is because the other construction tools create closed ring shapes that are invalid geometries in those layer types.

6. Preview the symbol used to display the new features created using this template.
7. Review the target layer, which is the one that will store the new features created with this template.
8. Click **OK**.

**Related Topics**

- About feature templates
- Best practices for using feature templates
- Creating new feature templates
- Filtering feature templates in the Create Features window
- Grouping feature templates in the Create Features window
- Organizing feature templates

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**Setting the default attribute values of a feature template**

The default attribute values are some of the most important properties you can set for a feature template. The attributes set on the Template Properties dialog box are assigned to new features created with that feature template. Setting the appropriate default values saves you time and improves accuracy, since the attributes are populated automatically in the new features.

Any geodatabase default values are populated automatically in the fields on the Template Properties dialog box. If you update the attribute values on the Template Properties dialog box, the new features created with that template are assigned the default attributes from the template rather than the geodatabase.

When you look at the attributes grid on the Template Properties dialog box, you may notice several different colors of shading in the cells, including green, light gray, and yellow. The colors indicate that these fields have special functionality or meaning.
Organize Feature Templates.

These steps describe opening the Organize Feature Templates dialog box from the Create Features window during an edit session, which is the easiest way. When you do this, you may need to rename the template so it is clearer which types of features you are creating when you use this template.

Fields with subtypes that are being used to symbolize the layer are shaded in green; any other subtype fields are shaded in gray. When you choose a different subtype, the new subtype's default attribute values are applied to all fields in the template—overwriting any edits you may have already made to the template properties.

You can also turn on highlighting for a field on the Fields tab of the Layer Properties dialog box. Highlighted fields are shaded in yellow so you can see them more easily.

Steps:

1. Double-click a template in the Create Features window.
   
   You can also right-click a template in the Create Features window and click Properties or use the template organizer to open the Template Properties dialog box.

2. Sort the fields as desired. This sorting setting is temporary and only reflected on the Template Properties dialog box.
   
   - Click Show Fields in Layer Order to display fields in the order as specified on the Fields tab of the Layer Properties dialog box.
   - Click Sort Fields Alphabetical to display the fields in alphabetical order.

3. Click View to view all fields and change the settings to display field aliases and descriptions. By default, any fields that you have hidden on the Fields tab of the Layer Properties dialog box are hidden on the Template Properties dialog box unless you view all fields.

   ArcGIS system fields, such as Shape_Length, Shape_Area, OBJECTID, SHAPE, or certain fields in annotation and dimension feature classes, are never shown on the Template Properties dialog box since ArcGIS maintains their attribute values.

   The Template Properties dialog box hides COGO fields, preventing you from inadvertently setting the default attribute values for those fields. This way, the correct COGO values can be populated when you create a new feature.

4. Type the default attribute value in the cell, or click the drop-down arrow and click a value if the field has subtypes or coded value domains.

   **Note:** When you change a feature's subtype, you are prompted about whether to change the existing values to the default values of the new subtype. If a field does not have a default value associated with it for the new subtype, its value remains unchanged.

5. To change the default attribute value for a field that is being used to symbolize the layer (a field shaded in green), click the ellipsis button in the cell and choose the new symbol from the list of the other available symbols.

6. Click OK.

Organizing feature templates

The Organize Feature Templates dialog box allows you to author and manage the templates in your map, such as by creating, deleting, copying, and renaming templates and setting template properties.

These steps describe opening the Organize Feature Templates dialog box from the Create Features window during an edit session, which is the easiest way. When you are not in an edit session, you can open the template organizer by right-clicking a layer in the table of contents, pointing to Edit Features, and clicking Organize Feature Templates.

Steps:

1. Click Organize Templates on the Create Features window.

2. To filter the list of layers in the template organizer, click Filter Layers and click to show only editable layers or only layers that have templates.

3. To create new templates, click New Template. For more information, see Creating new feature templates.

4. To create a copy of a template, click it and click Copy, or right-click it and click Copy.

5. You can also delete one or more templates. You might want to delete any extra templates for layers you do not plan to create features in to make it easier for you to access the templates you are using.

   - Click a template and click Delete to delete an individual template.
   - Click the Delete drop-down arrow and click Delete All In Layer to delete all the templates in the selected layer.
   - Click the Delete drop-down arrow and click Delete All In Map to delete all the templates in the active data frame.

6. To add tags to a template, click Tags. Tags are used when searching for templates. On the dialog box that appears, type the text of the tag, click Add, then click OK. You can also add tags from the Template Properties dialog box, delimited by semicolons.

7. To rename a template, click it once and type the new name, or right-click it and click Rename.

8. To change the properties of a template, such as to set the name, default construction tool, and default attributes for new features, click it and click Properties.

Related Topics

About feature templates
Best practices for using feature templates
Creating new feature templates
Filtering feature templates in the Create Features window
Grouping feature templates in the Create Features window
Setting feature template properties

Grouping feature templates in the Create Features window

Grouping or sorting feature templates by type, layer, or frequency of use makes it easier for you to find the template you want in the Create Features window.

Steps:
1. Click the Arrange Templates button on the Create Features window.
2. To group templates, point to Group By and choose how you want to group the templates.
   - Click Type to group templates by layer (geometry) type.
   - Click Layer to group templates by the layer to which they belong.
   - Click Frequency to group templates by how often they are used. The most commonly used templates appear higher in the list than those that you use less often.
3. Click Clear Grouping to remove all groupings and display the templates as a single list.

Related Topics
About feature templates
Best practices for using feature templates
Creating new feature templates
Filtering feature templates in the Create Features window
Organizing feature templates
Setting feature template properties

Filtering feature templates in the Create Features window

Filtering the list of feature templates allows you to display only certain templates. The templates are not deleted; they are simply hidden on the Create Features window. Templates can be filtered by geometry type, layers, and search terms you enter.

**Note:** Filtering templates applies only to the Create Features window. The list of templates is not filtered on the editing commands, such as Buffer, that require you to choose a template. All current templates that are valid for the output layer geometry type are displayed in those dialog boxes.

Steps:
1. To filter templates based on the results of a search, type a term in the Filter Templates <Search> box and click Search. If you already have a filter in place, the search only looks in the currently displayed templates. The templates that match your search terms are displayed. If no templates were found, click Clear Search and try it again.
2. To filter templates by type or layer, click the Arrange Templates button on the Create Features window, point to Filter By, then click how you want to filter the templates.
   - Click the type of layer, such as Point, Line, or Polygon, to show only templates of that type.
   - Click Layers to show templates from only certain layers. Click the layers to display and click OK.
3. To remove all filtering and display all templates, click Show All Templates.

Related Topics
About feature templates
Best practices for using feature templates
Creating new feature templates
Filtering feature templates in the Create Features window
Organizing feature templates
Setting feature template properties

Defining new types of features to be created

Sometimes you may want to create features of a certain type in an existing layer, but the layer is not set up to capture those features. For example, you want to add features to a roads layer to represent an unpaved road, but you currently only have categories in your data for freeway, major highway, and local road. Through a wizard, you can define everything about the unpaved road category at one time—making it easy to prepare your data to display and store the new types of features. ArcMap automatically adds a symbol for the new category, any required geodatabase information (such as subtype value or coded domain value) for that layer, and a feature template to use when creating an unpaved road. The wizard saves you from having to stop your work to open multiple dialog boxes to set up the data on your own.
To define new features, your data needs to be symbolized based on categories of some kind—either as unique values or representations. The unique values can come from a single text or numeric field or a field of geodatabase coded value domain attribute values or subtypes. Defining new feature types can be very useful in design scenarios when you want to experiment with adding roads, parks, or buildings, for example, during the planning process.

**Note:** The Define New Feature Type wizard is only available when the layer is symbolized by unique values on a single field or representations. If the wizard needs to add a subtype or representation rule to define the new type, you need to stop editing if you are in an edit session.

**Steps:**

1. Right-click the layer in the table of contents, point to **Edit Features**, then click **Define New Types Of Features**.
2. Click **Change Symbol** to choose the symbol used for drawing the new type's features.
3. Type a name and a description for the new type. These will be used as the feature template's name and description.
4. Click **Next**.
5. The next step of the wizard varies slightly based on how your data currently is symbolized. Click **Next** when you are finished with the panel.
   - For unique values, type a name and label for the new category.
   - For unique values based on a subtype, type the code to be used by the new subtype and the description. A new valid value is supplied automatically.
   - For unique values based on a coded value domain, type the new code and the description. If the field is a numeric type, a new numeric value will be added to the appropriate coded value domain using the name specified in the wizard. If the field type is text, a new value will be added to the coded value domain using the name of the new feature type. A new valid value is supplied automatically.
   - For representations, type a label for the new category (representation rule). The code is automatically entered for you.
6. Type the default attribute values for new features created of this type. This sets up the feature template with those values.
7. Click **Finish**. ArcMap adds a new subtype, coded value domain, or representation rule to the feature class (if needed); adds the new symbol to the table of contents and the renderer list on the **Symbology** tab of the **Layer Properties** dialog box; and creates a new feature template in the **Create Features** window. If you want to set additional options for the new feature template, open its properties from the **Create Features** window. You are now ready to create features representing that new type.

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**Creating a point feature by clicking the map**

Points are the simplest features to create. Simply click a point template in the Create Features window and the Point tool is automatically activated. Click the map where you want to add the point. You can right-click the map or use snapping to help you create points at exact locations. As you move around the map to place the feature, the pointer's on-screen feedback is what you see is what you get (WSIWYG)—showing the same symbol that will be used for the new point feature.

**Steps:**

1. Click a point feature template in the **Create Features** window.
2. Click the **Point** tool on the **Create Features** window. In most cases, the Point tool is automatically activated when you choose a point feature template.
3. Optionally, use snapping to help you create points at exact locations relative to other features.
4. Click the map to create the point. The point is created on your map and is selected.

**Related Topics**

- [Creating a point feature at the end of a line you sketch](#)
- [Creating a vertex by clicking the map](#)

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**Creating a point feature at the end of a line you sketch**

The Create Point At End Of Line tool allows you to draw a line and create a point at the end of it. To create the sketch line, you can simply digitize on the map, or utilize any shortcut or sketch constraint to place a vertex in the line, such as Length, Constrain Parallel, Direction, or Absolute X,Y.

This tool is useful if you need to add a point at a specific distance along a line or at an offset from an existing location. For example, to add a valve 50 meters along an existing water line, snap to the origin location on the water line, set a length constraint of 50 meters, then add a vertex. When you finish the sketch, a point is created at that vertex—which is exactly 50 meters from the origin.

**Steps:**

1. Click a point feature template in the **Create Features** window.
2. Click the **Create Point At End Of Line** tool on the **Create Features** window.
3. Click the map to create a sketch line as desired. For example, to make the line a certain length, right-click, click **Length**, type the distance measurement, then click to add a vertex.
4. To change the shape of the sketch segment, click a construction method type on the **Editor** toolbar or on the **Feature Construction** mini toolbar. Segments can be created using a variety of methods—for example, as straight lines, with curves, or traced from the shapes of other features. You can also use keyboard shortcuts or right-click to access a menu of commands to help you place vertices in the sketch.
5. Right-click anywhere on the map and click **Finish Sketch**. When you finish the sketch, a new point is created at the location of the last vertex of the line. The line is only a temporary sketch, so no line feature...
Creating a point or vertex at an exact x,y location (absolute x,y)

Absolute X,Y lets you create a point or vertex using an exact x,y location. For example, you might use an absolute x,y to create a bird’s nest in an animal habitat database with x,y coordinates obtained from a Global Positioning System (GPS) unit.

You can specify the location as a longitude-latitude coordinate pair, a Military Grid Reference System (MGRS) location, a U.S. National Grid (USNG) location, or a Universal Transverse Mercator (UTM) coordinate. If you are entering a coordinate pair, you see two boxes on the dialog box, compared with one box for grid locations.

For more information on valid formats when entering locations, see About distance units and editing.

Steps:
1. These steps can be used to create either point features or vertices in lines and polygons:
   - To create a point feature: Click a point feature template in the Create Features window and click the Point tool.
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Right-click the map and click Absolute X,Y, or press F6.
3. Click the Units button and click the unit you want to use to enter the location.
4. Type the coordinates or location and press ENTER.

Related Topics
- About distance units and editing
- Creating a point or vertex at a direction and distance
- Creating a point or vertex at the intersection of two distances
- Creating a point or vertex at the intersection of two segments
- Creating a point or vertex at the midpoint of two locations

Creating a point or vertex at the intersection of two distances

Distance-Distance allows you to create a point or vertex at the intersection of two distances from two other points. For example, the Distance-Distance method could be used to place a new electrical pole based on field measurements. The next point is known to be 50 feet from one building corner and 75 feet from another. Distance-Distance creates two circles based on these distances and finds two possible intersection points where the pole can be placed.

Steps:
1. These steps can be used to create either point features or vertices in lines and polygons:
   - To create a point feature: Click a point feature template in the Create Features window and click the Point tool.
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click Distance–Distance on the Editor toolbar construction method palette.
3. Click once to establish the centerpoint of the first circle, and press D on the keyboard.
4. Type the radius length for the first circle and press ENTER.
5. A circle is created with the specified radius.
6. Click once to establish the centerpoint of the second circle, and press D.
7. Type the radius length for the second circle and press ENTER.
6. A second circle is created with the specified radius. The two locations where the radii of the circles intersect are highlighted when you move the pointer over them.
7. Position the pointer over the location where you want to add the vertex, or point and click.
   You can also press TAB to alternate between the two points of intersection and press ENTER to create the point.

Related Topics
- Creating a point or vertex at a direction and distance
- Creating a point or vertex at an exact x,y location (absolute x,y)
- Creating a point or vertex at the intersection of two segments
- Creating a point or vertex at the midpoint of two locations

Creating a point or vertex at a direction and distance

Direction-Distance allows you to create a point or vertex using a distance from a known point plus a direction from a known point to define a bearing line. For example, a pole might be located at a specified distance from the corner of one building and at a defined angle from the corner of another building.

Steps:
1. These steps can be used to create either point features or vertices in lines and polygons:
2. Click **Direction–Distance** on the **Editor** toolbar construction method palette.
3. Click a point to specify the location from which the direction to the next vertex is measured.
4. Move the pointer to get the approximate direction toward the next vertex. As you move the pointer in the direction from the point you clicked, the direction is displayed in the lower left corner of the ArcMap window.
5. Press D and type the direction to the vertex from the point you clicked, then press ENTER.
6. Optionally, click again on the map to set the direction.
7. Click a point to specify the location from which the distance to the next vertex is measured.
8. Move the pointer to get the approximate distance from the point you clicked to the next vertex. As the pointer is moved, a circle, centered at the second point you clicked, is dragged out to intersect the direction line you just defined. The radius of the circle is displayed in the lower left corner.

9. Click the intersection of the circle and the direction line that corresponds to the position of the new vertex. The intersection point nearest the cursor is selected, and once clicked, the new vertex is placed. Optionally, you can press TAB to switch between the two intersection points and ENTER to select one of them.

### Related Topics
- [Creating a point or vertex at an exact x,y location (absolute x,y)]
- [Creating a point or vertex at the intersection of two distances]
- [Creating a point or vertex at the intersection of two segments]
- [Creating a point or vertex at the midpoint of two locations]

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### Creating a point or vertex at the intersection of two segments

**Intersection** creates a point or vertex at the place where two segments would intersect if extended far enough. In the example below, the Intersection construction method is used to create a parking lot adjoining an L-shaped building. The outer corner of the lot should be located at the point where the two outermost walls of the building would intersect if they were extended.

**Steps:**
1. These steps can be used to create either point features or vertices in lines and polygons:
   - To create a point feature: Click a point feature template in the **Create Features** window and click the **Point** tool.
   - To create a vertex in a line: Click a line feature template in the **Create Features** window and click the **Line** tool.
   - To create a vertex in a polygon: Click a polygon feature template in the **Create Features** window and click the **Polygon** tool.
2. Click **Intersection** on the **Editor** toolbar construction method palette. The pointer turns into crosshairs.
3. Position the crosshairs over the first segment you want to create an intersection with, and click. A line extends from that segment across the map display so that you can see the first angle used to construct the point of intersection.
4. Position the crosshairs over the second segment and click to add a vertex or point at the implied intersection of the two segments.

**Related Topics**
- [Creating a point or vertex at a direction and distance]
- [Creating a point or vertex at an exact x,y location (absolute x,y)]
- [Creating a point or vertex at the intersection of two distances]
- [Creating a point or vertex at the midpoint of two locations]

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### About creating segments

**Creating lines and polygons (segments)**

To create segments in lines or polygons, you will most commonly use the Line tool (with line templates) and the Polygon tool (with polygon templates). While these tools are used with different template types, they behave similarly. To create segments, simply click the map where you want to place vertices. You digitize a new line or polygon feature’s shape by drawing an edit sketch, which is the underlying representation of the feature’s geometry. As you sketch, you see a WFS/OGC preview with the actual symbology used for that template, with vertices symbolized as green and red squares. A sketch is composed of all the vertices and segments of the feature. Vertices are the points at which the sketch changes direction, such as corners; segments are the lines that connect the vertices.
When you want to create features, you’ll most commonly use the Create Features window’s construction tools and the construction methods on the Editor toolbar. With those tools, for example, you can create lines, arcs, tangent curves, vertices at intersections or midpoints, vertices based on distances and directions from other features, or new segments by tracing along existing ones.

By default, the Line and Polygon tools create straight segments between the vertices you click. These tools have additional ways to define a feature’s shape, such as creating curved lines or tracing existing features. These are construction methods, which are located on the Editor toolbar. To create a curved segment, click that construction type from the palette on the Editor toolbar and draw the curve on the map. You can even switch among construction types after each segment, allowing you to build the exact shape you want. For example, if you are drawing a road with a bend in it, you may want some of it to be straight and some to be curved. To do this, start with Straight Segment, digitize the straight segment, then click a curved segment construction method and create the curve.

Once you are satisfied with the shape of the sketch, you need to finish the sketch to complete the feature's geometry and actually create the feature with the attributes specified in the template. There are several ways that you can finish a sketch, including double-clicking with your mouse, choosing the command from a shortcut menu, or using a keyboard shortcut (F2). The left graphic below shows the polygon feature being constructed from an edit sketch. Once all the desired vertices are added, the sketch is finished and becomes a feature. You can double-click a feature with the Edit tool to modify the sketch, thereby changing the shape of the polygon.

To create a new line, at least two vertices—the start and end points—are required to finish the sketch, and therefore, create the feature. To create a new polygon with the Polygon tool, for example, at least three vertices are required. A sketch of a line records the direction it was digitized, which is important if you need to trim or extend the line or perform an operation on it that uses measurements originating from the start or end point. Vertices are marked in green, with the last vertex added marked in red. (You can change the colors of the edit sketch on the Editing Options dialog box.)

To enhance productivity, the construction methods palette is also found on the Feature Construction mini toolbar, which appears near your pointer when you are digitizing segments in new lines or polygons. The Feature Construction toolbar is semitransparent, so you can see the map under it until your pointer rests directly over the toolbar to make it become opaque. If the Feature Construction toolbar is blocking where you want to click, press the TAB key to move it to the other side of your sketch. You can also turn it off completely on the Editing Options dialog box. In addition, there are many keyboard shortcuts available, and you can right-click the map to access a shortcut menu containing commands for the precise placement of vertices. For example, you can add a vertex at a specific x,y location; draw a segment at an exact length and direction; or make a segment parallel or perpendicular to another segment.

In addition to the Line and Polygon tools, other tools are available to create lines and polygons. The Freehand tool creates a hand-drawn feature and automatically smooths it into Bézier curves. The Circle and Rectangle tools allow you to create circles and rectangles by dragging the mouse interactively, or at precise locations with keyboard shortcuts. The Ellipse tool allows you to create a new ellipse feature interactively or by using shortcuts to specify the location and major or minor radii. When creating polygons, you can also choose the Auto-Complete Polygon tool, which is used to create adjacent polygons that do not overlap or have gaps.
General workflow for creating a line or polygon

1. Choose a feature template (a category or layer in which your edits will be stored and containing information about the defaults for the feature creation).
2. Choose a construction tool. Different kinds of templates have different tools available.
3. Choose a sketch construction method.
4. Click the map or provide the proper inputs otherwise to build the sketch.
5. Finish the sketch to create the feature.
6. Update the attributes of the feature.

Related Topics
- Segment construction methods
- The Feature Construction toolbar

Segment construction methods

When you want to create features, you’ll most commonly use the Create Features window’s construction tools and the construction methods on the Editor toolbar. With those tools, for example, you can create lines, arcs, tangent curves, vertices at intersections or midpoints, vertices based on distances and directions from other features, or new segments by tracing along existing ones.

By default, the Line and Polygon tools create straight segments between the vertices you click. These tools have additional ways to define a feature’s shape, such as creating curved lines or tracing existing features. These are construction methods, which are located on the Editor toolbar. To create a curved segment, click that construction type from the palette on the Editor toolbar and draw the curve on the map. You can even switch among construction types after each segment, allowing you to build the exact shape you want. For example, if you are drawing a road with a bend in it, you may want some of it to be straight and some to be curved. To do this, start with Straight Segment, digitize the straight segment, then click a curved segment construction method and create the curve.

To access the feature construction methods, you can use either the Editor toolbar or the Feature Construction pop-up mini toolbar.

Each time you click the map with a sketch tool used to create segments, such as the Line or Polygon tool, the Feature Construction toolbar appears. The toolbar provides a shortcut to the segment construction methods on the Editor toolbar, so you can create straight or curved segments and easily access any of the other construction methods. As you click the map, the Feature Construction toolbar follows your clicks. The toolbar is not intended to be docked but rather to float freely around your sketch. If you find that it is in the way of where you want to place a new vertex, press the TAB key to relocate the toolbar. Pressing SHIFT+TAB hides the toolbar temporarily.

Below are the available construction methods.

**Straight**

Straight Segment 🔄 is the default method to digitize the vertices of line or polygon features. A vertex is placed each time you click, with the segments between vertices being straight lines.

**Arc**

Arc 🏛️ helps you create a segment that is a parametric (true) curve. Instead of being made of numerous vertices, a parametric curve has only two vertices as
endpoints. You might use Arc to digitize a cul-de-sac, using an aerial photo image as a backdrop.

**Bézier**

Bézier constructs smoothed curves. You can use the handles to change the angle, height, and shape of the curve. If you rotate the handles, you can create an S-shaped curve.

**Direction-Distance**

Direction-Distance allows you to create a point or vertex using a distance from a known point plus a direction from a known point to define a bearing line. For example, a pole might be located at a specified distance from the corner of one building and at a defined angle from the corner of another building.

**Distance-Distance**

Distance-Distance allows you to create a point or vertex at the intersection of two distances from two other points. For example, the Distance-Distance method could be used to place a new electrical pole based on field measurements. The next point is known to be 50 feet from one building corner and 75 feet from another. Distance-Distance creates two circles based on these distances and finds two possible intersection points where the pole can be placed.
Endpoint Arc

Endpoint Arc allows you to specify the start and endpoints of the curve, then define a radius for the curve. This is particularly useful in sketching culs-de-sac, where the beginning and ending points of the arc, as well as the radius of the cul-de-sac, are known.

Intersection

Intersection creates a point or vertex at the place where two segments would intersect if extended far enough. In the example below, the Intersection construction method is used to create a parking lot adjoining an L-shaped building. The outer corner of the lot should be located at the point where the two outermost walls of the building would intersect if they were extended.

Midpoint

Midpoint allows you to place a point or vertex by clicking two points; the new point or vertex is placed at the midpoint of the line between these points. If you were creating street centerlines from parcel data, you might use Midpoint to create the vertices directly between the parcels on opposing sides of the road.

Right Angle

Right Angle limits a segment to be at a 90-degree, right angle to the previous segment. You might use the Right Angle construction method to create building footprints or other features that have square corners.
Tangent

Tangent adds a segment that is tangential to the previously sketched segment. This method is practical when sketching rail lines in which the curves are nearly always tangential to the previous segment. To create a tangent curve, you need to have already sketched a segment using one of the other sketch construction methods.

Trace

Trace helps you create segments that follow along existing segments. Suppose you want to add a new road casing feature that is offset 15 meters from the front of a parcel subdivision. You could trace along the existing line features instead of typing the angle and length of each segment.

Related Topics

About creating segments
The Feature Construction toolbar

The Feature Construction toolbar

The Feature Construction mini toolbar provides quick access to some of the most commonly used commands when editing. It appears near your pointer when you are digitizing segments once you have placed the first vertex in a sketch. The toolbar is semitransparent so you can see the map under it, although it becomes opaque when you rest your pointer over the toolbar. To use a command on the Feature Construction toolbar, simply click it.
Each time you click the map with a sketch tool used to create segments, such as the Line or Polygon tool, the Feature Construction toolbar appears. The toolbar provides a shortcut to the segment construction methods on the Editor toolbar, so you can create straight or curved segments and easily access any of the other construction methods. As you click the map, the Feature Construction toolbar follows your clicks. The toolbar is not intended to be docked but rather to float freely around your sketch. If you find that it is in the way of where you want to place a new vertex, press the TAB key to relocate the toolbar. Pressing SHIFT+TAB hides the toolbar temporarily.

The Feature Construction toolbar also contains commands that allow you to create segments parallel or perpendicular to an existing feature. For example, if you click Constrain Parallel and click a feature, the next segment in the sketch will be parallel to the feature you clicked. As you move the pointer, the length of the segment can change, but not the angle. To clear a sketch constraint, press the ESC key.

While you will likely use the Feature Construction toolbar most often when creating new features, it is also useful when you are using a sketch to edit an existing feature, such as when reshaping or splitting lines or polygons. For example, to modify the shape of a polygon, click the Reshape Feature tool on the Editor toolbar; click the polygon; then use the Feature Construction toolbar, if needed, to help digitize the new shape.

If you do not want the Feature Construction toolbar to appear, turn off the display of mini toolbars on the General tab of the Editing Options dialog box.

**Related Topics**
- About creating segments
- Segment construction methods
- The Edit Vertices toolbar

### Changing the edit sketch vertex and segment symbols

You digitize a new line or polygon feature's shape by drawing an edit sketch, which is the underlying representation of the feature's geometry. As you sketch, you see a WYSIWYG preview with the actual symbology used for that template, with vertices symbolized as green and red squares.

If you are tracing features over a dark raster image, for example, you may want to change the colors so the sketch is easier to see. You can change the square boxes used to draw the vertices and the segment line connecting them. The selected vertex symbol is how a vertex appears when it is selected, such as when you draw a box around it with the Edit tool or check it in the Edit Sketch Properties window.

While the sketch is most commonly used for digitizing new features, it is also used when reshaping a feature, cutting a polygon, and so on. Changes you make to the edit sketch symbology are also reflected in those cases.

You can turn off the symbolized (WYSIWYG) preview so a feature displays as a wireframe when moving it or sketching. Turning off the symbolized drawing may be useful when you are tracing over an aerial photograph or working with large outline symbols. If you turn off this setting, the sketch symbols specified on the Editing Options dialog box are used when working with edit sketches.

**Steps:**
1. Click the Editor menu and click Options.
2. Click the General tab.
3. If you want to turn off the symbolized preview of a feature and display only a wireframe when moving or sketching, uncheck Display symbolized feature.
4. Click the edit sketch symbol buttons and use the Symbol Selector dialog box to change the symbology used to display vertices and segments in an edit sketch.
5. Click OK.

### Creating a vertex by clicking the map

You can click the map with the Line or Polygon tool to place a vertex.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click the Straight Segment construction method on the Editor toolbar.
3. Click the map to digitize the feature's vertices.
4. Right-click anywhere on the map and click Finish Sketch.
Creating a vertex relative to the location of the last vertex (delta x,y)

You can use Delta X,Y to place a vertex relative to the previous vertex.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Create at least one vertex.
3. Right-click away from the vertex or sketch and click Delta X,Y, or press CTRL+D.
4. Type the coordinates and press ENTER.

Creating a curve through start, middle, and end points (Arc)

Arc helps you create a segment that is a parametric (true) curve. Instead of being made of numerous vertices, a parametric curve has only two vertices as endpoints. You might use Arc to digitize a cul-de-sac, using an aerial photo image as a backdrop.

Arc creates a curve through the starting, middle, and ending points you specify. Click to place the start point, click again to place the midpoint of the curve, then click a third time to place the endpoint of the arc segment.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click Arc on the Editor toolbar.
3. Click once to establish the start point of the arc.
   A vertex is created.
4. Click once to establish the axis of the arc. This is the invisible point through which the curve passes.
   After you have clicked the second point to set the axis, you can press R to set the radius value. Press TAB to cycle through the possible curve solutions.
5. Click once to establish the endpoint of the arc.
   A segment that is a true (parametric) curve is created.

Creating a curve through endpoints (Endpoint Arc)

Endpoint Arc allows you to specify the start and endpoints of the curve, then define a radius for the curve. This is particularly useful in sketching culs-de-sac, where the beginning and ending points of the arc, as well as the radius of the cul-de-sac, are known.

To use Endpoint Arc, click to place the start point, click again to construct the endpoint, then drag the curve or press the R key to set the radius value.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click Endpoint Arc on the Editor toolbar construction method palette.
3. Click the start point of the arc, then click the endpoint of the arc.
4. Move the pointer to get the approximate radius for the curve.
5. Click once to establish the endpoint of the arc.
6. Press the R key and type the radius for the curve. You can also click again on the map to set the radius.

Related Topics
- Creating a Bézier curve
- Creating a curve through endpoints (Endpoint Arc)
- Editing Bézier curves
- Editing curved segments

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Creating a curve tangent to the previous segment (Tangent)

Tangent \( \checkmark \) adds a segment that is tangential to the previously sketched segment. This method is practical when sketching rail lines in which the curves are nearly always tangential to the previous segment. To create a tangent curve, you need to have already sketched a segment using one of the other sketch construction methods.

The Tangent construction method provides an interactive method of adding a tangent curve. To enter specific parameters for the curve, right-click and click the Tangent Curve command.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Create a segment using any construction method.
3. Click Tangent \( \checkmark \) on the Editor toolbar construction method palette.
4. As the pointer is moved, the arc bends and changes in length to remain tangent to the previous segment. Press R to set the radius value, then press TAB to cycle through the possible curve solutions.
5. Click again to place the endpoint of the arc.

**Related Topics**
- Creating a curve tangent to the previous segment by specifying parameters (Tangent Curve)

Creating a curve tangent to the previous segment by specifying parameters (Tangent Curve)

The Tangent Curve command on the menu that appears when you right-click the map with a construction tool can be used to add a circular arc curve to an existing segment—for example, to add a curved segment to extend a centerline along a curved road.

When you create a tangent curve with the Tangent Curve command, you must specify two parameters for the curve from the following options: arc length, chord, radius, or delta angle. You must also specify whether you want to create the curve to the right or left of the segment, according to the direction in which the line is drawn. The curve is created from the last vertex of the existing segment based on the parameters you define.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Create a segment using any construction method.
3. Right-click anywhere on the map and click Tangent Curve.
4. Click the drop-down arrows and click two parameters by which you want to define the curve.
5. Type the appropriate values for the parameters (distance in map units for arc length, chord, radius; degrees for delta angle). If you choose chord length and radius to construct the curve, there are two possible solutions—the major and minor portions of the circle.
   - The Minor check box appears at the bottom of the Tangent Curve dialog box. Check it to construct the minor portion of the circle.
6. Click the Left option to create the tangent curve to the left of the segment. Click the Right option to create the curve to the right.
7. Press ENTER.
   - A segment that is a circular arc curve is created from the last vertex of the segment according to the parameters you specified.

**Related Topics**
- Creating a curve tangent to the previous segment (Tangent)

Creating a Bézier curve

Bézier \( \checkmark \) constructs smoothed curves. You can use the handles to change the angle, height, and shape of the curve. If you rotate the handles, you can create an S-shaped curve.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click Bézier Curve \( \checkmark \) on the Editor toolbar construction method palette.
3. Click where you want the curve to begin.
4. Drag the handle to set the distance and angle of the curve.
5. Click where you want that curve to end.
6. Drag that handle to complete the curve's shape.
   Pressing the M key allows you to hold down the mouse button while dragging the Bézier control arm handle to shape the curve.
7. If you want to reshape the curve, you can edit the curve later by moving the handles with the Edit tool.

Related Topics
Creating a curve through endpoints (Endpoint Arc)
Creating a curve through start, middle, and end points (Arc)
Editing Bézier curves
Editing curved segments

Creating a fillet curve connecting between two lines

Fillets are segments of a circular arc that are often used to connect two intersecting lines. Fillets are used to create smoothly curving connections between lines, such as edge of pavement lines at street intersections or rounded corners on parcel features.

The Fillet tool creates a circular curve that is tangential to two line segments and optionally trims the overlapping segments from the original feature or features. The curve is constructed using an implied or fixed radius value through the tangent points that are derived from a hint point, which is the pointer location. It determines the region used to define the curve direction.

Right-click the map or press the O key to set the Fillet tool options. The options include whether to trim the existing features and use a fixed radius value.

Steps:
1. Click the Fillet tool on the Advanced Editing toolbar.
2. Optionally, right-click or press O to set options. Click OK when you are finished.
   - Check Trim existing segments if you want to remove the existing segments that extend beyond the tangent points.
   - Check Fixed radius and type a radius for the curve. Fillet uses the current data frame coordinate system units for the fillet radius unless you specify another unit of measure.
3. Click one line first, then the other, to specify the lines between which you want to construct the fillet.

Without a fixed radius, the fillet curve changes as you drag the pointer away from the first line you clicked.

4. When the curve has the correct radius, click to finish the curve.
5. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
6. Click OK.
   A new fillet curve joins the two selected lines. The extra line segments outside the curve are trimmed off if you checked Trim existing segments.

Creating a segment using an angle and a length

To create a segment at a specific angle, use the Direction command. Direction constrains the angle of the segment to an angular value. For example, if you type 45 as the angle, the segment is constrained to a 45-degree angle one way and a 225-degree angle the other. You can combine Direction with the Length command (Direction/Length) to enter an angle and a length for the next segment.

The Direction type and units are based on the settings on the Units tab of the Editing Options dialog box, accessed from the Editor menu. By default, east is 0
degrees, and positive angles are measured counterclockwise. For example, a 90-degree angle represents north, and a 180-degree angle represents west.

**Steps:**

1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line
     - Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon
     - Click a polygon feature template in the Create Features window and click the Polygon tool.

2. Click the Straight Segment construction method on the Editor toolbar.
3. Create at least one vertex.
4. Right-click away from the sketch and click Direction/Length, or press CTRL+G.
5. Type the angle and a length, then press ENTER to constrain the segment to the specified angle.

**Related Topics**
- Creating a segment at a right angle (90 degrees) to the previous segment
- Creating a segment at an angle from another segment
- Creating a segment parallel to another segment
- Creating a segment perpendicular to another segment
- Setting the direction type and units used when editing

---

Creating a segment at an angle from another segment

The Segment Deflection command creates a segment at an angle relative to any existing segment. You could use segment deflection to create a new road at an angle from an existing road. To choose the existing road as the segment to deflect from, simply right-click over it, click Segment Deflection, then type the angle.

The new road is constrained to be at that angle from the existing road.

The segment you work from with segment deflection is 0 degrees, and the deflection angle you specify for the new segment is calculated from there. Positive values are calculated in a counterclockwise direction from the existing segment, while negative values are calculated clockwise. To work only with positive angle values, convert negative angles to positive angles by adding 180 to the negative value. For example, a 45-degree angle (measured clockwise) becomes a 135-degree angle (measured counterclockwise).

**Steps:**

1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line
     - Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon
     - Click a polygon feature template in the Create Features window and click the Polygon tool.

2. Click the Straight Segment construction method on the Editor toolbar.
3. Create at least one vertex.
4. Position the pointer over the segment you want to create a new segment from, right-click, then click Segment Deflection.
5. Type the desired angle from the segment you have chosen and press ENTER. You can also press F7 to set the angle.
6. Click once to digitize the endpoint of the segment, or right-click and click Length to create the segment at an exact length.

**Related Topics**
- Creating a segment at a right angle (90 degrees) to the previous segment
- Creating a segment parallel to another segment

---

Tip: To create a segment at an angle from the last segment, right-click and click Deflection. Deflection uses the last segment as 0 degrees and calculates the angle you specify from there. Positive values are calculated in a counterclockwise direction from the existing segment, while negative values are calculated clockwise. You might use Deflection to create the bent end of a water or gas line at a 33-degree angle to a house.
Creating a segment perpendicular to another segment

Right Angle limits a segment to be at a 90-degree, right angle to the previous segment. You might use the Right Angle construction method to create building footprints or other features that have square corners.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.

2. Create a segment using any construction method.
3. Click Right Angle on the Editor toolbar construction method palette. As you move your pointer, the segment is limited to being at a right angle to the previous segment.
4. Click to place the vertex at the endpoint of the segment.

**Related Topics**
- Creating a segment at an angle from another segment
- Creating a segment parallel to another segment
- Creating a segment perpendicular to another segment
- Creating a segment using an angle and a length
- Squaring off a line or polygon

Creating a segment parallel to another segment

To create a new segment that is parallel to another segment, click Constrain Parallel on the Feature Construction pop-up toolbar and click the segment. As you move the pointer, the length of the segment can change, but not the angle. For instance, you might use this command to create a gas main line parallel to the street.

Another way of making a parallel segment is to right-click and click Parallel. This limits the next segment to be parallel to the feature underneath your pointer where you right-clicked.

To cancel a sketch constraint, press the ESC key.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon: Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click the Straight Segment construction method on the Editor toolbar.
3. Create at least one vertex.
4. Click Constrain Parallel on the Feature Construction pop-up toolbar and click the segment. Constrain Parallel first searches the edit sketch for existing segments to be parallel to, then by the drawing order of layers.
5. Click once to digitize the endpoint of the segment, or right-click and click Length to create the segment at an exact length.

**Related Topics**
- Creating a segment at a right angle (90 degrees) to the previous segment
- Creating a segment at an angle from another segment
- Creating a segment perpendicular to another segment
- Creating a segment using an angle and a length

Creating a segment perpendicular to another segment

To create a new segment that is perpendicular to another segment, click Constrain Perpendicular on the Feature Construction pop-up toolbar and click the segment. As you move the pointer, the length of the segment can change, but not the angle. For instance, you might use this command to place a utility service line perpendicular to the main electric line.

Another way of making a perpendicular segment is to right-click and click Perpendicular. This limits the next segment to be perpendicular to the feature underneath your pointer where you right-clicked.

To cancel a sketch constraint, press the ESC key.

**Steps:**
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line: Click a line feature template in the Create Features window and click the Line tool.
Because the default stream tolerance is zero, you must enter a tolerance value before you start digitizing, or the vertices will join together or overlap each other. You can change the stream tolerance at any time, even when you are in the process of digitizing a feature.

You must also specify the number of streaming vertices you want to group together. The number you set tells ArcMap how many vertices to delete when you click the Undo button. For example, if you set this number to 20 and click the Undo button while you are digitizing a feature, ArcMap deletes the last 20 digitized vertices from your feature.

Steps:
1. Click the Editor menu and click Options.
2. Click the General tab.
3. Type the stream tolerance (in map units). You can also give the stream tolerance value in other units by specifying a distance units abbreviation with the value that you enter. For example, to specify a distance of 10 feet, type 10ft. Distance unit abbreviations only work if your data frame is projected.
4. Type the number of vertices you want to group together. Now when you click the Undo button while digitizing in stream mode, the number of vertices you specify are deleted.
5. Click OK.

Related Topics
Creating a feature by drawing freehand
Creating segments by tracing
Setting options for streaming

Creating segments by streaming vertices

When streaming, ArcMap automatically adds vertices at an interval as you move around the map. You might want to stream when creating a curved line, such as a river. Streaming, or stream mode digitizing, is commonly used with a digitizing tablet but can be used simply with a mouse.

To begin digitizing in stream mode, right-click and click Streaming on the Editor toolbar. You can also press the F8 key to enter stream mode. If you click the map, streaming is suspended. This allows you to click buttons, menus, and other user interface elements. This means you can right-click to access the shortcut menus, enabling you to place a vertex using Absolute X,Y, Delta X,Y, or any of the other commands on that menu. Click the map again to start streaming. To exit from stream mode entirely, right-click and click Streaming or press F8.

An alternative to streaming is the Freehand construction tool, which may be useful in the context of redlining or designing. Freehand creates smooth, Bézier curves automatically.

Steps:
1. These steps can be used to create vertices in either lines or polygons:
   - Click a polygon feature template in the Create Features window and click the Polygon tool.
   - Click a line feature template in the Create Features window and click the Line tool.
2. Click the Straight Segment construction method on the Editor toolbar.
3. Right-click and click Streaming, or press F8.
4. Digitize the first vertex of the line or polygon feature and move the pointer to draw the feature's shape. ArcMap creates vertices at the stream tolerance you specified.
5. If you click the map, streaming is suspended, so you can switch among construction methods, such as straight or curved, and also click buttons, menus, and other user interface elements. Click the map again to start streaming.
6. If you want to exit from stream mode entirely, click the map to suspend streaming, then right-click and click Streaming, or press F8.
7. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Creating a feature by drawing freehand
Creating segments by tracing
Setting options for streaming

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Creating a feature by drawing freehand

The Freehand tool allows you to create lines that follow the movement of your pointer. The segments are smoothed into Bézier curves when you finish the sketch. For this reason, the Freehand tool is most useful when making quick, free-form design notes (redlining), such as indicating a study area on a map.

Steps:

1. These steps can be used to create lines or polygons:
   - To create lines, click a line feature template in the Create Features window.
   - To create polygons, click a polygon feature template in the Create Features window.
2. Click the Freehand tool on the Create Features window.
3. Click the map to start the freehand drawing. You do not need to hold down the mouse button.
4. Drag the pointer in the shape you want. Hold down the SPACEBAR to snap to an existing feature.
5. Click the map to finish the sketch and create the feature. The freehand drawing line is automatically smoothed into Bézier curves.

Tip: If you are creating a polygon, it is closed to form a continuous ring. If you click the map to stop sketching just before reaching the original start point, you can avoid creating an extraneous multipart polygon or jagged edge where the polygon closes. If you do overshoot the start point, double-click the feature with the Edit tool and delete the extra vertices.

Related Topics
Creating segments by streaming vertices
Creating segments by tracing
Setting options for streaming

Creating a circle feature

The Circle tool is used to create round features, such as water storage tanks.

The following keyboard shortcuts are available with the Circle tool:

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Enter a radius</td>
</tr>
<tr>
<td>A</td>
<td>Enter x,y coordinates for the center point</td>
</tr>
</tbody>
</table>

Circle tool keyboard shortcuts

Steps:

1. These steps can be used to create lines or polygons:
   - To create lines, click a line feature template in the Create Features window.
   - To create polygons, click a polygon feature template in the Create Features window.
2. Click the Circle tool on the Create Features window.
3. Click to place the center of the circle, then drag. A line representing the radius appears inside the circle as you draw it. You can also right-click or use keyboard shortcuts to enter x,y coordinates or type a radius. The radius is given in map units by default, but you can also give the value in other units by specifying a distance units abbreviation with the value that you enter.
4. Click once to finish the circle.

Related Topics
Creating a rectangle feature
Creating an ellipse feature

Creating an ellipse feature

The Ellipse tool is used to create ellipse features.

The following keyboard shortcuts are available with the Ellipse tool:

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAB</td>
<td>By default, the Ellipse tool creates ellipses outward from a center point. Use TAB to draw the ellipse from an endpoint instead. This enters a mode where all the ellipses will be drawn from an endpoint. Press TAB again to exit this mode and create ellipses from a center point.</td>
</tr>
<tr>
<td>A</td>
<td>Enter x,y coordinates for the center (or end) point of the radius</td>
</tr>
<tr>
<td>D</td>
<td>Specify an angle direction after you set the first point</td>
</tr>
<tr>
<td>R</td>
<td>Enter a major or minor radius</td>
</tr>
<tr>
<td>SHIFT</td>
<td>Make a circle instead of an ellipse</td>
</tr>
</tbody>
</table>
Ellipse tool keyboard shortcuts

Steps:
1. These steps can be used to create lines or polygons:
   - To create lines, click a line feature template in the Create Features window.
   - To create polygons, click a polygon feature template in the Create Features window.
2. Click the Ellipse construction tool on the Create Features window.
3. Click to place the center of the ellipse, then drag.
4. Click to set the major or minor radius, then drag.
   You can also right-click or use keyboard shortcuts to enter x,y coordinates, set a direction angle, choose whether the ellipse is constructed from the center or an endpoint, or enter a major or minor radius. The radius is given in map units by default, but you can give the value in other units by specifying a distance units abbreviation with the value that you enter.
5. Click once to finish the ellipse.

Related Topics
Creating a circle feature
Creating a rectangle feature

Creating a rectangle feature

The Rectangle tool is used to create rectangular features, such as buildings.

The following keyboard shortcuts are available with the Rectangle tool.

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAB</td>
<td>Press TAB to orient the rectangle straight (vertical or horizontal at 90-degree angles) rather than rotated. This enters a mode where all the rectangles you create will be straight. Press TAB again to exit this mode and create rectangles with a rotation angle.</td>
</tr>
<tr>
<td>A</td>
<td>Enter x,y coordinates for a corner. You can set the coordinates for the first corner or any of the subsequent corners once you have established the angle of the rectangle</td>
</tr>
<tr>
<td>D</td>
<td>Specify an angle direction after you set the first corner point</td>
</tr>
<tr>
<td>L or W</td>
<td>Enter a measurement for the length and width of the sides</td>
</tr>
<tr>
<td>SHIFT</td>
<td>Make a square instead of a rectangle</td>
</tr>
</tbody>
</table>

Steps:
1. These steps can be used to create lines or polygons:
   - To create lines, click a line feature template in the Create Features window.
   - To create polygons, click a polygon feature template in the Create Features window.
2. Click the Rectangle tool on the Create Features window.
3. Click where you want to place the first corner of the rectangle.
4. Drag and click to set the rotation angle of the rectangle.
   You can also right-click or use keyboard shortcuts to enter x,y coordinates, set a direction angle, choose whether the rectangle is horizontal or rotated, or enter measurements for the length and width of the sides. The measurements are given in map units by default, but you can give the value in other units by specifying a distance units abbreviation with the value that you enter.
5. Drag and click to create and finish the rectangle.

Related Topics
Creating a circle feature
Creating an ellipse feature
Squaring off a line or polygon

Squaring off a line or polygon

Square and Finish is a way of completing a polygon or closed line. It finishes a polygon or line by adding two new segments at 90-degree angles. Square and Finish saves you time and ensures precision when creating square-cornered buildings.

Two other ways of creating square corners are to use either the Right Angle construction method, which creates each segment at a 90-degree angle to the previous segment, or the Rectangle tool, which makes rectangular features.

Steps:
1. These steps can be used to create vertices in either lines or polygons:
   - To create a vertex in a line Click a line feature template in the Create Features window and click the Line tool.
   - To create a vertex in a polygon Click a polygon feature template in the Create Features window and click the Polygon tool.
2. Click the Straight Segment construction method on the Editor toolbar.
3. Digitize at least two segments.
4. Right-click anywhere on the map and click Square and Finish.
   The angles from the first vertex and the last vertex are squared. A new vertex is added, and the polygon or polyline is finished where the resulting
segments intersect.

Related Topics
Creating a rectangle feature
Creating a segment at a right angle (90 degrees) to the previous segment

Creating a multipoint feature

Sometimes, you need to create a feature that has more than one physical part but only references one set of attributes in the database. These are called multipoint features for point or multipart features for line and polygon features. Mass point observations from lidar data are often represented in a feature class with multipoint geometry. The multipoint geometry type is set when you create a new feature class.

To create a multipoint feature, you need to finish each part first, then finish the whole sketch once you have created the individual parts. Once the feature is created, when you click one part of the multipoint feature to select it, all points are automatically selected because they all belong to one multipoint feature.

Steps:
1. Click a multipoint feature template in the Create Features window.
2. Click the map to create parts of the multipoint feature.
3. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Creating a multipart feature

Creating a multipart feature

Sometimes, you need to create a feature that has more than one physical part but only references one set of attributes in the database. These are called multipoint for point or multipart for line and polygon features. A group of islands could be represented as a multipart polygon feature. To create a multipart feature, you need to finish each part first, then finish the whole sketch once you have created the individual parts. Once you create the feature and click one part of the feature to select it, all parts are automatically selected because they all belong to one multipart feature. Also note that there is one selection anchor (the "x") for a multipart feature and one record in the attribute table.

Keep in mind that parts in a multipart polygon are spatially separated. They can touch each other at vertices, but they cannot share edges or overlap. When you are sketching a multipart polygon, any parts that share an edge will be merged into a single part when you finish the sketch. In addition, any overlap among parts will be removed, leaving a hole in the polygon.

If you have existing features that you want to combine to make a multipart feature, you can do this with either Merge or Union. Merge allows you to combine features within the same layer, while Union works with features in different layers. You can also use Merge or Union to add another part to a multipart feature. To do this, create the new feature, select it and the existing feature, and then use Merge or Union.

To make multipart features into separate features, you can use either the Explode command on the Advanced Editing toolbar or the Multipart to Singlepart geoprocessing tool.

Steps:
1. Click a line feature template in the Create Features window and click the Line tool.
2. Click a polygon feature template in the Create Features window and click the Polygon tool.
3. Click the map to create the segments.
4. To change the shape of the sketch segment, click a construction method type on the Editor toolbar or on the Feature Construction mini toolbar. Segments can be created using a variety of methods—for example, as straight lines, with curves, or traced from the shapes of other features. You can also use keyboard shortcuts or right-click to access a menu of commands to help you place vertices in the sketch.
5. Hold the SHIFT key and double-click the last vertex as a shortcut to finishing the part.

About geodetic features
A geodetic feature is one whose measurements account for the inherent distortion of projected space. Geodetic features are useful when you want to create a feature that spans a large distance, such as a flight path across an ocean.

The features you draw in ArcMap are not geodetic (they are planar) unless you create them using either the Construct Geodetic command or one of the following geoprocessing tools: Bearing Distance To Line, Table To Ellipse, or KY To Line. Geodetic features do not account for changes in terrain, though. By their nature, maps and geospatial data contain distortion. The act of taking a 3D spherical surface, such as the earth, and projecting it to a flat 2D space warps the spatial relationships between locations on the original surface. To complicate matters, the earth is neither perfectly spherical nor perfectly smooth. It is flattened at the poles and it bulges at the equator. Map projections compensate for these irregularities, but they still contain spatial distortion. For more information on projections and coordinate systems, see What are map projections?

**Note:** Geodetic features contain densified geometry, which is a shape created by a series of connected vertices. For example, a densified curve is composed of a succession of points along the entire path of the curve, whereas a Bézier curve is smooth. Densified geometries require more resources to store and manipulate and are more difficult to edit than standard geometries. Editing or moving geodetic features makes them non-geodetic, so if you need to change or move a geodetic feature, re-create it instead.

**Types of geodetic features you can create**

- **Geodesic line**—The shortest line between any two points on the Earth’s surface on a spheroid (ellipsoid). One sample use for a geodesic line is when you want to determine the shortest distance between two cities for an airplane’s flight path. Another example is the creation of the path between the point of impact and the point of origin of a missile. This is also known as a great circle line if based on a sphere, rather than an ellipsoid. The geodesic line type allows you to create line only. In addition, you can create a multi-segment line which is a series of geodesic lines that make up a single line feature. You can use a multi-segment line when you want to create an airplane’s flight path with waypoints, such as an air route with multiple stops that make up a full route.

- **Geodesic circle**—A shape whose edge is defined as a particular geodetic distance from a fixed point. Depending on the coordinate system in which it is displayed, it may not appear to be a circle. You might use this if you are creating a range ring of a weapon system, such as to show a weapon’s effective range. Geodesic circles can be used to create either lines or polygons.

- **Geodesic ellipse**—A shape whose sum of geodetic distances from a fixed pair of points is a constant. You could use this to create a signal error ellipse. This is also known as a geodesic circle when the major and minor axes are the same length. The geodesic ellipse type allows you to create circles or polygons.

- **Great elliptic**—The line on a spheroid (ellipsoid) defined by the intersection at the surface by a plane that passes through the center of the spheroid and the start and end points of a segment. This is also known as a great circle when a sphere is used. The great elliptic type allows you to create lines only.

- **Loxodrome**—A loxodrome is not the shortest distance between two points, but instead defines the line of constant bearing, or azimuth. Great circle routes are often broken into a series of loxodromes, which simplifies navigation. This is also known as a rhumb line. The loxodrome type allows you to create lines only.

**Related Topics**

Creating geodetic features
Measuring distances and areas

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**Creating geodetic features**

You can create geodetic features—lines, circles, and ellipses—that are spatially accurate and geodetically correct in any projection. For example, if you are creating a feature that spans a large distance, such as an airplane’s flight path across an ocean or the effective range of a weapon, you should use a geodetic feature. For an overview of geodetic features and more information on the distortion they account for, see About geodetic features.

You can enter coordinates for whole features or feature segments by clicking the map or by typing the values. You can specify the location as a longitude-latitude coordinate pair, a Military Grid Reference System (MGRS) grid location, a U.S. National Grid (USNG) location, or a Universal Transverse Mercator (UTM) coordinate. Click the Units button next to the text box to enter values using different units, such as kilometers. Distances, such as the radius or axis length, are specified in map units of the data frame by default. You can enter values using different units by clicking the Units button next to the text box. For example, when the map units are decimal degrees, clicking the Units button allows you to enter values in distance units, such as kilometers.

**Note:** Geodetic features contain densified geometry, which is a shape created by a series of connected vertices. For example, a densified curve is composed of a succession of points along the entire path of the curve, whereas a Bézier curve is smooth. Densified geometries require more resources to store and manipulate and are more difficult to edit than standard geometries. Editing or moving geodetic features makes them non-geodetic, so if you need to change or move a geodetic feature, re-create it instead.

**Steps:**

1. In ArcMap, start an edit session with either line or polygon layers.
2. Click Construct Geodetic on the Advanced Editing toolbar. The Construct Geodetic dialog box appears.
3. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.

**Note:** The list of available feature templates (or layers) is determined by the type of geodetic feature you are creating. Geodesic circles and geodesic ellipses allow you to create line or polygon features, so both line and polygon feature templates are listed. However, if you choose to create the other types, only line feature templates are shown.

4. Click the Type drop-down arrow and click the type of geodetic feature you want to create. For a description of each type, see About geodetic features.
   - The Construction area of the dialog box changes to reflect the type you selected.
Digitizing is the process of converting features on a paper map into digital format. To digitize a map, you use a digitizing tablet (also known as a digitizer), which offers another way, besides screen digitizing freehand, to create and edit spatial data. You can convert features from almost any connected to your computer to trace over the features that interest you. The x,y coordinates of these features are automatically recorded and stored as spatial data.

This topic describes the workflow for preparing a map to be digitized.

5. If you are creating a geodesic line, great elliptic, or loxodrome:
   a. Type the starting x- and y- coordinate values. You can also click the Interactive Start Point Selection tool, then click the map display to set the start point.
   b. Click the Segment arrow to set whether you want to create the segment by entering a coordinate for the end point or by a distance and bearing direction.
   c. Enter the end coordinate or the distance and direction.
   d. If you want to create a multi-segment line, click Add so the current end coordinate will become the start coordinate for the next segment. The Add button becomes enabled when you have entered two valid coordinates for points, directions, distances, and lengths.

Tip: To add multiple segments quickly, you can use the TAB key to move through the coordinate entry boxes, then press ENTER to add the segment. You can press ESC if you need to cancel creating a multi-segment feature.

6. If you are creating a geodesic circle:
   a. Type the center x- and y- coordinate values. You can also click the Interactive Start Point Selection tool, then click the map display to set the center point.
   b. Type the radius value.

7. If you are creating a geodesic ellipse:
   a. Type the center x- and y- coordinate values. You can also click the Interactive Start Point Selection tool, then click the map display to set the center point.
   b. Type the major axis, minor axis, and direction values.

8. As you enter locations, you see a preview of the feature on the map. Once you are ready to create the feature, click the Create button.
9. Repeat these steps to create additional features. Close the Construct Geodetic dialog box when you are finished creating features.

Related Topics
About geodetic features

About preparing to digitize a paper map

Digitizing is the process of converting features on a paper map into digital format. To digitize a map, you use a digitizing tablet (also known as a digitizer) connected to your computer to trace over the features that interest you. The x,y coordinates of these features are automatically recorded and stored as spatial data.

Digitizing with a digitizing tablet offers another way, besides screen digitizing freehand, to create and edit spatial data. You can convert features from almost any paper map into digital features. You can use a digitizer in conjunction with the editing tools in ArcMap to create new features or edit existing features on a digital map.

You might want to digitize features into a new layer and add the layer to an existing map document or create a completely new set of layers for an area for which no digital data is available. You can also use a digitizer to update an existing layer on your digital map.

This topic describes the workflow for preparing a map to be digitized.

Step 1: Set up your digitizing tablet and install the driver software

To use a digitizing tablet with ArcMap, it must have WinTab-compliant digitizer driver software. To find out if a WinTab-compliant driver is available for your digitizer, see the documentation that came with the tablet or contact the manufacturer.

If you installed ArcGIS before installing your digitizer, the Digitizer tab may not appear in the Editing Options dialog box. To add the tab, you must register the digitizer.dll file using the ArcGIS ESRIRegAsm.exe utility. You need to have administrator privileges to perform these steps.

Tip: If you have installed the ArcGIS ArcObjects Software Development Kit, you can simply browse to the directory containing the digitizer.dll, right-click it, then register it from the shortcut menu.

1. Close any open ArcGIS applications.
2. Start the DOS Command Prompt, which is usually accessed by clicking Start, pointing to Programs (or All Programs), then clicking Accessories.
3. In the Command Prompt window, type cd and a space, followed by the path to the directory containing the ESRIRegAsm.exe utility: C:\Program Files\Common Files\ArcGIS\bin. This changes the Command Prompt's active directory to the folder where the ESRIRegAsm.exe utility is installed.
4. Press the ENTER key.
5. Type ESRIRegAsm.exe, a space, a quotation mark, the full path to your ArcGIS installation location with the name of the DLL, and a closing quotation mark. The default path is "C:\Program Files\ArcGIS\Desktop10.0\bin\digitizer.dll". If you installed ArcGIS in another directory, substitute that path.
6. Press the ENTER key.
7. If the registration was successful, close the Command Prompt window. The Editing Options dialog box will have the Digitizer tab when you restart ArcMap.

When ArcGIS is installed at the default location, the Command Prompt window should look like this. The text you need to type is shown in bold.

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Note: This example depicts Windows XP, so the initial paths shown when you open the Command Prompt window may be slightly different on another operating system. The text you need to type is still the same. On 64-bit systems, though, you need to use Program Files (x86) in the path.

Step 2: Configure the digitizer puck buttons

After installing the driver software, use the WinTab Manager setup program to configure the buttons on your digitizer puck (you might have to turn on your digitizer and reboot your machine before you can use the setup program). One puck button should be configured to perform a single click to digitize point features and vertices; another button should be configured to perform a double-click to finish digitizing line or polygon features. You might also want to configure a button to perform a right-click so you can access shortcut menus.

With any development programming language, you can configure additional buttons to run specific ArcMap commands.

Step 3: Ensure the quality of your paper map

Your map should ideally be reliable, up-to-date, flat, and not torn or folded. Paper expands or shrinks according to the weather. To minimize distortion in digitizing, experienced digitizers often copy paper maps to a more stable material, such as Mylar.

Step 4: Establish control points on the paper map

Before you can begin digitizing from your paper map, you must first establish control points that you will later use to register the map to the geographic space in ArcMap. If your map has a grid or a set of known ground points, you can use these as your control points. If not, you should choose between four and 10 distinctive locations, such as road intersections, and mark them on your map with a pencil. Give each location a unique number, and write down its actual ground coordinates.

Once you have identified at least four well-placed control points, place your map on the tablet and attach it with special residue-free putty; masking tape; or drafting tape, which looks like masking tape but leaves less residue when it’s removed. You do not have to align the map precisely on your tablet; ArcMap corrects any alignment problems when you register the map and displays such adjustments in the error report.

Step 5: Register the paper map

After identifying your control points, you must register your paper map in real-world coordinates. This allows you to digitize features directly in geographic space.

Registering your map involves recording the ground coordinates for the control points you identified. These are recorded using the Digitizer tab of the Editing Options dialog box.

After you have entered the ground coordinates, ArcMap displays an error report. The error report includes two error calculations: a point-by-point error and a root mean square (RMS) error. The point-by-point error represents the distance deviation between the transformation of each input control point and the corresponding point in map coordinates. The RMS error is an average of those deviations.

ArcMap reports the point-by-point error in current map units. If the RMS error is too high, you can reregister the appropriate control points. To maintain highly accurate data, your RMS error should be less than 0.004 digitizer units (often inches) or the equivalent scaled distance in map units—the ground units in which the coordinates are stored. For less accurate data, the value can be as high as 0.008 digitizer units.

Step 6: Set the correct projection

If you know what coordinate system (projection) your paper map is in, you should set the same projection for the layer into which you’re digitizing. If you are digitizing features into an existing feature layer, you must ensure that your paper map and digital layer share the same coordinate system.

Step 7: Enable digitizing mode and begin digitizing

To digitize features, you need to enable digitizing mode to create features.

Digitizing tablets generally operate in two modes: digitizing (absolute) mode and mouse (relative) mode. When you are in digitizing mode, you can only digitize features; you cannot choose buttons, menu commands, or tools from the ArcMap user interface because the screen pointer is locked to the drawing area. In mouse mode, however, there is no correlation between the position of the screen pointer and the digitizing tablet. When digitizing, you can switch between digitizing mode and mouse mode using the Editing Options dialog box. This allows you to use the digitizer puck to digitize features as well as access user interface choices (as a substitute for the mouse). Also, you can use your mouse to choose interface elements at any time, whether your digitizer is in mouse mode or digitizing mode.

You can digitize features on a paper map in two ways: point mode digitizing or stream mode digitizing (streaming). You can switch back and forth between the two modes as you digitize by pressing F8.

When you start a digitizing session, the default is point mode. With point mode digitizing you convert a feature on a paper map by digitizing a series of precise points, or vertices. ArcMap connects the vertices to create a digital feature. Point mode digitizing works the same way with a digitizer as with screen digitizing with the construction tools; the only difference is that with the digitizer you are converting a feature from a paper map using a digitizer puck instead of a mouse.

When streaming, ArcMap automatically adds vertices at an interval as you move around the map. You might want to stream when creating a curved line, such as a river. Streaming, or stream mode digitizing, is commonly used with a digitizing tablet but can be used simply with a mouse.

To begin digitizing in stream mode, right-click and click Streaming when creating features. You can also press the F8 key to enter stream mode. If you click the map, streaming is suspended. This allows you to click buttons, menus, and other user interface elements. This means you can right-click to access the shortcut menu, enabling you to place a vertex using Absolute X,Y, Delta X,Y, or any of the other commands on that menu. Click the map again to start streaming. To exit from stream mode entirely, right-click and click Streaming or press F8.

Related Topics

Enabling digitizing mode

Registering a paper map for digitizing

Registering a paper map for digitizing
Before you can start digitizing, you must register your paper map into real-world coordinates. This allows you to digitize features directly in geographic space. Always register your map at the start of each digitizing session, even if this means registering the same map more than once. Your paper map might shift between sessions; reregistering helps ensure that your digitizing is accurate.

The Digitizer tab on the Editing Options dialog box displays the current x,y location of the digitizer puck on the tablet. The coordinates change as you move the puck along the tablet surface. This helps orient you to the location you’re digitizing.

When registering your map, you have the option of saving the ground coordinates you entered for later use—for example, if you want to reregister your map or register another map that uses the same control points. These ground coordinates are stored in text files.

**Steps:**

1. Click the **Editor** menu and click **Options**.
2. Click the **Digitizer** tab.

**Note:** If you installed ArcGIS before installing your digitizer, the Digitizer tab may be missing. To add the tab, you must register the digitizer.dll file. When you restart ArcMap, the Editing Options dialog box will have the Digitizer tab.

3. If this is the first time you have registered the map, perform the following:
   a. With the digitizer puck, digitize the control points you established earlier on your paper map (with the puck over each control point on the map, press the button you configured to perform a mouse click). A record appears in the **X Digitizer** and **Y Digitizer** columns for each control point you digitized.
   b. Type the actual ground coordinates for each control point in the **X Map** and **Y Map** fields. An error in map units is displayed at each control point. A root mean square (RMS) error is displayed in map units and in digitizer inches.
   c. Optionally, click **Save** to save the ground coordinate values for future use.
   d. If you want to remove all the ground coordinate records and start over, click **Clear** on the Digitizer tab. To remove an individual record, click the number in the **Point** column corresponding to the coordinates you want to remove and press Delete.

4. You can also register the map by loading control points from a text file.
   a. Click **Load**.
   b. Navigate to the file you want to use and click **Open**.
   c. Click the first record and digitize the first control point with the digitizer puck. The ground coordinates appear under the **X Map** and **Y Map** fields.
   d. Digitize each of the other control points and note the RMS error.

5. Click **OK** to register the map.

**Related Topics**

*About preparing to digitize a paper map*

*Enabling digitizing mode*

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**Enabling digitizing mode**

Digitizing tablets generally operate in two modes: digitizing (absolute) mode and mouse (relative) mode. When you are in digitizing mode, you can only digitize features; you cannot choose buttons, menu commands, or tools from the ArcMap user interface because the screen pointer is locked to the drawing area. In mouse mode, however, there is no correlation between the position of the screen pointer and the digitizing tablet. When digitizing, you can switch between digitizing mode and mouse mode using the Editing Options dialog box. This allows you to use the digitizer puck to digitize features as well as access user interface choices (as a substitute for the mouse). Also, you can use your mouse to choose interface elements at any time, whether your digitizer is in mouse mode or digitizing mode.

**Steps:**

1. Click the **Editor** menu and click **Options**.
2. Click the **General** tab.
3. Type the stream tolerance (in map units). You can also give the stream tolerance value in other units by specifying a distance units abbreviation with the value that you enter. For example, to specify a distance of 10 feet, type **10ft**. Distance unit abbreviations only work if your data frame is projected.
4. Type the number of vertices you want to group together. Now when you click the **Undo** button while digitizing in stream mode, the number of vertices you specify are deleted.
5. Click the **Digitizer** tab.
6. Check **Enabled** to use the puck in digitizing mode.
7. Click **OK**.
8. Trace the puck over the feature on the paper map and create features as desired. Press F8 if you want to create vertices by streaming.

**Related Topics**

*About preparing to digitize a paper map*

*Registering a paper map for digitizing*

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**Copying and pasting features**

You can copy an existing feature by using the tools on the Standard toolbar. You can copy a feature and paste it into another layer, but it must be the same type of geometry (such as point, line, or polygon) as the one from which you copied. However, you can copy polygons into a line layer. Attributes will be copied and pasted along with the geometry if the source and target layers are the same or if they are in different layers that have identical
When the source and target layers have different schemas, a copy of the geometry (but not the attributes) of the selected feature is created. If the target feature class or subtype has default values, feature-linked annotation, or connectivity rules defined in a geodatabase, the copy will have the default values and behavior appropriate for the target layer. Attributes without default values will have a null value. You can copy and paste the individual attributes or use the Attribute Transfer tool on the Spatial Adjustment toolbar to pass along the existing attribute values to the new features. Another method is to join the attribute table for the source features to the attribute table for the new features, then use the Field Calculator to append permanently the existing values to the new features.

If you want to copy and paste features while in layout view, make sure you are working with a focused data frame. This way, you’ll be able to copy and paste the features inside the data frame rather than copying and pasting the data frame itself. To give a data frame focus, click it and click the Focus Data Frame button on the Layout toolbar, or simply double-click the data frame.

**Note:** Using Cut and Paste (rather than Copy and Paste) will only transfer geometry. Attributes are not pasted, even if the source and target layers are the same or have identical schema. The appropriate geodatabase behavior and default or null values will be populated in the target layer.

### Steps:

1. Click the **Edit** tool on the Editor toolbar.
2. Click the feature you want to copy. Hold down **SHIFT** while clicking features to select additional features.
3. Click the **Copy** button on the Standard toolbar.
4. Click the **Paste** button on the Standard toolbar.
5. Click the layer in which to store the pasted feature. When copying and pasting features, you choose the layer in which to store the new feature. This allows you to retain the attribute values from the copied feature, rather than having them be overwritten with values from a feature template.
6. Click **OK**.

   The feature is pasted on top of the original feature.

### Related Topics

- **Copying and scaling features with the Copy Features tool**
- **Creating a mirror image copy of a feature**

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**Copying and scaling features with the Copy Features tool**

When you use Copy and Paste on the Standard toolbar, the features are pasted directly on top of the features you copied. However, if you use the Copy Features tool on the Advanced Editing toolbar, you can simply click where you want to paste the features. In addition, you can drag a box to scale the features when they are pasted. This is useful because it allows you to copy features from noneditable layers that are outside the extent of your editable layers and scale them to fit inside the extent of the features you are editing.

For example, you have some building features in a CAD layer (the pink features in the graphic below) that need to be added to your geodatabase buildings layer (the yellow features), but the CAD features are too big to fit properly. Simply select the CAD features and drag a box with the Copy Features tool to scale them.

![Image of CAD features being scaled](image-url)

The features are added into the target layer you choose on the dialog box that appears when you release the mouse button. You can then use other editing tools, such as Edit, Scale, Rotate, and the spatial adjustment tools, to position the features you copied.

![Image of edited features](image-url)

Attributes will be copied and pasted along with the geometry if the source and target layers are the same or if they are in different layers that have identical schemas. When the source and target layers have different schemas, a copy of the geometry (but not the attributes) of the selected feature is created. If the target feature class or subtype has default values, feature-linked annotation, or connectivity rules defined in a geodatabase, the copy will have the default values and behavior appropriate for the target layer. Attributes without default values will have a null value. You can copy and paste the individual attributes or use the Attribute Transfer tool on the Spatial Adjustment toolbar to pass along the existing attribute values to the new features. Another method is to join the attribute table for the source features to the attribute table for the new features, then use the Field Calculator to append permanently the existing values to the new features.

### Steps:

1. Click the **Edit** tool on the Editor toolbar.
2. Click the feature you want to copy. Hold down **SHIFT** while clicking features to select additional features.
3. Click the **Copy** button on the Standard toolbar.
4. Click the **Paste** button on the Standard toolbar.
5. Click the layer in which to store the pasted feature. When copying and pasting features, you choose the layer in which to store the new feature. This allows you to retain the attribute values from the copied feature, rather than having them be overwritten with values from a feature template.
6. Click **OK**.

   The feature is pasted on top of the original feature.

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*Note:* Using Cut and Paste (rather than Copy and Paste) will only transfer geometry. Attributes are not pasted, even if the source and target layers are the same or have identical schema. The appropriate geodatabase behavior and default or null values will be populated in the target layer.
1. Click the Edit tool on the Editor toolbar.
2. Click the feature you want to copy. Hold down the SHIFT key while clicking features to select additional features.
3. Click the Copy Features tool on the Advanced Editing toolbar.
4. Click the place where you want a copy of the feature to be pasted, or drag a box into which the features will be scaled and pasted.
5. Click the layer in which to store the pasted feature. When copying and pasting features, you choose the layer in which to store the new feature. This allows you to retain the attribute values from the copied feature, rather than having them be overwritten with values from a feature template.
6. Click OK.

Related Topics
Copying and pasting features
Creating a mirror image copy of a feature

Creating a mirror image copy of a feature

The Mirror Features tool creates a mirror image copy of selected features on the other side of a line you create. For example, you can create houses in a housing development where houses are mirror images of those on the opposite side of the street. In the graphic below, the house polygon on the left side of the line (representing the street) is selected. The house polygon on the right is the resulting mirrored feature.

Steps:
1. To use the Mirror Features tool, you must first add it to an ArcMap toolbar from the Commands tab of the Customize dialog box. The Mirror Features tool is found in the Editor category.
2. Click the Edit tool on the Editor toolbar and click the feature.
3. Click the Mirror Features tool on the toolbar to which you added it.
4. Construct a line by clicking once on the start point and once on the end point.

Related Topics
Copying and pasting features
Copying and scaling features with the Copy Features tool

Creating new lines from points

You have several ways to use points to create new lines. For example, you might have some locations collected in the field using a GPS and want to draw a line to connect the points. For example, you might have the locations of rare plant sightings and want to draw the line representing the route you traversed through the forest.

- You can simply enable point snapping and digitize the line manually.
- You can use the Points To Line geoprocessing tool. This tool allows you to construct lines between points using the order on the map or a custom sort order.

Related Topics
Creating new points along a line

Creating a buffer around a feature

You can create a buffer around selected points, lines, or area features by using the Buffer command. Buffered features are created as line or polygon features using the settings of the chosen feature template.

For instance, you might use buffers to show an ecological zone around a waterway, distances from schools or public buildings that certain retail stores are located, or the area around a contaminated well. You can buffer more than one feature at once, but a separate buffer will be created around each feature.

The buffer distance is given in map units by default. You can also give the value in other units by specifying a distance units abbreviation with the value that you enter.
Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the feature around which you want to create a buffer.
3. Click the Editor menu and click Buffer.
4. Type the distance in map units for the buffer area around the feature.
5. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
6. Click OK.

Merging features in the same layer

Merge combines selected features of the same layer into one feature. The features must be from either a line or a polygon layer.

When merging, you choose which feature's attributes are preserved during the operation. When you click an entry on the Merge dialog box, the feature flashes on the map. The features are shown in the list by the name of the layer they belong to and the display expression. The merge policy, if present, does not determine the value of the attributes in the merged feature.

When features are not adjacent, a multipart feature is created. For example, you could merge the individual islands that make up Hawaii to create a multipart polygon feature.

Features that participate in geometric networks can also be merged.

Note: If you select line features with COGO fields and those features can be formed into a single COGO line, two extra options are available on the Merge dialog box. Checking the Merge into a single COGO line check box ensures that the newly merged feature has a single straight line segment or a single circular arc segment. Checking the Update COGO attributes check box ensures that the COGO description for the new feature is updated.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the features you want to merge. The features must be from the same layer.
3. Click the Editor menu and click Merge.
4. Click the feature that the features will be merged into and will supply the attributes for the merged feature.
5. Click OK.

Combining features from different layers (Union)

Union combines selected features into one new feature. Although the features may be from different layers, the layers must be of the same geometry type—either line or polygon. Union maintains the original features and their attributes—that is, the selected features are not deleted or edited during the Union operation. The new feature is created with the chosen template using the default attribute values. For example, with Union, you can use some selected parcels to create a polygon representing a neighborhood crime prevention area.

You can also create a multipart feature using the Union command by combining nonadjacent features from different layers. For example, to create a sedimentary rock polygon in a new rock classification layer given selected clay and quartz polygons in an existing rock composite layer, use the Union command to combine the clay and quartz features to create a new multipart sedimentary rock feature in the rock classification layer.

The Union command works on selected features, allowing you to choose which features will be combined in the output. On the other hand, the Union geoprocessing tool combines features from all input layers or feature classes and allows you to determine which attributes from the input features are transferred to the output feature class.

You can use the Merge command on the Editor menu instead of Union if the selected features are all in the same layer and you want to combine them into a single feature and choose the resulting attributes.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the features you want to combine into one.
3. Click the Editor menu and click Union.
4. Choose the target in which the new feature will be created.
   • If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   • If you do not have feature templates, click the layer in which to create the feature.
5. Click OK.

Related Topics
Intersecting features

Intersecting features

Intersect creates a new feature from the common areas or edges of any two selected features of the same geometry type. The new intersected feature is created using the settings specified in the chosen feature template.

You can create a new feature from the intersection of features of different layers, but the layers must be of the same geometry type (either line or polygon). The original features are maintained, and the new feature is created without attribute values in the current layer. You must manually enter attribute values for the new feature.

For instance, you can create a new sales territory out of overlapping sales areas. The top image shows two selected sales areas, and the bottom shows the result after using the Intersect command: a single sales territory (the purple selected feature) is created from the common sales areas.

• Before Intersect:

• After intersect (and assigning attributes to the new feature):

If you are trying to intersect line features, they must share a common edge. For example, two lines that cross one another (for example, as an X) share a common point but not a common edge. To break this type of line intersection, use the Planarize Lines command located on the Topology toolbar or the Split tool on the Editor toolbar with intersection snapping enabled.

The Intersect command works on selected features, allowing you to choose which features are intersected in the output, although you cannot specify the output's attributes. On the other hand, the Intersect geoprocessing tool creates new features from the overlaps in all input layers or feature classes, and it allows you to determine which attributes from the input features are transferred to the output feature class.

Steps:
1. To use the Intersect command, you must first add it to a toolbar from the Commands tab of the Customize dialog box. Intersect is found in the Editor category.
2. Click the Edit tool on the Editor toolbar.
3. Click the features from whose intersection you want to create a new feature.
4. Click Intersect on the toolbar to which you added it.
5. Choose the target in which the new feature will be created.
   • If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   • If you do not have feature templates, click the layer in which to create the feature.
6. Click OK.

Related Topics
Combining features from different layers (Union)

Separating a multipart feature (Explode)

You can use Explode on the Advanced Editing toolbar to separate a selected multipart feature into its individual, component features. This would be useful if you needed to alter the attributes of one of the elements in a multipart feature.
There are also geoprocessing tools available to merge and separate features. The Merge and Multipart To Singlepart geoprocessing tools work on all features in a layer rather than just the selected features.

**Steps:**
1. Click the Edit tool on the Editor toolbar.
2. Select the multipart feature you want to separate into individual features.
3. Click Explode on the Advanced Editing toolbar.
   
   The parts of the multipart feature become independent features, with each one being assigned identical attribute values.

**Related Topics**
- Deleting a part from a multipart feature

**Constructing polygons from the shapes of other features**

*This topic applies to ArcEditor and ArcInfo only.*

**Note:** You can use Construct Polygons regardless of whether you have a geodatabase or map topology. You need an ArcEditor or ArcInfo license, though.

You can use topology tools to make new features from existing ones. Construct Polygons on the Topology toolbar can create new polygons from selected lines or other polygons. For example, you might need to create a new parcel feature from some parcel boundary lines.

**Steps:**
1. Click the Edit tool on the Editor toolbar.
2. Select the features you want to use to construct new polygons.
3. Click Construct Polygons on the Topology toolbar.
4. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
5. Optionally, type a cluster tolerance. You should use the default cluster tolerance or match the cluster tolerance of the geodatabase topology, if you are using one.
6. Optionally, check Use existing features in target to create new polygons considering the boundaries of existing polygons as input geometry.
7. Click OK. The new features are created in the target feature class.

**Related Topics**
- Splitting a polygon by an overlapping feature
- Splitting lines at intersections with Planarize Lines

**About creating and editing annotation**

Using annotation is one option in ArcGIS for storing text to place on your maps. Annotation can be used to describe particular features or add general information to the map. With annotation, the position, text string, and display properties are all stored together and are all individually editable. Annotation provides flexibility in the appearance and placement of your text because you can select individual pieces of text and edit them.

When you are working with geodatabase annotation—that is, an annotation feature class stored in a geodatabase—you can use the ArcMap editing environment within an edit session to create and edit annotation features.

Before you can create annotation features using these tools in ArcMap, you'll need to create an annotation feature class in your geodatabase. Once you have an annotation feature class, some of the tasks you can complete include creating annotation features using various construction methods and modifying where your annotation is placed and how it looks. In addition, you can use keyboard shortcuts to make editing annotation features quicker and more efficient.

Annotation stored in a map document is edited in ArcMap, but an edit session is not required and you will use a different set of tools—those on the Draw toolbar. The tools on the Editor toolbar cannot be used with map document annotation.

**Creating new annotation**

The Create Features window and the Editor toolbar provide the tools you need to create new annotation features. The Create Features window allows you to choose the construction method for your new annotation—horizontal, curved, leader line, and so on. Once you choose the tool to use, the Annotation Construction window appears, so you can enter the text of the new annotation, control how the text is placed, and override the default annotation properties as defined by the feature template.
The default construction tool is one of the properties of a feature template. When you choose a template on the Create Features window, the default construction tool is activated. For example, if you are creating annotation that identifies the names of roads or rivers, you might want to make the default construction tool be the Follow Feature Annotation tool, which is used to create annotation that follows along the shapes of polygons or lines. To set the properties of a feature template, double-click it in the Create Features window.

When you are creating annotation, you can change the symbol properties for the annotation. If you find that you are making many changes to the symbology, you should consider using or creating a new symbol rather than modifying the symbol extensively.

**Editing annotation**

You can use the editing tools in ArcMap to edit both standard annotation and feature-linked annotation. Some of the editing tasks you can complete include resizing, moving, rotating, and applying various follow feature options to your annotation.

You can use the editing tools, including the Edit Annotation tool, to change how your annotation looks. You modify annotation appearance with the Edit Annotation tool and the Attributes window.

The Edit Annotation tool shortcut menu, which you can open by selecting an annotation feature and right-clicking, provides you with a list of many annotation editing functions. With a menu open and a command highlighted, you can press SHIFT+F1 to get a description of that command.

### Shortcuts you can use when constructing annotation

The following keyboard shortcuts are available when constructing annotation:

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Toggle between construction, Edit, and Edit Annotation tools</td>
</tr>
<tr>
<td>F6</td>
<td>Absolute x,y</td>
</tr>
<tr>
<td>A</td>
<td>Activate the Text box on the Annotation Construction window, so you can change the text for constructing new annotation.</td>
</tr>
<tr>
<td>CTRL+W</td>
<td>Find Text: Populate the text box on the Annotation Construction window with a text expression from a feature under the cursor position. If the target is a feature-linked annotation feature class, text is derived only from a feature in the origin feature class. With a standard annotation feature class as the target, the text is based on the label expression of the layer containing the first visible and selectable feature.</td>
</tr>
<tr>
<td>O</td>
<td>Open Follow Feature Options dialog box when creating new annotation in follow feature mode</td>
</tr>
<tr>
<td>L</td>
<td>Flip selected annotation features 180 degrees when creating new annotation in follow feature mode</td>
</tr>
<tr>
<td>P</td>
<td>Toggle annotation placement angle between parallel and perpendicular when creating new annotation in follow feature mode</td>
</tr>
<tr>
<td>TAB</td>
<td>Toggle annotation placement between left side and right side when creating new annotation in follow feature mode</td>
</tr>
</tbody>
</table>

**Annotation construction tools keyboard shortcuts**

### Shortcuts you can use when editing annotation

The following keyboard shortcuts are available when you are editing annotation:

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTRL</td>
<td>Move the selection anchor</td>
</tr>
<tr>
<td>SHIFT</td>
<td>Add to/Remove from the selection</td>
</tr>
<tr>
<td>N</td>
<td>Select next annotation</td>
</tr>
<tr>
<td>R</td>
<td>Enter/Exit rotate mode</td>
</tr>
<tr>
<td>F</td>
<td>Enter/Exit follow feature mode</td>
</tr>
<tr>
<td>L</td>
<td>Flip annotation</td>
</tr>
<tr>
<td>O</td>
<td>Set follow feature options</td>
</tr>
<tr>
<td>P</td>
<td>Toggle annotation placement angle between parallel and perpendicular when in follow feature mode</td>
</tr>
<tr>
<td>TAB</td>
<td>Switch to the other side of line while in follow feature mode</td>
</tr>
<tr>
<td>E</td>
<td>Toggle between construction, Edit, and Edit Annotation tools</td>
</tr>
</tbody>
</table>

**Edit Annotation tool keyboard shortcuts**

### Editing annotation stored in ArcGIS 8 geodatabases

If your annotation feature classes were created in ArcGIS 8 and you want to use the Convert Labels To Annotation command or the Editor toolbar editing and construction tools, you’ll first need to upgrade your geodatabase and use the Update Annotation Feature Class tool. It is important to note that you won’t be able to view updated annotation in ArcGIS 8. You can always view earlier versions of annotation in later versions of ArcGIS. Geodatabases and annotation feature classes created in ArcGIS 9 do not need to be updated.

### Creating horizontal annotation

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Steps:
1. Click an annotation feature template in the Create Features window.
2. Click the Horizontal construction tool on the Create Features window.

Tip: The default construction tool becomes active as soon as you click a feature template on the Create Features window. You can change the default construction tool by double-clicking a feature template in the Create Features window and updating the Default Tool property.

3. Type the text of the new annotation feature into the text box on the pop-up Annotation Construction window.
   If you want the text string to come from an attribute of an existing feature on the map, click Find Text and click the feature, or press CTRL+W over a feature. Find Text populates the text box with a text expression from a feature under the cursor position. If the target is a standard annotation feature class, the text is based on the label expression of the layer containing the first visible and selectable feature. With a feature-linked annotation feature class, the text is derived only from a feature in the origin feature class. If no suitable target is found, the string reverts to the word Text.
4. Use the Annotation Construction window to change the formatting of the text, such as the font, size, and symbol. Click Toggle Formatting Options to show additional settings. You can also enter text formatting tags with the text string, allowing you to change the appearance of just a part of the text.
5. Click where you want to place the annotation on the map.
   Horizontal annotation is created.

Related Topics
Creating annotation that follows the edge of a line or polygon
Creating annotation with a leader line
Creating curved annotation
Creating straight annotation

Creating straight annotation

Steps:
1. Click an annotation feature template in the Create Features window.
2. Click the Straight construction tool on the Create Features window.

Tip: The default construction tool becomes active as soon as you click a feature template on the Create Features window. You can change the default construction tool by double-clicking a feature template in the Create Features window and updating the Default Tool property.

3. Type the text of the new annotation feature into the text box on the pop-up Annotation Construction window.
   If you want the text string to come from an attribute of an existing feature on the map, click Find Text and click the feature, or press CTRL+W over a feature. Find Text populates the text box with a text expression from a feature under the cursor position. If the target is a standard annotation feature class, the text is based on the label expression of the layer containing the first visible and selectable feature. With a feature-linked annotation feature class, the text is derived only from a feature in the origin feature class. If no suitable target is found, the string reverts to the word Text.
4. Use the Annotation Construction window to change the formatting of the text, such as the font, size, and symbol. Click Toggle Formatting Options to show additional settings. You can also enter text formatting tags with the text string, allowing you to change the appearance of just a part of the text.
5. Click where you want to place the annotation on the map.
   As you move your pointer, the text rotates about the first point.
6. Click again to place the second point.
   Straight annotation is created.

Related Topics
Creating annotation that follows the edge of a line or polygon
Creating annotation with a leader line
Creating curved annotation
Creating horizontal annotation

Creating annotation that follows the edge of a line or polygon

The Follow Feature tool allows you to place annotation while constraining its location relative to the edge of a feature in your map. Both standard and feature-linked annotation can be created this way.

Steps:
1. Click an annotation feature template in the Create Features window.
2. Click the Follow Feature construction tool on the Create Features window.
When you need to create annotation with a leader line or callout, you can use the Leader tool to add the leader to a regular annotation feature template. This symbol every time you create a new annotation feature, create an annotation class and a feature template from it that has a predefined leader symbol.

3. Type the text of the new annotation feature into the text box on the pop-up Annotation Construction window.
   If you want the text string to come from an attribute of an existing feature on the map, click Find Text and click the feature, or press CTRL+W over a feature. Find Text populates the text box with a text expression from a feature under the cursor position. If the target is a standard annotation feature class, the text is based on the label expression of the layer containing the first visible and selectable feature. With a feature-linked annotation feature class, the text is derived only from a feature in the origin feature class. If no suitable target is found, the string reverts to the word Text.

4. Use the Annotation Construction window to change the formatting of the text, such as the font, size, and symbol. Click Toggle Formatting Options to show additional settings. You can also enter text formatting tags with the text string, allowing you to change the appearance of just a part of the text.

5. Optionally, click Follow Feature Options on the pop-up Annotation Construction window to set options. You can also press the O key. The Follow Feature Options dialog box sets the options for all follow feature annotation.
   a. For feature-linked annotation, check whether to use the placement properties defined in the annotation class. When unchecked, the individual settings specified on the Follow Feature Options dialog box are used. (This check box only applies to feature-linked annotation and is not used with standard annotation.)
   b. Click Straight or Curved to set whether the annotation follows the feature as a straight line through the end points of the text string or as a curve.
   c. Click Parallel or Perpendicular to set to follow parallel along the feature or perpendicular to the feature.
   d. Click one of the Constrain Placement buttons to determine how annotation is placed along a feature when you drag the annotation. Slide cursor is on constrains annotation to the same side as the cursor. Left side or Right side constrains relative to the digitized direction of the feature. With On the line, annotation is placed on top of the feature.
   e. Optionally, type a value to offset the annotation from the feature.
   f. Click OK.

6. Click the feature you want your annotation to follow. The feature flashes to indicate which one is being followed. If you clicked the incorrect feature, pressing ESC allows you to choose a different feature to follow.

7. If you need to override any of the follow feature options when constructing this feature, you can click the buttons on the Annotation Construction window to flip the annotation or change the side or angle.

8. Click again to place the annotation in the position you want along the feature.

Related Topics
Creating annotation with a leader line
Creating curved annotation
Creating horizontal annotation
Creating straight annotation

Creating annotation with a leader line

When you need to create annotation with a leader line or callout, you can use the Leader tool to add the leader to a regular annotation feature template. This method is flexible because you can set a different leader for each annotation feature or use the same one for all features. If you want to use the same leader line symbol every time you create a new annotation feature, create an annotation class and a feature template from it that has a predefined leader symbol.

Steps:
1. Click an annotation feature template in the Create Features window.
2. Click the Leader construction tool on the Create Features window.

   Tip: The default construction tool becomes active as soon as you click a feature template on the Create Features window. You can change the default construction tool by double-clicking a feature template in the Create Features window and updating the Default Tool property.

3. Type the text of the new annotation feature into the text box on the pop-up Annotation Construction window.
   If you want the text string to come from an attribute of an existing feature on the map, click Find Text and click the feature, or press CTRL+W over a feature. Find Text populates the text box with a text expression from a feature under the cursor position. If the target is a standard annotation feature class, the text is based on the label expression of the layer containing the first visible and selectable feature. With a feature-linked annotation feature class, the text is derived only from a feature in the origin feature class. If no suitable target is found, the string reverts to the word Text.

4. Use the Annotation Construction window to change the formatting of the text, such as the font, size, and symbol. Click Toggle Formatting Options to show additional settings. You can also enter text formatting tags with the text string, allowing you to change the appearance of just a part of the text.

5. Click where you want to start the annotation feature's leader line.
6. Drag the annotation feature where you want to place it.
7. Click again to finish placing the annotation.
   Annotation with a leader line is created.
Related Topics
Adding a leader line to annotation
Creating annotation that follows the edge of a line or polygon
Creating curved annotation
Creating horizontal annotation
Creating straight annotation
Setting annotation leader line symbol properties

Creating curved annotation

Steps:
1. Click an annotation feature template in the Create Features window.
2. Click the Curved construction tool on the Create Features window.
   
   **Tip:** The default construction tool becomes active as soon as you click a feature template on the Create Features window. You can change the default construction tool by double-clicking a feature template in the Create Features window and updating the Default Tool property.
3. Type the text of the new annotation feature into the text box on the pop-up Annotation Construction window.
   If you want the text string to come from an attribute of an existing feature on the map, click Find Text and click the feature, or press CTRL+W over a feature. Find Text populates the text box with a text expression from a feature under the cursor position. If the target is a standard annotation feature class, the text is based on the label expression of the layer containing the first visible and selectable feature. With a feature-linked annotation feature class, the text is derived only from a feature in the origin feature class. If no suitable target is found, the string reverts to the word Text.
4. Use the Annotation Construction window to change the formatting of the text, such as the font, size, and symbol. Click Toggle Formatting Options to show additional settings. You can also enter text formatting tags with the text string, allowing you to change the appearance of just a part of the text.
5. Click where you want to start the curved annotation.
6. Click to add vertices to define the baseline of the curved annotation feature.
7. Double-click to finish the sketch and place the annotation.
   The annotation is placed along the baseline.

Related Topics
Creating annotation that follows the edge of a line or polygon
Creating annotation with a leader line
Creating horizontal annotation
Creating straight annotation

Setting annotation leader line symbol properties

Steps:
1. Click the Editor menu and click Options.
2. Click the Annotation tab.
3. Click the Leader button.
4. Click the Type drop-down arrow and click the type of callout you want to use. The following steps apply to line callouts.
5. Click one of the style buttons to set the style of the leader line.
6. Check Leader.
7. Click the Symbol box underneath Leader to change the color and width of the leader line.
8. Optionally, check the Accent Bar and Border boxes to add them to your leader line symbol. Click Symbol to change those symbol properties.
9. Set the gap, leader tolerance, margins, and any other options.
10. Click OK on all dialog boxes.

Related Topics
Adding a leader line to annotation
Creating annotation with a leader line

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You can copy and paste annotation features into the same or a different annotation feature class. The way the annotation symbology is stored can impact the display of the pasted annotation.

- If the annotation feature references a symbol in the symbol collection, the annotation feature is copied and pasted so that it maintains the reference to that text symbol and also any overrides that exist.
  - When you are editing within the same feature class, the reference points to the original text symbol for that annotation feature, and the draw properties of the text do not change.
  - If you are copying and pasting to a different annotation feature class, the annotation may be displayed differently if the symbol collection for the new annotation feature class is different.
  - To ensure the same display of the annotation, create a new symbol in the symbol collection and calculate the SymbolID of the pasted features to that new text symbol number.
- If the SymbolID of the feature does not exist in the new symbol collection, the annotation is not displayed, and its bounding box appears as a red box. To display the annotation, either calculate the SymbolID to an existing symbol in the symbol collection or create a new symbol and calculate the SymbolID to that value.
- If the annotation feature stores all of its properties inline (in other words, the SymbolID value is -1, and the feature does not reference a text symbol in the symbol collection), the feature is pasted as it appears in the original annotation feature class.

Steps:
1. Click the Edit tool or the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Hold down the SHIFT key while clicking features to select additional features.
3. Click the Copy button on the Standard toolbar.
4. Click the Paste button on the Standard toolbar.
5. Click the layer in which to store the pasted feature. When copying and pasting features, you choose the layer in which to store the new feature. This allows you to retain the attribute values from the copied feature, rather than having them be overwritten with values from a feature template.
6. Click OK. The feature is pasted on top of the original feature.

Related Topics
Copying and pasting features

Placing unplaced annotation features

Labels that could not be placed on the map become unplaced annotation features when you convert labels to annotation. In addition, any features that could not be displayed when you use Annotate Selected Features are also unplaced annotation. The unplaced annotation features are listed in the Unplaced Annotation window so you can interactively review and add them to the map. Once the annotation is placed on the map, you can edit and reposition the feature.

The following keyboard shortcuts are available with the Unplaced Annotation window.

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPACEBAR</td>
<td>Place selected annotation</td>
</tr>
<tr>
<td>P</td>
<td>Pan to selected annotation</td>
</tr>
<tr>
<td>Z</td>
<td>Zoom to selected annotation</td>
</tr>
</tbody>
</table>

Unplaced Annotation dialog box keyboard shortcuts

Steps:
1. Click the Editor toolbar, point to Editing Windows, then click Unplaced Annotation.
2. In the Unplaced Annotation window, click the Show drop-down arrow and choose the annotation feature class with the unplaced annotation.
3. Click Search Now to list the unplaced annotation.
   - Each time you save your edits (Editor > Save Edits) during an edit session, the contents of the Unplaced Annotation window are cleared. You need to click Search Now to populate the list again. Doing this ensures that the window always shows the most up-to-date unplaced annotation features for your geodatabase.
   - By default, unplaced annotation is not displayed on the map. To draw the unplaced annotation, check the Draw box.
   - If you want to work with annotation within a particular extent only, zoom to the extent, check the Visible Extent box, then click Search Now to update the list.
   - Double-click the text in the list to flash the location of the unplaced annotation.
   - To zoom in to the area of any unplaced annotation, right-click text in the list and click Zoom to Annotation or Zoom to Feature.
   - To place annotation on the map, right-click text in the list and click Place Annotation.
   - After you have placed an annotation feature on your map, the feature is selected. Use the Edit Annotation tool to drag the annotation to where you want to place it.

Related Topics
Converting labels to annotation features
Generating feature-linked annotation from selected features

About editing feature-linked annotation

This topic applies to ArcEditor and ArcInfo only.
Feature-linked annotation can be created and edited in ArcInfo and ArcEditor but is read-only in ArcView.

Feature-linked annotation is a special type of geodatabase annotation that is directly linked to features. Feature-linked annotation reflects the current state of features in the geodatabase: it is automatically updated when features are moved, edited, or deleted. The benefit of using feature-linked annotation compared to standard annotation is that ArcGIS performs the maintenance work for you. For example, when you create a new feature, new annotation is automatically generated from the attributes of the feature. If you move or reshape a feature, the annotation is repositioned as well. If you change an attribute of the feature on which the annotation text is based, the annotation text changes. Finally, if you delete the feature, the annotation is also deleted.

Feature-linked annotation is stored as an annotation feature class in a geodatabase along with the geographic data (a point, line, or polygon feature class) with which it is associated. A geodatabase feature class can have any number of linked annotation feature classes; however, an annotation feature class can be linked to only one geographic feature class.

Creating feature-linked annotation

Creating feature-linked annotation is a two-step process. First, you create an annotation feature class in a geodatabase to store the annotation, then you create the individual pieces of text annotation that are linked to each feature. Or you can do both of these steps at once by converting labels to annotation.

There are two ways to create a feature-linked annotation feature class. First, you can create one in ArcCatalog or the Catalog window. If you are creating feature data, create a feature class, then create a feature-linked annotation feature class linked to your new feature class. Then, as you use the editing tools in ArcMap to create features in your feature class, annotation will be created for you and automatically linked to your features.

A second way to create a feature-linked annotation feature class is in ArcMap by converting your labels to annotation. This is the fastest way to create feature-linked annotation if you already have features in your geographic feature class. Start by labeling your geodatabase feature class in ArcMap, then convert your labels to annotation.

There are two ways to create a feature-linked annotation feature class:

1. Create the feature class in ArcCatalog or the Catalog window and then link the annotation feature class to it.
2. Convert labels to annotation in ArcMap.

Once you have a feature-linked annotation feature class, you need to add annotation to it. If you are editing in ArcMap, as you create features, annotation is automatically created for you in the linked annotation feature class. If your feature has default values for the field from which the annotation text string is derived, the annotation appears instantly. If the field from which the annotation text is derived does not have a default value, you need to enter an attribute value for this field (or a value for the text string of the annotation) for the linked annotation to appear on the map.

Creating feature-linked annotation

Once you have a feature-linked annotation feature class, you need to add annotation to it. If you are editing in ArcMap, as you create features, annotation is automatically created for you in the linked annotation feature class. If your feature has default values for the field from which the annotation text string is derived, the annotation appears instantly. If the field from which the annotation text is derived does not have a default value, you need to enter an attribute value for this field (or a value for the text string of the annotation) for the linked annotation to appear on the map.

If you already have features and want to create feature-linked annotation, there are several ways to add the annotation. One way is to convert labels to annotation. Converting labels to annotation automatically creates an annotation feature class and populates it with annotation elements. Once labels are converted to annotation, you can manually move individual pieces of text to position them exactly where you want them.

A second way to create annotation is to start ArcMap and add both a geodatabase feature class and its linked annotation feature class. You can then select some geographic features and use the Annotate Selected Features command to automatically create annotation in the linked annotation feature class for only the selected features. You do not need to be editing to use the Annotate Selected Features command. Although this command allows you to create annotation for only a few features at a time, it's a good idea to consider the map as a whole when generating annotation.

Editing the features linked to feature-linked annotation

When editing features with feature-linked annotation, the new annotation created will be placed using the label engine parameters referenced in the annotation feature class. Examples of these edits are modifying the shape of a feature, editing a field that a label parameter is based on, creating a new feature, or annotating a selected feature. If the feature edit only updates the attribute or attributes that the annotation text is based on, the text will be updated but the original placement of the annotation feature relative to the linked feature will be maintained. If the feature edit updates the shape of the feature in a move operation, the annotation will be moved along with the feature and maintain the same position relative to the feature. If the edit updates the shape of the feature or an attribute used for field base rotation, the annotation will be replaced by the label engine according to the labeling rules.

Related Topics

Creating a feature-linked annotation feature class at the root level of a geodatabase
Creating a feature-linked annotation feature class in a feature dataset
Generating feature-linked annotation from selected features

Generating feature-linked annotation from selected features

This topic applies to ArcEditor and ArcInfo only.

Feature-linked annotation can be created using the Annotate Selected Features command.

**Steps:**

1. Add a feature class and its linked annotation feature class to your map.
2. Select the features in the origin feature class (the point, line, or polygon layer) for which you want to generate annotation. To create annotation for all the features, select all the features.
3. Right-click the layer in the table of contents, point to **Selection**, then click **Annotate Selected Features**.
4. Check the annotation classes in which you want to store the annotation.
5. Check the box if you want to convert unplaced labels to annotation. Sometimes some of the generated annotation cannot automatically be placed on the map, so it is added to the database to be placed later. You need to use the **Unplaced Annotation window** to display these annotation features.

License: Feature-linked annotation can be created and edited in ArcInfo and ArcEditor but is read-only in ArcView.
6. Click OK.

Related Topics
About editing feature-linked annotation
Placing unplaced annotation features

Deleting a feature

You can select a feature and delete it to remove it from the map and database.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the feature you want to delete. Hold down the SHIFT key while clicking features to select additional features.
3. Click the Delete button on the Standard toolbar or press DELETE on the keyboard. You can also right-click a feature and click Delete.
4. To delete a feature from the Attributes window, right-click the feature and click Delete. If you have an attribute table window open, you can select records in the table and delete them as well.

Moving a feature by dragging it

Dragging is the easiest way to move a feature. Use this method when you have a general idea of where you want to move the feature. Use the Edit tool to select and drag features.

Use either the Edit tool or the Edit Annotation tool to drag annotation features. The Edit Annotation tool enables functionality specifically for editing annotation features.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the feature or features you want to move. Hold down the SHIFT key while clicking features to select additional features.
3. Drag the feature or features to the desired location.

Related Topics
Moving a feature and snapping it to another feature
Moving a feature relative to its current location (delta x,y)
Moving annotation along the edge of a line or polygon

Moving annotation along the edge of a line or polygon

You can move standard and feature-linked annotation so they follow along an edge.

Feature-linked annotation automatically follows its related line feature by default, but you can use the steps below to move feature-linked annotation along a different feature. You can turn off this setting on the Annotation tab of the Editing Options dialog box.

Steps:
1. Click the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Optionally, right-click the map, point to Follow, then click Follow Feature Options to set options for how the feature should be placed relative to the edge.
   a. For feature-linked annotation, check whether to use the placement properties defined in the annotation class. When unchecked, the individual settings specified on the Follow Feature Options dialog box are used. (This check box only applies to feature-linked annotation and is not used with standard annotation.)
   b. Click Straight or Curved to set whether the annotation follows the feature as a straight line through the end points of the text string or as a curve.
   c. Click Parallel or Perpendicular to set the annotation to follow parallel along the feature or perpendicular to the feature.
   d. Click one of the Constrain Placement buttons to determine how annotation is placed along a feature when you drag the annotation. Side cursor is on constrains annotation to the same side as the cursor. Left side or Right side constrains relative to the digitized direction of the feature. With On the line, annotation is placed on top of the feature.
   e. Optionally, type a value to offset the annotation from the feature.
   f. Click OK.
3. Right-click the feature you want the annotation to follow and click Follow This Feature. The feature the annotation is going to follow flashes on the screen and the annotation is moved.
   The feature the annotation follows is determined by the position of the cursor when you right-click. The first selectable and visible feature under your cursor is followed. The feature must be from a line or polygon layer. Feature-linked annotation automatically follows its related line feature by default.
4. Click and drag the annotation to the position you want along the feature.

Related Topics
Moving a feature by dragging it
Rotating annotation using the rotate handles

Annotation features selected with the Edit Annotation tool have special handles that you can drag to rotate the annotation. If you want to rotate about a pivot point other than a rotate handle, use rotate mode. Rotate handles are not shown for curved annotation, so you should use rotate mode to rotate those features.

Steps:
1. Click the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Move the pointer over a rotate handle. The cursor changes to the rotate symbol while it is positioned over the rotate handle.
3. Click a rotate handle and drag the annotation to where you want it placed. The other rotate handle is the pivot point.

Tip: To turn off the rotate and resize handles, click Editor, click Options, then click the Annotation tab and uncheck the Show resize and rotate handles check box.

Related Topics
Rotating annotation in rotate mode

Rotating annotation in rotate mode

The Edit Annotation tool has a rotate mode that gives you additional rotation options. In this mode, as with the Rotate tool, you can drag one or more annotation features to rotate around the selection anchor. You can also enter a specific rotation angle, using one of two options: either rotate all selected annotation around the selection anchor (same as Rotate tool), or specify an absolute rotation angle that is applied to each individual annotation feature.

To specify the exact amount of rotation, press A while in rotate mode, and type the number of degrees. There are two options:

- Choose the Geographic option to rotate the selected annotation relatively about the selection anchor. A positive number rotates annotation clockwise, and a negative number rotates annotation counterclockwise. The following illustration shows a positive geographic rotation:

- Choose the Absolute option to specify an absolute rotation angle for each selected annotation. Each piece of selected annotation rotates to the specified angle. The lowerleft corner of each individual annotation is used as an anchor. Enter 0 to make all the annotation horizontal. Entering positive numbers rotates the annotation features counterclockwise, and entering negative numbers rotates them clockwise. The following illustration shows a positive absolute rotation:

Steps:
1. Click the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Right-click and click Rotate Mode, or press the R key.
3. Click and drag the text to where you want it placed. The text rotates freely about the selection anchor. You can also press the A key to enter a specific angle for the rotation.
4. You can change the rotate mode pivot point by dragging the selection anchor to another location. To rotate and snap the annotation to another annotation or feature, turn on the secondary selection anchor. Press the S key to toggle this secondary anchor point on and off. You can move the secondary anchor the same way you move the selection anchor.
5. When you have positioned the text where you want it, right-click and click Finish Rotate Mode, or press the R key again.

Related Topics
Rotating annotation using the rotate handles

Changing the size of annotation

Annotation features selected with the Edit Annotation tool have special handles that you can drag to resize the annotation.

Steps:
1. Click the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Move the pointer over the red resize handle. The resize handle's location is determined by the alignment of the text. For example, an annotation feature with text that is leftaligned has its resize handle located on the right.
The pointer becomes a line with arrows at both ends while it is positioned over the resize handle.

3. Drag the text to make it larger or smaller.

Tip: To turn off the rotate and resize handles, click the Editor menu, click Options, then click the Annotation tab and uncheck the Show resize and rotate handles check box.

Related Topics
Changing annotation formatting and symbology
Editing the attributes of annotation

Editing the attributes of annotation

You can edit annotation attributes in the Attributes window, which provides access to the record values in the attribute table. When these edits are made, the BLOB element is updated and you can see the change to the annotation’s display. You can edit the following attributes in the Attributes window:

<table>
<thead>
<tr>
<th>FeatureID</th>
<th>Bold</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>AnnotationClassID</td>
<td>Italic</td>
<td>FontLeading</td>
</tr>
<tr>
<td>SymbolID</td>
<td>Underline</td>
<td>WordSpacing</td>
</tr>
<tr>
<td>Status</td>
<td>VerticalAlignment</td>
<td>CharacterWidth</td>
</tr>
<tr>
<td>TextString</td>
<td>HorizontalAlignment</td>
<td>CharacterSpacing</td>
</tr>
<tr>
<td>FontName</td>
<td>XOffset</td>
<td>FlipAngle</td>
</tr>
<tr>
<td>FontSize</td>
<td>YOffset</td>
<td>Override</td>
</tr>
</tbody>
</table>

These attributes cannot be edited at the database level with SQL code. When these fields are updated through ArcGIS, it results in changes to the feature's BLOB element that SQL does not trigger. When you update these fields using SQL outside ArcGIS, the text symbol fields associated with each annotation feature for all the updated rows do not update. To perform these updates outside ArcGIS, ArcObjects must be used.

Learn more about updating data using SQL

Steps:
1. Click the Edit tool or the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Click the Attributes button on the Editor toolbar.
3. Click the Annotation or the Attributes tab. The Annotation tab allows you to make multiple changes and preview them before applying them, while the Attributes tab provides a grid of attribute fields and values.
4. If you need to update the text for feature-linked annotation, update the attributes of the origin feature (for example, the attributes of the line the annotation is linked to) from which the annotation is derived. When you do that, the updates are reflected immediately in the annotation feature's text. If you directly edit the TextString property of the annotation feature itself, any changes will be overwritten if the attribute on the linked feature is modified later.
5. Optionally, modify other attributes, such as the font or font size.
6. To change an attribute value for more than one feature at a time, select all the annotation features you want to change, click the annotation layer name, then set the values.
7. If you are using the Annotation tab, click Apply to commit the changes. If you are using the Attributes tab, the changes are updated as soon as you click away from the field.

Related Topics
Changing annotation formatting and symbology
Changing the size of annotation

Changing annotation formatting and symbology

You can use the Attributes window to modify the appearance of your annotation. You can work with annotation in the Attributes window in one of two views: formatted and unformatted. Formatted view contains a menu that allows you to apply quick formatting, such as bolding, italicizing, and underlining text. If the zoom box is present in the lower right corner of the Attributes window, you are working in formatted view. Both views allow you to update text formatting by clicking buttons that change the font, color, alignment, size of the text, and so on. You may need to resize the Attributes window to see the formatting buttons, which are at the bottom of the window.

You can use text formatting tags to control the formatting of annotation. Tags can be entered when annotation is being created, or by using the Attributes window once the feature has been added to the map.
Steps:

1. Click the Edit tool or the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Click the Attributes button on the Editor toolbar.
3. Click the Annotation tab.
4. If you have defined more than one annotation symbol for the annotation feature class, you can choose a new annotation symbol from the drop-down list.
5. To change the symbology interactively, select the text you want to modify.
6. Click the formatting buttons at the bottom, or right-click and choose the formatting you want to apply.
7. If you want to enter text formatting tags, switch to unformatted view by clicking the arrow button and type the tags you want to apply to your text.

**Note:** & and < are special characters and are not valid if formatting tags are used. Use the equivalent character codes &amp; and &lt; instead. For example, instead of &lt;ITA&gt;John &amp; Paul&lt;/ITA&gt;, use &lt;ITA&gt;John &amp;amp; Paul&lt;/ITA&gt;.

8. To change the annotation symbology for more than one feature at a time, select all the annotation features you want to change, click the annotation layer name in the list of selected features, then set the new symbology.
9. Click Apply.

Related Topics

- About text formatting tags
- Changing the size of annotation
- Editing the attributes of annotation

**Editing the shape of curved annotation**

You can select curved annotation with the Edit Annotation tool and edit its baseline sketch to change its shape.

**Steps:**

1. Click the Edit Annotation tool on the Editor toolbar and select the annotation.
2. Right-click and click Edit Baseline Sketch.
3. To move a vertex, position the pointer over the vertex until the cursor's shape changes, then drag.
   When modifying the shape of curved annotation, move the green inflection point vertices to change the shape of the baseline. Move the purple vertices to change part of the baseline curvature.

4. To add a vertex, right-click the baseline sketch and click Insert Vertex.
5. To delete a vertex, right-click and click Delete Vertex.
6. When you are finished, right-click and click Finish Baseline Sketch.

**Flipping annotation**

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To flip the direction of annotation, use the Flip command. You can also use it to invert annotation that follows a feature.

**Steps:**
1. Click the **Edit Annotation** tool on the Editor toolbar and select the annotation.
2. Hold down the SHIFT key while clicking features to select additional features.
3. Right-click and click **Flip**, or press the L key.

### Converting annotation to multiple parts

Multiple-part annotation may be useful if you need to be able to work with a part (such as a word) of an annotation feature but do not want to make it into a completely separate feature. You might want to do this if you have a large feature that you want to identify by spreading out the text of the annotation over the whole shape, such as a long river or mountain range.

**Steps:**
1. Click the **Edit Annotation** tool on the Editor toolbar and select the annotation.
2. Right-click and click **Convert to Multiple Parts**.
3. Click the part you want to edit. By default, the part is highlighted in magenta stripes.

**Tip:** The Annotation tab of the Editing Options dialog box allows you to change how parts in multiple-part annotation look when they are selected. By default, selected parts are highlighted in magenta stripes.

4. You can drag the part to a new location or right-click to access other commands.
5. To convert multiple-part annotation to a single part, select the annotation features, right-click, then click **Convert to Single Part**.

### Stacking and unstacking annotation

Stacking annotation places the text of geodatabase annotation on multiple lines. If your annotation has several words, you can use stacking to make it easier to fit it on your map.

Stacking is based on spaces, typically between words. Each time you stack the annotation, your annotation is broken into a new line at one of these spaces. If the Stack command is not enabled, check that the selected annotation has spaces and is not curved.

**Steps:**
1. Click the **Edit Annotation** tool on the Editor toolbar and select the annotation.
2. To stack your annotation, right-click and click **Stack**.
   The text is placed in multiple lines.

3. To further stack your annotation, right-click again and click **Stack**.
4. To completely unstack your annotation, right-click and click **Unstack**.

### Adding a leader line to annotation

You can add a leader line to an existing annotation feature.

**Steps:**
1. Click the **Edit Annotation** tool on the Editor toolbar and select the annotation.
2. Right-click and click **Add Leader**.
3. Optionally, change the position of the start of the leader line. Move your pointer over the vertex until the cursor's shape changes, then drag.
4. Drag the annotation to the desired position.
5. To remove the leader, right-click again and click **Delete Leader**.

**Related Topics**
- Creating annotation with a leader line
- Setting annotation leader line symbol properties
Changing annotation placement to straight, curved, or horizontal

You can right-click an annotation feature and change it to be straight, curved, or horizontal.

**Steps:**
1. Click the **Edit Annotation** tool on the **Editor** toolbar and select the annotation.
2. Right-click and point to **Curvature**.
   - To make horizontal or curved annotation straight, click **Straight**.
   - To make horizontal or straight annotation curved, click **Curved**.
   - To make straight or curved annotation horizontal, click **Horizontal**.

About creating and editing dimension features

*This topic applies to ArcEditor and ArcInfo only.*

Dimension features are a special kind of text for showing lengths or distances on a map. You can create dimension features by defining them on the map or by using tools to create them from existing features. You can create aligned, simple aligned, horizontal linear, vertical linear, or rotated linear dimension features in a variety of shapes. Dimension features draw and symbolize themselves based on the properties of their assigned style.

To draw dimensions, start with the Create Features window. This is where you choose the feature template used to create the features with and the dimension construction tool used to create them. Click a template and click a tool at the bottom of the window. Each template has a default construction tool, but you can override it and choose another tool.

Once a dimension feature has been created, you can use the editing tools to modify its geometry and the Attributes window to modify its properties.

- **Note:** A dimension feature class must be edited in its native projection. If you start editing while a dimension feature class is being projected on the fly, a **warning message** appears to indicate the layer cannot be edited.

Related Topics
- Dimension feature geometry
- Dimension feature properties
- The dimension construction tools

The dimension construction tools

**Dimension construction tools**

To draw dimensions, start with the Create Features window. This is where you choose the template into which your features will be saved and the dimension construction tool used to create them. The tool used dictates the type of dimension that is created and the number of points that are required. The sketch is finished automatically once you have input the correct number of points. The type of dimension feature you are creating dictates the number of points that are required as input.

When creating dimension features, the edit sketch will actually show you how the resulting dimension feature will look as you move the pointer. The exceptions are the free dimension construction methods. With these construction methods, the edit sketch display is the same as that for creating simple features.

You can use snapping to facilitate more precise measurements. For example, if you want to draw a dimension showing the width of a parcel, snap to the edges of parcel boundaries.

The following is a list of dimension types and the number of points required for their construction with each tool:

- **Simple aligned**

  The Simple Aligned tool requires two points as input: the start dimension point and the end dimension point. The sketch is automatically finished after the second point is input.

- **Aligned**

  The Aligned tool requires three points as input: the start dimension point, the end dimension point, and a third point describing the height of the dimension line. The sketch is automatically finished after the third point is input.

- **Linear (horizontal and vertical)**
Creating an aligned dimension feature

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the Simple Aligned tool on the Create Features window.
3. Click the map at the start dimension point. As you move the pointer, the new dimension dynamically draws itself with your pointer location as the end dimension point.
4. Click the map at the end dimension point.

Related Topics
Creating a dimension feature with the Free Aligned tool
Creating an aligned dimension feature

Creating an aligned dimension feature

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the Aligned tool on the Create Features window.
3. Click the map at the start dimension point. As you move the pointer, the new dimension dynamically draws itself with your pointer location as the end dimension point.
4. Click the map at the end dimension point. The new dimension continues to dynamically draw itself, however, the start and end dimension points are fixed, and the height of the dimension line changes as you move the pointer.
5. Click the map where you want the dimension line to be. With the Aligned construction method, the dimension line is parallel to the baseline.

Related Topics
Creating a dimension feature with the Free Aligned tool
Creating a simple aligned dimension feature

Creating a simple aligned dimension feature

Creating dimensions based on other features

Using the Dimension Edge, Baseline Dimension, Continue Dimension, and Perpendicular Dimensions tools, you can create new dimension features based on existing features as well as other features.

Dimension Edge works on any type of feature. The Dimension Edge tool automatically creates a dimension whose baseline is described by a line segment of an existing feature. The Dimension Edge tool creates only horizontal and vertical linear dimension features.

Baseline Dimension and Continue Dimension are both used only on existing dimension features. The Baseline Dimension tool creates a new dimension feature whose start dimension point is the same as the existing dimension feature that is being baselined. The Continue Dimension tool creates a new dimension feature whose start dimension point is the same as the end dimension point of the existing dimension feature being continued.

The Perpendicular Dimensions tool creates two dimension features that are perpendicular to each other. This tool can be used to create dimensions for the supposed intersection of two features in space, such as the edge of one building and the corner of another.
This topic applies to ArcEditor and ArcInfo only.

With the Free Aligned tool, if you add two points, a simple aligned feature is created. With three points, an aligned dimension feature is created.

The first point entered will be used as the start dimension point. The second point will be used as the end dimension point. If you add three points, the third one will be used as the dimension line height point.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the **Free Aligned** tool on the Create Features window.
3. Click the map at the start dimension point. As you move the pointer, the dimension feature will not dynamically draw itself.
4. Use the construction methods to enter the end dimension point.
5. Use the construction methods to enter the point where you want the dimension line to be.
6. If you create more than three points or any points that do not represent the start or end dimension point or dimension line height, you must delete them before continuing.

The free construction methods allow you to enter as many points to help you define your dimension feature points. However, it is your responsibility to delete any point that does not correspond to one of the required dimension feature points. If you have too few or too many points, your edit operation will fail.

7. Right-click anywhere on the map and click **Finish Sketch**.

---

Creating a linear dimension feature

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the **Linear** tool on the Create Features window.
3. Click the map at the start dimension point. As you move the pointer, the new dimension dynamically draws itself with your pointer location as the end dimension point.
4. Click the map at the end dimension point. The new dimension continues to dynamically draw itself; however, the start and end dimension points are fixed, and the height of the dimension line changes as you move the pointer. If you move the pointer to the left or right of the baseline, you will see a vertical linear dimension feature. If you move the pointer above or below the baseline, you will see a horizontal linear dimension feature.
5. Click the map where you want the dimension line to be. A linear dimension feature's dimension line is generally not parallel to its baseline. Therefore, the distance represented by a linear feature is not the length of the baseline.

Related Topics

- Creating a dimension feature with the Free Linear tool
- Creating a rotated linear dimension feature

---

Creating a rotated linear dimension feature

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the **Rotated Linear** tool on the Create Features window.
3. Click the map at the start dimension point. As you move the pointer, the new dimension dynamically draws itself with your pointer location as the end dimension point.
4. Click the map at the end dimension point. The new dimension continues to dynamically draw itself; however, the start and end dimension points are fixed, and the height of the dimension line changes as you move the pointer. If you move the pointer above or below the baseline, you will see a vertical linear dimension feature. If you move the pointer to the left or right of the baseline, you will see a horizontal linear dimension feature. If you move the pointer above or below the baseline, you will see a horizontal linear dimension feature.
5. Click the map where you want the dimension line to be. The new dimension continues to dynamically draw itself; however, the start and end dimension points and dimension line height are fixed, and the angle of the extension lines changes as you move the pointer.

When creating rotated linear dimensions, the extension line angle is calculated such that the dimension line is parallel to the line between the third and fourth construction points.

6. Click the map at the angle you want the extension lines to be.

Related Topics

- Creating a dimension feature with the Free Linear tool
- Creating a linear dimension feature

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Creating a dimension feature with the Free Linear tool

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This topic applies to ArcEditor and ArcInfo only.

With the Free Linear tool, if you input three points, a vertical or horizontal linear dimension feature is created. With four points, a rotated linear dimension feature is created.

The first point entered is used as the start dimension point. The second point entered is used as the end dimension point. The third point is used as the dimension line height point. If you add four points, the fourth point is used to describe the extension line angle.

Steps:
1. Click a dimension feature template in the Create Features window.
2. Click the Free Linear tool on the Create Features window.
3. Click the map at the start dimension point. As you move the mouse pointer, the dimension feature does not dynamically draw itself.
4. Use the construction methods to enter the end dimension point.
5. Use the construction methods to enter the points where you want the dimension line to be.
6. Use the construction methods to enter the point that describes the extension line angle.
7. If you create more than four points or any points that do not represent the start or end dimension point, dimension line height, or extension line angle, you must delete them before continuing.
   The free construction methods allow you to enter as many points to help you define your dimension feature points. However, it is your responsibility to delete any point that does not correspond to one of the required dimension feature points. If you have too few or too many points, your edit operation will fail.
8. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Creating a linear dimension feature
Creating a rotated linear dimension feature

Creating a dimension feature with the Continue Dimension tool

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Click a dimension feature template in the Create Features window.
2. Click the Continue Dimension tool on the Create Features window.
3. Click an existing dimension feature whose end dimension point you want to use as the begin dimension point for your new dimension feature.
   As you move the mouse pointer, the new dimension feature dynamically draws with the begin dimension point fixed at the end dimension point of the selected dimension feature. The height is also fixed at the height of that dimension. The end dimension point changes as you move the pointer, keeping the baseline for the new dimension feature parallel to the baseline of the selected existing feature.
4. Click the map where you want the end dimension point to be. The dimension type will be the same as the original selected dimension feature.
5. To create back-to-back dimensions, click the previous dimension, then drag and click to create more dimensions in a row.

Related Topics
Creating a dimension feature with the Baseline Dimension tool
Creating a dimension feature with the Dimension Edge tool
Creating a dimension feature with the Perpendicular Dimensions tool

Creating a dimension feature with the Perpendicular Dimensions tool

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Click a dimension feature template in the Create Features window.
2. Click the Perpendicular Dimensions tool on the Create Features window.
3. Click the map at the start dimension point for the first dimension feature. As you move the pointer, a line is dynamically drawn through the point you clicked on the map. This line represents the direction of the dimension line for the first dimension feature.
4. Click the map to indicate the direction of the first dimension’s dimension line. The line will freeze at that point. As you move the pointer, you will see the first dimension feature parallel to the line. The second dimension feature will also draw as you move the pointer. This second dimension feature will be perpendicular to the line and, therefore, perpendicular to the first dimension feature.
5. Click the map at the start dimension point for the second dimension feature. The start points for each dimension feature are the points on the map you clicked, and the end dimension points for the new dimension features are the intersection of those dimension features.

Related Topics
Creating a dimension feature with the Baseline Dimension tool
Creating a dimension feature with the Continue Dimension tool
Creating a dimension feature with the Dimension Edge tool
This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the Baseline Dimension tool on the Create Features window.
3. Click an existing dimension feature whose end dimension point you want to use as the start dimension point for your new dimension feature. As you move the pointer, the new dimension feature dynamically draws itself with the start dimension point fixed at the start dimension point of the selected dimension feature. The height is fixed at the height of the dimension feature you selected plus the baseline height for that style. The end dimension point changes as you move the pointer, keeping the baseline for the new dimension feature parallel to the baseline of the selected dimension feature. For a dimension feature created with the Baseline Dimension tool, the height of the dimension line will be controlled by the baseline height property of its style. The baseline height is only used for creating dimension features. If you change an existing dimension feature’s style to a style with a different baseline height, the height of the dimension line will not change.
4. Click the map where you want the end dimension point to be. The dimension type will be the same as the original selected dimension feature.
5. To create back-to-back dimensions, click the previous dimension, then drag and click to create more dimensions in a row.

Related Topics
Creating a dimension feature with the Continue Dimension tool
Creating a dimension feature with the Dimension Edge tool
Creating a dimension feature with the Perpendicular Dimensions tool

Creating a dimension feature with the Dimension Edge tool

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click a dimension feature template in the Create Features window.
2. Click the Dimension Edge tool on the Create Features window.
3. Click the line or polygon edge you want to use as the baseline for your dimension feature. As you move the mouse pointer, the new dimension dynamically draws itself with the start and end dimension points fixed at the ends of the edge you clicked; the height of the dimension line changes. If you move the mouse pointer to the left or right of the baseline, a vertical linear dimension feature is shown. If you move your mouse pointer above or below the baseline, a horizontal linear dimension feature is shown. The Dimension Edge tool only creates linear dimension features by automatically using vertices on existing features for their start and end dimension points.
4. Click the map where you want the dimension line to be.
5. To create another dimension edge feature, click a line or polygon feature, and click and drag the dimension.

Related Topics
Creating a dimension feature with the Baseline Dimension tool
Creating a dimension feature with the Continue Dimension tool
Creating a dimension feature with the Perpendicular Dimensions tool

Dimension feature geometry

Dimension features draw and symbolize themselves based on their assigned style and are also able to regulate the modification of their geometry. By using the editing tools in ArcMap that you use to modify the geometry of other types of features, you can modify a dimension feature’s geometry while maintaining the correct configuration of points for a valid dimension feature. When you are modifying a dimension feature, there are a series of vertices you can pick up and move with the Edit tool to alter the dimension feature’s geometry. You cannot add vertices or delete any of the existing vertices. The following diagram illustrates what aspect of a dimension feature is modified when one of these vertices is moved:

You can move a dimension feature’s text away from its dimension line. The way the text is shown is dependent on the style chosen for the dimension feature. Some styles have line decoration including a leader line. For these styles, if you move the dimension feature’s text far enough from the dimension line that it surpasses the leader line tolerance, that leader line will automatically be displayed.
The extension line angle and the other properties of a dimension feature's geometry can be modified by altering the values of some of its fields. The following is a list of the fields you can modify for a dimension feature and how they correspond to its geometry:

<table>
<thead>
<tr>
<th>Field</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEGINX</td>
<td>X-coordinate of the start dimension point</td>
</tr>
<tr>
<td>BEGINY</td>
<td>Y-coordinate of the start dimension point</td>
</tr>
<tr>
<td>ENDX</td>
<td>X-coordinate of the end dimension point</td>
</tr>
<tr>
<td>ENDY</td>
<td>Y-coordinate of the end dimension point</td>
</tr>
<tr>
<td>DIMX</td>
<td>X-coordinate of the dimension line height</td>
</tr>
<tr>
<td>DIMY</td>
<td>Y-coordinate of the dimension line height</td>
</tr>
<tr>
<td>TEXTX</td>
<td>X-coordinate of the text point (null if the text has not been moved relative to the dimension feature)</td>
</tr>
<tr>
<td>TEXTY</td>
<td>Y-coordinate of the text point (null if the text has not been moved relative to the dimension feature)</td>
</tr>
<tr>
<td>EXTANGLE</td>
<td>Extension line angle</td>
</tr>
</tbody>
</table>

Related Topics

Modifying a dimension feature's geometry

Steps:

1. Click the Edit tool on the Editor toolbar and double-click the feature you want to edit.
2. Position the pointer over the vertex that corresponds to the aspect of the dimension's geometry you want to modify.
3. Drag and drop the vertex on the desired location. In addition to modifying the dimension line height, you can also modify the begin dimension point, the end dimension point, and the dimension text placement.
   As you move the pointer, the dimension feature dynamically updates itself so you can see how the feature will look after you have modified its geometry. The original feature will also be visible until you choose to finish the sketch.
4. Right-click anywhere on the map and click Finish Sketch.

Related Topics

Dimension feature geometry

A dimension feature gets most of its properties from its style. However, you can override some aspects of a dimension feature's style. The following are the properties that can differ between a dimension feature and its style:

- Dimension line display
- Dimension line arrow symbol display
- Extension line display

In addition to overriding these style properties, you can also change a dimension feature's style, specify a custom value to use for the dimension text instead of the length of the dimension feature, and change the extension line angle.

Dimension features can be modified using the Attributes window. Dimension features have a special Attributes window to allow you to easily modify their various properties. You can also use the standard attributes list to modify the properties of a dimension feature or modify the values of fields you have added to your dimension feature class. You might need to resize the window to see all the items.

Each property of a dimension feature that you can change in the dimensioning Attributes window can also be changed by altering the values of some of its fields. A list of the fields you can modify for a dimension feature and how they correspond to its properties is below:

<table>
<thead>
<tr>
<th>Field</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>STYLEID</td>
<td>ID of the dimension style.</td>
</tr>
<tr>
<td>USECUSTOMLENGTH</td>
<td>A value of 0 indicates that the feature's length is used for the dimension text; 1 indicates that a custom value is used for the dimension text.</td>
</tr>
<tr>
<td>CUSTOMLENGTH</td>
<td>Value used for the dimension text if USECUSTOMLENGTH is 1.</td>
</tr>
<tr>
<td>DIMDISPLAY</td>
<td>Null indicates that both dimension lines are displayed, 1 indicates that only the start dimension line is displayed, 2 indicates that only the end dimension line is displayed, and 3 indicates that none of the dimension lines are displayed.</td>
</tr>
<tr>
<td>EXTDISPLAY</td>
<td>Null indicates that both extension lines are displayed, 1 indicates that only the start extension line is displayed, 2 indicates that only the end extension line is displayed, and 3 indicates that none of the extension lines are displayed.</td>
</tr>
</tbody>
</table>
Related Topics

Modifying a dimension feature's style

### Modifying a dimension feature's style

This topic applies to ArcEditor and ArcInfo only.

All dimension features are associated with a dimension style. When you create a new dimension feature, you must assign it a dimension style. This dimension style must exist in the dimension feature class in which you are creating your new dimension feature. Once a dimension feature is created, it assumes all the properties of its style. You can use the Attributes window to modify some of those properties; however, some properties, such as the symbology of the dimension feature elements, cannot be modified.

You may need to resize the Attributes window to see the properties and the Commit button.

**Steps:**

1. Click the **Edit** tool on the **Editor** toolbar and click the feature.
2. Click the **Attributes** button on the **Editor** toolbar.
3. Click the **Dimension Style** drop-down arrow and click the dimension style you want to assign to this feature.
4. Click **Commit** to apply the changes to the dimension.

Related Topics

Dimension feature properties

---

### Selecting features while editing

Selecting features identifies the features on which you want to perform certain editing operations. For example, before you move, delete, or copy a feature, you must select it. You must also select features before you can view their attributes in the Attributes window.

You can select geodatabase annotation features using the Edit Annotation tool. Only geodatabase annotation features are selectable with this tool.

**Steps:**

1. Select the **Annotation** tool in the **Editor** toolbar.
2. Click the **Annotation** tool in the **Editor** toolbar.
3. Click the **Annotation** tool in the **Editor** toolbar.
4. Click the **Annotation** tool in the **Editor** toolbar.

Related Topics

Selecting a feature from overlapping features

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### Selecting features with the Edit tool compared with other selection tools

When you are editing, it is recommended that you make selections with the Edit tool rather than the selection tools on the Tools toolbar (Select By Rectangle, Select By Lasso, and so on). While the Edit tool and the other selection tools select features and follow the currently selectable layers and selection options (such as selection color and tolerance), the Edit tool has additional functionality to help you during an edit session. The other selection tools do not provide any editing functionality. The following are some of the differences when using the Edit tool compared with the selection tools on the Tools toolbar:

- The Edit tool is only available during an edit session.
- The Edit tool has a specialized right-click shortcut menu containing common editing commands and also has editing-related keyboard shortcuts. Although the other selection tools can be used to select features in an edit session, their shortcut menus mostly contain commands related to map navigation.
- The Edit tool does not follow the interactive selection mode and always creates a new selection.
- The Edit tool only selects the topmost selectable feature, whereas the other selection tools select every selectable feature underneath where you clicked.
- The Edit tool has the selection chip, allowing you to refine the selection and choose the exact feature you want to select when features overlap. With the Edit tool, if you are trying to select one feature from a series of overlapping features, you can either use the selection chip or press the N key to cycle through the choices to select the next coincident feature.
- The Edit tool allows you to interact with and modify the vertices of a feature and access a feature's geometry. In addition, the Edit Vertices pop-up toolbar appears when you are editing a feature's shape, allowing you to select, edit, add, and delete vertices.
- The Edit tool allows you to move a feature once you have selected it. If you initially select a feature with another selection tool, you need to switch to the Edit tool if you want to move the feature. However, if you find yourself inadvertently moving features when you drag a box with the Edit tool, increase the Sticky Move Tolerance setting on the Editing Options dialog box.

Related Topics

Preventing inadvertent movement of features when selecting
Selecting a feature from overlapping features
Selecting a feature from overlapping features

When you use the Edit tool to click the map to select a feature, a small icon appears if there are multiple selectable features underneath the location where you clicked. This icon, known as the selection chip, allows you to refine the selection and choose the exact feature you want to select. The selection chip only appears when you click the map to select features and does not show up when you drag a box to select features.

Click the button on the chip to cycle the selection to the next coincident feature. This deselects the feature on top and selects the next feature underneath it. Click the arrow to the right of the icon to view a list of the features from which you can select. The features are grouped by layer and listed by their display expression and symbol. As you rest your pointer over a feature or use the keyboard arrows to navigate the list, the active feature flashes so you can see it more easily on the map. Once you know the feature you want, click it in the list to select it on the map.

In addition, when you are trying to select from overlapping features, you can either use the selection chip or press the N key to cycle through the choices to select the next coincident feature. You can press the N key as many times as you need to select the feature you want.

**Note:** The selection chip also appears when you click the map with the Edit Annotation tool in a location where there are overlapping annotation features. Since only annotation features can be selected with the Edit Annotation tool, no other feature types are shown in that tool’s selection chip.

If you find yourself inadvertently moving features when you click or drag a box with the Edit tool, increase the Sticky Move Tolerance setting on the Editing Options dialog box.

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar and click the feature.
2. If there are other selectable features where you clicked, the selection chip appears so you can select the correct feature.
3. Click the arrow to the right of the icon to view a list of the features from which you can select. Features are listed in the selection chip by their display expression.
4. Rest your pointer over a feature in the list to flash it on the map. You can also use the arrow keys on the keyboard to navigate the list.
5. Click the feature in the list you want to select.

**Related Topics**
- Preventing inadvertent movement of features when selecting
- Selecting features while editing

Preventing inadvertent movement of features when selecting

The sticky move tolerance allows you to set a minimum number of pixels your pointer must move on the screen before a selected feature is actually moved. The effect of setting the sticky move tolerance is to delay moving selected features until the pointer has moved at least that distance. This can be a useful way to prevent features from being accidentally moved small distances when they are clicked with the Edit tool.

**Steps:**
1. Click the **Editor** menu and click **Options**.
2. Click the **General** tab.
3. Click inside the **Sticky move tolerance** box and type a new value (in pixels).
4. Click **OK**.

**Related Topics**
- Selecting a feature from overlapping features
- Selecting features while editing
Moving a feature and snapping it to another feature

You can use snapping to move one or more features to a precise location in relation to another feature. For example, with snapping, you can move a polygon feature representing a new building and, when it is moved within the snapping tolerance, have one of its corners jump, or snap, precisely to the corner of an existing building. To do this, make sure the buildings have vertex snapping enabled, and move the new building’s selection anchor to its corner vertex. Then drag the new building until the selection anchor snaps to the corner vertex of the existing building.

The graphic shows two buildings, with one of them (building 2) selected. The left side of the graphic shows that building 2's selection anchor has been moved from its default place in the center of the feature to one of its corners. The right side shows the same buildings, but with building 2 snapped and moved to the corner of building 1.

Normally, the selection anchor is in the center of selected features. To move a selection anchor, use the Edit tool and hold down the CTRL key while you rest your pointer over the selection anchor (the x). When the pointer turns into the move pointer, click the selection anchor and drag it to the new location.

Related Topics
Moving a feature by dragging it
Moving a feature relative to its current location (delta x,y)

Rotating a feature

You can rotate features using the Rotate tool. With this tool active, drag the pointer to rotate the selected features to the desired orientation. You can also specify an exact rotation angle by pressing the A key while rotating.

There are many cases where your data is not oriented properly and needs to be rotated. One might be that you need to duplicate some features and position them at a different orientation from the original features. Another case could be that you have received some data that just needs to be rotated to fit in with the rest of your data.

For example, you have imported some CAD building footprint data into your geodatabase. However, the buildings are oriented vertically when they need to be horizontal.

You can use the Rotate tool and rotate the features either interactively or at a specific angle so they fit properly into your parcel data.

The Rotate tool uses the selection anchor (the small x located in the center of the selected features) as a pivot point for the rotation. You can drag the selection anchor to a new location to change the center of rotation. You can use snapping to accurately place it.

While rotating features you can use the auxiliary anchor to snap the features. Press the S key to turn on/off the auxiliary anchor. Move the pointer over it, then drag the auxiliary anchor to the desired location. The selection anchor and auxiliary anchor both use the current snapping environment when you are dragging them. The auxiliary anchor snaps to features while you are rotating.

Rotating annotation: You can rotate annotation features using the Rotate tool. In addition, annotation features selected with the Edit Annotation tool have special handles that allow you to rotate them by clicking and dragging or by using rotate mode.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the feature or features that you want to rotate. Hold down the SHIFT key while clicking features to select additional features.
3. Click the Rotate tool on the Editor toolbar.
4. Click anywhere on the map and drag the pointer to rotate the feature to the desired orientation. To specify the exact degree of rotation, press the A key, and type the number of degrees. The angle is applied relative to the current orientation. A positive number rotates the feature to the right; a negative number rotates it to the left. Angular units are determined by the angular or direction units setting on the Units tab of the Editing Options dialog box.

Deleting a part from a multipart feature

If you have multipart features, you can delete one or more of their parts. The graphic below shows the inside part of a multipart feature being deleted, which fills in the hole. (Of course, parts don't have to be holes.)

When the Edit tool is active and you are editing the shape of a feature, the Edit tool pointer changes from a black arrow to a white arrow to show you can directly select vertices and modify segments. The black arrow pointer is shown when you are working with whole features rather than the individual vertices and segments that make up the feature.

Steps:
1. Click the **Edit** tool on the Editor toolbar and double-click the feature you want to edit.
2. Right-click the part you want to delete, point to **Part**, then click **Delete**.
3. Right-click anywhere on the map and click **Finish Sketch**.

You can also click **Finish Sketch** on the **Edit Vertices** toolbar.

Related Topics
Separating a multipart feature (Explode)

Reshaping a polygon

The Reshape Feature tool lets you reshape a polygon by constructing a sketch over a selected feature. The feature takes the shape of the sketch from the first place the sketch intersects the feature to the last.

When you reshape a polygon, if both endpoints of the sketch are within the polygon, the shape is added to the feature.

If the endpoints are outside the polygon, the feature is cut away.

Tip: If you want to reshape a feature to match another one, you can use the Reshape Feature tool in conjunction with the Trace construction method. Select the feature, click the Reshape Feature tool, click Trace from the palette on the Editor toolbar, and follow along the edge to perform the reshape.

Steps:
1. Click the **Edit** tool on the Editor toolbar.
2. Click the feature you want to reshape.
3. Click the **Reshape Feature** tool on the Editor toolbar.
4. Click the map to create a line according to the way you want the feature reshaped.
   You can snap the sketch to the selected edge or cross it to indicate where to start and stop reshaping. The sketch must cross (or touch the edge) two or more times for it to be reshaped.
5. To change the shape of the sketch segment, click a construction method type on the Editor toolbar or on the Feature Construction mini toolbar.
   Segments can be created using a variety of methods—for example, as straight lines, with curves, or traced from the shapes of other features. You can also use keyboard shortcuts or right-click to access a menu of commands to help you place vertices in the sketch.
6. Right-click anywhere on the map and click **Finish Sketch**.

Related Topics
Reshaping a line
Splitting a polygon

To split a polygon, use the Cut Polygons tool, then draw a line across the polygon. The cut operation updates the shape of the existing feature and creates one or more new features using the default attribute values for the feature class.

When you are splitting polygons, make sure your sketch cuts completely through the selected polygon. Edge snapping often helps ensure that the cut operation is completed successfully.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the polygon you want to split.
3. Click the Cut Polygons tool on the Editor toolbar.
4. Click the map to create a line that cuts completely through the original polygon as desired.
5. To change the shape of the sketch segment, click a construction method type on the Editor toolbar or on the Feature Construction mini toolbar. Segments can be created using a variety of methods—for example, as straight lines, with curves, or traced from the shapes of other features. You can also use keyboard shortcuts or right-click to access a menu of commands to help you place vertices in the sketch.
   For example, to create the sketch by tracing a line or polygon edge that overlaps the polygon to cut, click the Trace construction method on the Editor toolbar palette and click and trace along the existing feature. You might use this if you want to split a forest polygon by a stream line that runs through it.
6. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Splitting a polygon by an overlapping feature

Scaling a feature

You can scale a feature—make the entire feature larger or smaller—using the Scale tool. You might use the Scale tool when working with data for which the scale is slightly inaccurate—for example, subdivision parcels from multiple sources. You can use the Scale tool to scale parcels so that they fit together properly. The left image shows two selected polygons that should fit within the gap left by the adjacent polygons. The right shows the polygons after being scaled, so they are now the appropriate size.

Scaling is performed based on the location of the selection anchor (the small x located in the center of selected features). If the selection anchor is in the middle of the feature, it is scaled equally from the center. However, if you move it to another position, the scaling is anchored to the selection anchor's position. The graphics below show the result of scaling with the selection anchor in the center of a feature (left graphic), and with the selection anchor moved to the bottom of the feature (right graphic). When the selection anchor is moved, the feature is scaled much differently.
While scaling features, you can use the auxiliary anchor to snap the features. Press the S key to turn on/off the auxiliary anchor. Move the pointer over it, then drag the auxiliary anchor to the desired location. The selection anchor and auxiliary anchor both use the current snapping environment when you are dragging them. The auxiliary anchor snaps to features while you are scaling.

**Note:** You cannot scale any network features.

**Steps:**
1. To use the Scale tool, you must first add it to an ArcMap toolbar from the Commands tab of the Customize dialog box. The Scale tool is found in the Editor category.
2. Click the Edit tool on the Editor toolbar.
3. Click the feature that you want to scale.
4. Click the Scale tool on the toolbar to which you added it.
5. Move the selection anchor (the x), if necessary, since the feature is scaled based on the selection anchor's location.
6. Drag the pointer over the feature to scale it, or press the F key to set a scale factor.
7. Release the mouse button when you are finished scaling the feature.

---

**Clipping a polygon feature**

You can clip polygon features that touch or are within a buffered distance of a selected feature using the Clip command. To be clipped, the polygon features must be editable and visible. Only polygon features are clipped.

For example, suppose you want to model the effect of a proposed road widening project on the lots of a subdivision block. You can do this using the Clip command. Select the road centerline where the proposed widening is to occur and click Clip from the Editor menu.

On the Clip dialog box, type the length measurement of the widening and choose the option to Discard the area that intersects. The Clip command then buffers the selected road feature and clips all portions of editable and visible features that are within the buffered region.

Here is the result after clipping the subdivision lots, using the option to Discard the area that intersects. This option clips features within the buffer.

The Editor > Clip command only works on polygon features that are within a buffer distance of a selected feature. On the other hand, the Clip geoprocessing tool can clip any geometry type that overlaps a polygon clip layer.

**Steps:**
1. Click the Edit tool on the Editor toolbar.
2. Select the feature you want to use to clip.
3. Click the Editor menu and click Clip.
4. Type a buffer value. You can leave the value as 0 if you are clipping with a polygon feature.
5. Click the type of clip operation: whether to discard or maintain the area that intersects.
6. Click OK to clip the feature.

---

**Splitting lines manually**

The Split tool is used to manually split one line into two at the location you click with the mouse. For example, you can use the Split tool to divide a street centerline into two features when a new intersecting road is constructed. If the two roads cross, you can use intersection snapping to precisely locate the point to split.

**Steps:**
1. Click the Edit tool on the Editor toolbar and click the feature.
2. Click the Split tool on the Editor toolbar.
3. As you move your pointer over the line, a marker is visible on the line at the place where it will be split. You can use snapping to split the line at an exact location—for example, vertex or at the place where a point falls along the line.
4. Click to split the line. The line is split into two features, where the split operation updates the shape of the existing feature and creates a new feature using the default attribute values for the feature class.
Methods for splitting line features
- Splitting a line into an equal number of parts
- Splitting lines at a specified distance or percentage
- Splitting lines at intersections
- Splitting lines at intersections with Planarize Lines
- Splitting lines proportionally

The Split command on the Editor menu can split a selected line from either the start point or end point of the line by using a specified distance value, a percentage of total length, or an m-value. Split updates the shape of the existing feature and creates one or more new features using the default attribute values for the feature class.

The Split dialog box displays the length of the original feature in current map units to help you split it accurately. Arrows are shown on the feature to indicate the line's direction, so you can choose whether you want to split the line from the start or end point of the line. These arrows will help ensure that the line is split from the proper orientation.

**Steps:**
1. Click the *Edit* tool on the *Editor* toolbar and click the feature.
2. Click the *Editor* menu and click *Split*.
3. Choose the split method you want to use:
   - Split the feature at a certain distance.
   - Split the feature at a certain percentage of the whole.
   - Use measures (m-values) to split the line.
4. Type a distance, percentage, or m-value based on the split method.
5. Arrows are shown on the selected line to indicate its direction. Click *From Start Point of Line* if you want to split the feature starting from the first vertex, or click *From End Point of Line* if you want to split the feature starting from the last vertex.
6. Click *OK*.

The line is split, where Split updates the shape of the existing feature and creates one or more new features using the default attribute values for the feature class.

Related Topics
- Methods for splitting line features
- Splitting a line into an equal number of parts
- Splitting lines at intersections
- Splitting lines at intersections with Planarize Lines
- Splitting lines manually
- Splitting lines proportionally

The Split command on the Editor toolbar allows you to split a line into an equal number of new features. For example, you can use this Split option to break a line into pieces that are the same length. This functionality is similar to the Divide command available in previous ArcGIS releases.

**Steps:**
1. Click the *Edit* tool on the *Editor* toolbar and click the feature.
2. Click the *Editor* menu and click *Split*.
3. Click the *Into Equal Parts* split option and type the number of parts.
4. Click *OK*.

The line is split, where Split updates the shape of the existing feature and creates one or more new features using the default attribute values for the feature class.

Related Topics
- Methods for splitting line features
- Splitting lines at a specified distance or percentage
- Splitting lines at intersections
- Splitting lines at intersections with Planarize Lines
- Splitting lines manually
- Splitting lines proportionally

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Splitting lines at intersections

The Line Intersection tool allows you to split line features at their intersections. The lines are split at the location where you click the mouse. The split operation updates the shape of the existing feature and creates a new feature using the default attribute values for the feature class.

There can be many potential intersections between the lines’ features, and the intersection points can be either at specific locations in the middle of both lines or at implied intersections along extensions to one or both lines. When a feature needs to be extended to a point of intersection, you can either extend the existing feature or add a new feature.

In the simplest case, there is a single intersection between the line features. In the graphics below, the line features are drawn in black, and the pointer is placed at the intersection. The graphic on the right shows red lines leading to an implied intersection. In that case, the lines will be extended to the intersection.

In more complex cases, there can be many points of intersection, although you can split only one intersection at a time. You can press the TAB key to cycle through the possible intersections. As you move your pointer, the intersection solution closest to the pointer is shown. Click at that location to perform the split.

When working with multipart lines, only one part will be split at a time. Even if more than one part intersects the same line feature, only the part that corresponds to the intersection solution you clicked will be split. Once you have split the first part, simply use the Line Intersection tool again and split the other part at the second intersection.

Steps:
1. Click the Line Intersection tool on the Advanced Editing toolbar.
2. Click the first feature you want to intersect.
3. Click the second feature you want to intersect.
4. Optionally, press the O key to set the intersection options. You can choose whether a feature is extended to the point of intersection or a new feature is added.
5. Move the pointer to the intersection solution you want. Alternatively, press TAB to cycle through all the intersection solutions. The final click chooses which intersection solution is correct and splits or extends the features at the intersection.

Tip: When lines are split, the operation updates the shape of the existing feature and creates a new feature using the default attribute values for the feature class.

Related Topics
Methods for splitting line features
Splitting a line into an equal number of parts
Splitting lines at a specified distance or percentage
Splitting lines at intersections with Planarize Lines
Splitting lines manually
Splitting lines proportionally

Splitting lines at intersections with Planarize Lines

This topic applies to ArcEditor and ArcInfo only.

You can split selected lines where they intersect using Planarize Lines on the Topology toolbar. You do not need to have a map topology or geodatabase topology to use Planarize.

When Planarize is used on a multipart line feature, it is split at the point of intersection into a new feature.
Steps:
1. Click the **Edit** tool on the **Editor** toolbar.
2. Select the line features you want to split at intersections.
3. Click **Planarize Lines** on the **Topology** toolbar.
4. Optionally, type a cluster tolerance.
5. Click **OK**.

The selected lines are split into new features where they intersect. Planarize also removes overlapping line segments—such as those created by constructing lines from polygons that have shared boundaries.

Related Topics
- Constructing polygons from the shapes of other features
- Methods for splitting line features
- Splitting a line into an equal number of parts
- Splitting a polygon by an overlapping feature
- Splitting lines at a specified distance or percentage
- Splitting lines at intersections
- Splitting lines manually
- Splitting lines proportionally

Splitting lines proportionally

This topic applies to ArcEditor and ArcInfo only.

The Proportion command on the COGO toolbar splits a selected line feature into a number of segments, based on specified distance values. If there is a difference between the feature length and the entered values, this difference is proportioned between all the new segments. Proportion is useful when you are working with exact measurements, such as COGO or survey data.

For example, you have line features that need to be split into specific lengths. The example below shows a line feature that needs to be split into four parts: 13.79 feet, 48 feet, 60 feet, and 60 feet. The Proportion command is used to split this feature into the four new features.

![Image](https://example.com/image.png)

The lengths you entered add to 181.79 feet. If the length of the input feature is either longer or shorter than this value, the difference is proportioned among the new features. So if the length of the original feature was 182 feet, it is to be proportioned into features that are as follows: 13.807 feet, 48.055 feet, 60.069 feet, and 60.069 feet long.

Steps:
1. Click the **Edit** tool on the **Editor** toolbar and click the feature.
2. Click **Proportion** on the **COGO** toolbar.
3. The direction of the selected line is indicated by arrows on the map. Choose which end to start proportioning by clicking either from the start point or the endpoint of the line.
4. Click the label **<Click To Enter Length>**, type the distance value, then press ENTER to add the length. The Proportioned column shows the GIS length of the feature that will be created. Proportioned Value = (Length / Entered Length) * Feature Length.
5. Continue to add lengths until you are done. Press ESC once to get out of enter mode.
6. To modify an existing length, either double-click to edit it or press the SPACEBAR while it is highlighted.
7. To move a length up or down the list, highlight it and hold down CTRL and press the up or down arrow keys, or click the **Move Up** or **Move Down** buttons.
8. To remove a length from the list, highlight it and press the DELETE key, or click the **Delete** button.
9. To duplicate and reenter a highlighted length, press ALT+D or click the **Duplicate** button to open the **Proportion - Duplicate** dialog box.
10. Click **OK** when you are done entering lengths.

The line is split proportionally to the length of the measured segments. Any difference between the line length and the sum of the length of the segments is allocated proportionally to the new line's length. If your line feature has COGO fields and valid COGO attributes, the length you entered will be updated for each output feature.

Related Topics
- Methods for splitting line features
- Splitting a line into an equal number of parts
- Splitting lines at a specified distance or percentage
- Splitting lines at intersections
- Extending multiple lines

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If you need to extend multiple lines, use the Extend Line geoprocessing tool. The tool extends lines to an intersection within a dangle length tolerance distance. The dangle length is the maximum length that a line will be extended; if no intersections are found within that distance, the line is not extended. The tool can extend all lines or just the selected ones.

This tool is useful for cleaning up features that were not digitized using snapping or were imported from another format, such as CAD. You might want to use the Extend Line tool in conjunction with the Trim Line tool, which removes lines shorter than the dangle length. In addition, after running these tools, it may be useful to build a geodatabase topology containing the Must Not Have Dangles rule and further refine the quality of your data.

Related Topics
Extend Line
Extending a line to an intersection with another line

Trimming a line to a specific length

The Trim to Length command on the shortcut menu that appears when you right-click a sketch trims the length of the sketch using an exact distance measurement. The value entered will be the new length of the sketch. The length is given in map units by default. You can also give the length in other units by specifying a distance units abbreviation with the value that you enter.

Steps:
1. Click the Edit tool on the Editor toolbar and double-click the feature you want to edit.
2. Right-click any part of the line and click Trim to Length.
3. Type the length to trim the line (beginning at the last vertex marked in red) and press ENTER.
   The length is trimmed. You can flip a line to trim it from the first vertex instead of the last.
4. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Trimming a line to an intersection with another line
Trimming multiple lines

Trimming multiple lines

If you need to trim multiple lines, use the Trim Line geoprocessing tool. The tool deletes lines that are shorter than a dangle length tolerance. The tool can trim all lines or just the selected ones.

This tool is useful for cleaning up features that were not digitized using snapping or were imported from another format, such as CAD. You may want to use the Trim Line tool in conjunction with the Extend Line tool, which extends lines to intersect within the dangle length. In addition, after running these tools, it may be useful to build a geodatabase topology containing the Must Not Have Dangles rule and to refine further the quality of your data.

Related Topics
Trim Line
Trimming a line to a specific length
Trimming a line to an intersection with another line

About simplifying and smoothing a feature

The Advanced Editing toolbar provides tools to enable you to smooth and simplify features. This includes line and polygon features.

The Generalize command simplifies the shape of the selected features using the published algorithm (Douglas and Peucker, 1973). The degree to which the geometry is simplified depends on the maximum allowable offset, which limits how far the output geometry can be from the input geometry. For features composed of linear segments, the output vertices are a subset of the original feature vertices.

The Smooth command is used to smooth the straight edges and angular corners of a feature. The feature geometry is replaced by a series of smoothed line segments.
The Smooth tool combines the following steps:

- Simplification with the specified maximum allowable offset (see the description of the Generalize tool, above) to produce a subset (indicated by the blue dashed line in the illustration below) of the original feature vertices (indicated by the black line in the illustration below).

- Bézier interpolation without any parameters, which fits Bézier curves through the subset vertices from the above simplification. The Bessel tangent is used to connect the curves smoothly at vertices (Farin, 1997). The resulting geometry (the red line in the illustration below) can be farther away from the input geometry than the specified maximum allowable offset.

References

Related Topics
Simplifying a feature (Generalize)
Smoothing a feature (Smooth)

Simplifying a feature (Generalize)

You can simplify a feature by using either the Generalize command on the Advanced Editing toolbar or the Generalize geoprocessing tool in the Editing toolbox. The following steps describe the Generalize command, which simplifies only one selected line. To simplify multiple lines, use the Generalize geoprocessing tool.

Steps:
1. Click the Edit tool on the Editor toolbar and click the feature.
2. Click Generalize on the Advanced Editing toolbar.
3. Type the maximum allowable offset. The maximum allowable offset is the maximum distance in map units that any part of the output geometry can be from the input geometry. You can also give the value in other units by specifying a distance units abbreviation with the value that you enter. To learn more, see About distance units and editing.
4. Click OK.

Related Topics
About simplifying and smoothing a feature
Smoothing a feature (Smooth)

Smoothing a feature (Smooth)

You can smooth a feature by using the Smooth command on the Advanced Editing toolbar or the Smooth Line geoprocessing tool or Smooth Polygon geoprocessing tool. The following steps describe the Smooth command, which smooths only one selected line. To smooth multiple lines, use the geoprocessing tools.

Steps:
1. Click the Edit tool on the Editor toolbar and click the feature.
2. Click Smooth on the Advanced Editing toolbar.
3. Type the maximum allowable offset. The maximum allowable offset is used to derive an intermediate, simplified line from the input line. From this intermediate line, a final smoothed line is then produced. The offset is in map units. You can also give the value in other units by specifying a distance units abbreviation with the value that you enter. To learn more, see About distance units and editing.
4. Click OK.

Related Topics
About simplifying and smoothing a feature
Simplifying a feature (Generalize)

Editing vertices and segments

When the Edit tool is active and you are editing the shape of a feature, the Edit tool pointer changes from a black arrow to a white arrow to show you can directly select vertices and modify segments. The black arrow pointer is shown when you are working with whole features rather than the individual vertices and segments that make up the feature.

Steps:
1. Click the Edit tool on the Editor toolbar and click the feature.
2. Click Edit Vertices on the Editor toolbar, or simply double-click the edge with the Edit tool. When you are working with the vertices of a feature, the Edit Vertices toolbar appears, providing an easy way to select vertices, add and delete them, and modify segments.

<table>
<thead>
<tr>
<th>Edit Vertices toolbar</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Click the Add Vertex tool on the Edit Vertices toolbar. You can also right-click a segment and click Insert Vertex, or hold down the A key and click.</td>
<td></td>
</tr>
<tr>
<td>Insert a vertex</td>
<td></td>
</tr>
<tr>
<td>Hold down A and click and drag the new vertex.</td>
<td></td>
</tr>
<tr>
<td>Insert a vertex and move it in one step</td>
<td></td>
</tr>
<tr>
<td>Click the Delete Vertex tool on the Edit Vertices toolbar and click the vertex to delete. You can also right-click a vertex and click Delete Vertex, or hold down the D key and click.</td>
<td></td>
</tr>
<tr>
<td>Delete a vertex</td>
<td></td>
</tr>
<tr>
<td>Click the Delete Vertex tool on the Edit Vertices toolbar and drag a box around the vertices to delete. You can also hold down D and drag a box, or press BACKSPACE, to delete selected vertices.</td>
<td></td>
</tr>
<tr>
<td>Delete multiple vertices</td>
<td></td>
</tr>
<tr>
<td>Select one or more vertices and drag and drop them to the new location.</td>
<td></td>
</tr>
<tr>
<td>Move a vertex by dragging it</td>
<td></td>
</tr>
<tr>
<td>Select one or more vertices, right-click, then click Move.</td>
<td></td>
</tr>
<tr>
<td>Move a vertex by a relative x,y distance</td>
<td></td>
</tr>
<tr>
<td>Right-click the vertex and click Move To.</td>
<td></td>
</tr>
<tr>
<td>Move a vertex to an absolute x,y location</td>
<td></td>
</tr>
<tr>
<td>Right-click a segment; point to Change Segment; then click either Straight, Circular Arc, or Bézier.</td>
<td></td>
</tr>
<tr>
<td>Change the segment type</td>
<td></td>
</tr>
<tr>
<td>Click and drag an arc segment, or press the R key and type a radius.</td>
<td></td>
</tr>
<tr>
<td>Change the shape of an arc segment</td>
<td></td>
</tr>
</tbody>
</table>

3. Right-click anywhere on the map and click Finish Sketch.

Related Topics
The Edit Vertices toolbar

The Edit Vertices toolbar

The Edit Vertices toolbar provides quick access to some of the most commonly used commands when editing vertices. It appears on-screen whenever either the Edit tool or the Topology Edit tool is active and you are editing the vertices of a feature or topology edge. The toolbar floats the first time it appears but can be docked after that.

When the Edit tool is active and you are editing the shape of a feature, the Edit tool pointer changes from a black arrow to a white arrow to show you can directly select vertices and modify segments. The black arrow pointer is shown when you are working with whole features rather than the individual vertices and segments that make up the feature.

The Edit Vertices toolbar allows you to select vertices and add and remove them easily. When you are done modifying the vertex, finish the sketch.

- The Modify Sketch Vertices tool allows you to select vertices and edit segments.
- To add a vertex, click the Add Vertex tool and click the segment at the location where you want to insert it.
- To delete a vertex, click the Delete Vertex tool and click the vertex to delete. To delete multiple vertices, drag a box around them.

To hide the Edit Vertices toolbar temporarily, click the Close button in the corner or press SHIF+TAB. To show the toolbar again, press the TAB key.

Related Topics
Editing vertices and segments
The Feature Construction toolbar

Adding a vertex manually

You can add vertices to reshape features using the Edit tool and the Edit Vertices toolbar. For example, suppose you have an existing layer with curb lines and you receive an aerial photo that shows that the lines in the layer are incorrectly shaped. Using the aerial photo as a backdrop, you can add vertices to reshape the curb lines to match the photo.
When the Edit tool is active and you are editing the shape of a feature, the Edit tool pointer changes from a black arrow to a white arrow to show you can directly select vertices and modify segments. The black arrow pointer is shown when you are working with whole features rather than the individual vertices and segments that make up the feature.

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Below are some of the ways to add a vertex:
   - Click the **Add Vertex** tool on the **Edit Vertices** toolbar and click where you want to insert the vertex.
   - Hold down the A key and click the vertex. When you hold down A, a plus sign (+) appears next to the white Edit tool pointer. If you hold down A, then click and drag, you can insert the vertex and move it in one motion.
   - Move the pointer to where you want the vertex added, right-click, then click **Insert Vertex**.
3. Right-click anywhere on the map and click **Finish Sketch**.

**Related Topics**
- Adding a vertex at an interval to densify an edge
- Adding a vertex at the midpoint of a segment

---

**Adding a vertex at the midpoint of a segment**

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Click the **Sketch Properties** button on the **Editor** toolbar.
   - When the Edit tool or a construction tool is active, you can press P as a shortcut to open the Edit Sketch Properties window.
3. In the **Edit Sketch Properties** window, select the vertex before or after the place you want to insert a new vertex. When you check a vertex in the Edit Sketch Properties window, the vertex is selected and drawn with a hollow, white box on the map. You can also select a vertex on the map to help you locate it in the Edit Sketch Properties window.
4. Right-click the selected vertex and click **Insert Before** to add a vertex before it, or click **Insert After** to add the vertex after it.
5. Click **OK**.

**Related Topics**
- Adding a vertex at an interval to densify an edge
- Adding a vertex manually

---

**Adding a vertex at an interval to densify an edge**

If you need to add many vertices to a line or polygon or a set of selected lines or polygons, use the Densify geoprocessing tool. The tool converts a parametric or true curve (such as an arc, ellipse, or Bézier curve) into a series of straight segments by placing vertices at an interval defined by a maximum distance or angle from the original curve's shape. However, keep in mind that running this tool on a curve that shares an edge with another feature could result in the boundary between them no longer being coincident.

A common use for densification is to maintain a feature's shape during projection or to enable snapping, such as when using spatial adjustment rubbersheeting to align linear features with a different number of vertices.

**Related Topics**
- Adding a vertex at the midpoint of a segment
- Adding a vertex manually
- Densify

---

**Deleting a vertex**

If the shape of a feature contains too many vertices, you can delete a vertex or multiple vertices at a time to reshape the feature.

When the Edit tool is active and you are editing the shape of a feature, the Edit tool pointer changes from a black arrow to a white arrow to show you can directly select vertices and modify segments. The black arrow pointer is shown when you are working with whole features rather than the individual vertices and segments that make up the feature.

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Below are some of the ways to delete a vertex:
   - Click the **Delete Vertex** tool on the **Edit Vertices** toolbar and click the vertex you want to delete.
   - Hold down the D key and click the vertex. When you hold down D, a minus sign (-) appears next to the white Edit tool pointer.
   - Position the pointer over the vertex until the pointer changes to the move pointer, right-click, then click **Delete Vertex**.
3. Below are some of the ways to delete multiple vertices:
   - Click the **Delete Vertex** tool on the **Edit Vertices** toolbar and drag a box around the vertices.
   - Hold down the D key and drag a box around the vertices. When you hold down D, a minus sign appears next to the white Edit tool pointer.
Select the vertices and press the BACKSPACE key.

4. Right-click anywhere on the map and click Finish Sketch.

Moving a vertex by dragging it

You can click a vertex and drag it to a new location when you want to reshape a feature according to additional data you receive. For instance, you can drag a vertex to reshape a road feature in an existing layer to match it to the feature in a more accurate aerial photograph. You can also drag a box around one or more vertices and move them together. Selected vertices are shown with white boxes.

In the graphic below, the inside corner vertex, which is selected, is moved to the upper right corner to reshape the feature. Selected vertices are drawn as white boxes, by default.

Steps:
1. Click the Edit tool on the Editor toolbar and double-click the feature you want to edit.
2. Position the pointer over the vertex until it changes to the move pointer.
   To move multiple vertices, drag a box around them and position the pointer over one of the selected vertices.
3. Click and drag the vertex (or vertices) to the desired location.
4. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Moving a point to a specific x,y location (absolute x,y)
Moving a vertex relative to its current location (delta x,y)
Moving a vertex without changing a feature's general shape

Moving a vertex relative to its current location (delta x,y)

Suppose an electrical pole must be moved 15 feet east and 5 feet north of its current location due to a road widening. Before moving the pole, you must reshape its electrical line so the pole can connect to the line in the new location; you can do this by moving the vertex of the electrical line on which the pole sits using relative (delta) x,y coordinates. You can also select multiple vertices and move them all at the same time to a relative location.

The original location of the vertex as the origin (0,0) is used, and the vertex is moved to the new location using the map unit coordinates you specify (for example, 15,5). After the vertex is moved and the electrical line is reshaped, you can snap the pole feature to the vertex in its new location.

Steps:
1. Click the Edit tool on the Editor toolbar and double-click the feature you want to edit.
2. Position the pointer over the vertex until it changes to the move pointer. To move multiple vertices, drag a box around them and position the pointer over one of the selected vertices.
3. Right-click and click Move.
4. Type the delta x,y coordinates of the place you want to move the vertex (or vertices).
5. Right-click anywhere on the map and click Finish Sketch.

Related Topics
About distance units and editing
Moving a point to a specific x,y location (absolute x,y)
Moving a vertex by dragging it
Moving a vertex without changing a feature's general shape

Moving a vertex without changing a feature's general shape

If you need to move a vertex but keep the general shape of a feature, you can proportionally stretch a feature's geometry. When you drag a vertex to a new location with proportional stretching on, the proportions of the feature's segments are maintained, thereby maintaining the general shape of the feature.

Below are some examples of how polygon and line features will react to dragging a vertex with and without proportional stretching.

With proportional stretching: When it is on, other vertices are moved too. The sketch of the feature rubber sheets to maintain its shape.
No proportional stretching: When there is not proportional stretching, a vertex moves independently when it is dragged. This is the default setting.

Tip: You can stretch features proportionally when merging data from different data sources—for example, utility lines from one source and subdivision parcels from another. Suppose the data for the subdivision parcels is very accurate, but the data for the utility lines is not as accurate. While the shapes of the utility lines are generally correct, you might want to change the position of one line relative to the parcels by moving a vertex. By stretching the utility line feature proportionally, you can make it fit accurately with the parcels without losing the general shape of the line.

Tip: Turning on the option to Stretch geometry proportionately when moving a vertex is recommended when performing spatial adjustments on data that participates in a geometric network. For more information on adjusting geometric networks, see About spatial adjustment rubbersheeting.

Steps:
1. Click the Editor menu and click Options.
2. Click the General tab.
3. Check Stretch geometry proportionately when moving a vertex.
4. Click OK.
5. Move a vertex as desired.
6. To turn off proportional stretching, open the Editing Options dialog box and uncheck the box.

Related Topics
- Moving a point to a specific x,y location (absolute x,y)
- Moving a vertex by dragging it
- Moving a vertex relative to its current location (delta x,y)

Using the Edit Sketch Properties window

You can use the Edit Sketch Properties window to view and edit the coordinates, m-values, and z-values of the vertices that make up a feature. You can choose which vertices are modified by checking the boxes in the Edit Sketch Properties window or by selecting the vertices on the map. In addition, the Edit Sketch Properties window allows you to sort the order of vertices and navigate to them. If a feature has multiple parts (a multipart feature), vertices are grouped under the part to which they belong.

Note: To add m- or z-values to a vertex, you must have specified that the feature class be able to store them when you created the feature class. If you did not set this property, you need to create a new feature class and import the existing features into it.

Steps:
1. Click the Edit tool on the Editor toolbar and double-click the feature you want to edit.
2. Click the Sketch Properties button on the Editor toolbar.
   When the Edit tool or a construction tool is active, you can press the P key as a shortcut to open the window.

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3. Check the boxes for the vertices you want to modify in the **Edit Sketch Properties** window. You can also use the **Edit** tool to drag a box around a vertex on the map to select it. Selected vertices appear as white boxes on the map.

4. When working in the **Edit Sketch Properties** window, you can do the following:

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add a vertex at the midpoint of a segment</td>
<td>Right-click a vertex and click either <strong>Insert Before</strong> (adds a vertex before the vertex you right-clicked) or <strong>Insert After</strong> (adds a vertex after the vertex you right-clicked).</td>
</tr>
<tr>
<td>Change a value</td>
<td>Click a cell for an x-coordinate, y-coordinate, m-value, or z-value and type a new value.</td>
</tr>
<tr>
<td>Change one or more z-values</td>
<td>Check the boxes next to the vertices you want to edit, or select them on the map. Click the <strong>Z</strong> button and type a new value.</td>
</tr>
<tr>
<td>Change one or more m-values</td>
<td>Check the boxes next to the vertices you want to edit, or select them on the map. Click the <strong>M</strong> button. You can either clear the m-values (they become NaN values) or type a new m-value.</td>
</tr>
<tr>
<td>Flash a vertex on the map</td>
<td>Click the vertex, or right-click it and click <strong>Flash</strong>.</td>
</tr>
<tr>
<td>Zoom to a vertex</td>
<td>Right-click the vertex and click <strong>Zoom To</strong>.</td>
</tr>
<tr>
<td>Pan to a vertex</td>
<td>Right-click the vertex and click <strong>Pan To</strong>.</td>
</tr>
<tr>
<td>Delete a vertex</td>
<td>Right-click the vertex and click <strong>Delete</strong>, or check the box next to it and click the <strong>Delete</strong> button.</td>
</tr>
</tbody>
</table>

5. When you are done, click **Finish Sketch** on the **Edit Sketch Properties** window.

### Related Topics

- **Editing a vertex’s m-value or z-value**

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### Changing a segment into a straight line, a circular arc, or a Bézier curve

You can convert a straight segment into an arc or a Bézier curve segment, and vice versa.

**Steps:**

1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Position the pointer over the segment until the pointer changes to the segment cursor.
3. Right-click the segment, point to **Change Segment**, then click **Straight**, **Circular Arc**, or **Bézier**.
   - The current segment type will be disabled in the list.
4. Right-click anywhere on the map and click **Finish Sketch**.

### Related Topics

- **Editing Bézier curves**
- **Editing curved segments**

---

### Editing curved segments

You can drag the shape of a curve or change its radius to reshape the segment.

**Steps:**

1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. To change the height of a curve, click and drag the curve.
3. To set a specific radius for a circular arc segment, press the **R** key and type the value.
4. To move the endpoints of the segment rather than modifying the curve, press and hold **CTRL** as you drag.
5. Right-click anywhere on the map and click **Finish Sketch**.

### Related Topics

- **Changing a segment into a straight line, a circular arc, or a Bézier curve**
- **Creating a Bézier curve**
- **Creating a curve through endpoints (Endpoint Arc)**
- **Creating a curve through start, middle, and end points (Arc)**
- **Editing Bézier curves**

---

### Editing Bézier curves

Bézier curves are smooth linear transitions between two vertices. The shape of the curve is defined by the locations of the vertices and additional control points at the end of blue Bézier handles that radiate from each vertex.
Steps:

1. Click the **Edit** tool on the **Editor** toolbar and double-click the feature you want to edit.
2. Click and drag a Bézier handle control point to change the shape and height of the curve. As you rest over the control point, the pointer changes to the **Bézier handle control point pointer**.
3. If you rest your pointer on a Bézier handle control point from a vertex shared by two adjacent Bézier curves, holding down CTRL will only modify one of the curves when you move the handle.
4. If you have a vertex and a Bézier handle control point under the Edit tool pointer when you click and drag, the vertex will be moved. Hold down CTRL if you want to move the Bézier control point instead.
5. Right-click anywhere on the map and click **Finish Sketch**.

Related Topics

- Changing a segment into a straight line, a circular arc, or a Bézier curve
- Creating a Bézier curve
- Creating a curve through endpoints (Endpoint Arc)
- Creating a curve through start, middle, and end points (Arc)
- Editing curved segments

About editing attributes

When you want to add, delete, or update attribute values, you can use either the Attributes window or the table window.

**Editing attributes in the Attributes window**

The **Attributes** window allows you to view and edit attributes of features you have selected. You can open it by clicking the **Attributes** button on the **Editor** toolbar.

While the window can be reoriented, it is vertical by default. The top of the window lists the features you have selected. Features are listed by their display expression and grouped by layer. Use the **Fields tab of the Layer Properties dialog box** to customize how the fields appear by setting up field aliases, hiding fields, and changing the field order.
The bottom of the Attributes window contains two columns: the attribute fields of the layer you are viewing and the values of those attribute properties. The attribute values that appear depend on what you click in the tree at the top.

- To modify a value for a single feature, click the feature and make your changes in the attribute value column.
- To modify values for all selected features in a layer at the same time, click the layer name and make your changes in the attribute value column.
- To modify values for just a few of the selected features in a layer, click each feature you want to update so it is highlighted in the Attributes window, and make the edits.
- To edit the attributes of feature or records that are related to the selected features, click and traverse through the tree, and edit the values.
- To modify the attributes of multiple related features or records, click each related item you want to update so it is highlighted it in the Attributes window, and make the edits.

### Editing attributes in the table window

You can also edit attributes in the table window. An attribute table window can show you the values for all features in a layer. Editing attributes through the table window also allows you to quickly make changes to several features (records) at once using the field calculator.

### Related Topics

- Editing attributes in the Attributes window

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**Note:** The values for fields in joined tables are read-only. You need to open the source table to edit those.
10. To copy attribute values, select the contents of the cell, right-click, then click **Copy**. Then, right-click and click **Paste** to paste the attribute values into a different cell.

11. To delete attribute values, right-click the cell and click **Delete**.

**Related Topics**

- **About editing attributes**
- **Applying the same attribute values to multiple features in a layer**
- **Entering attributes immediately after creating a new feature**

---

**Entering attributes immediately after creating a new feature**

You can turn on a setting so you will be prompted to enter attributes into the Attributes window after any editing operation that results in new features. You will need to close the window before you can do anything else with ArcMap.

Turning on this setting is most useful in the following situations:

- Your geodatabase does not allow features to have null attribute values or requires that attribute values be unique. When prompted, you can edit the attribute values before the new feature is stored in the geodatabase. This may be useful when working in a nonversioned edit session with ArcSDE data.
- You are creating new features and want to attribute them immediately. This is especially true when you are creating a few new features at a time, and they have known attributes or subtypes. This is useful when the values cannot be determined ahead of time; otherwise, you should set these values as part of the feature template.

Being prompted to enter attributes may be less efficient in cases where you create a batch of features at a time. For example, if you are using a command that creates a number of new features, you may find that it is difficult to enter and keep track of the attributes for so many features at once.

**Steps:**

1. Click the **Editor** menu and click **Options**.
2. Click the **Attributes** tab.
3. Check the **Display** box.
4. Specify whether to show the Attributes window for all layers or just certain ones. If you want it to display for certain layers, check those layers.
5. Click **OK**.
6. Finish a sketch or perform any editing operation that results in at least one new feature being created. The **Attributes** window opens.
7. Type the attribute values.
   - If you have created multiple features at once and want to assign the same attribute values to them, click the layer name and type the values.
8. Click **OK**.
   - A message appears if there is a problem with the values, such as if you have null values when they are not allowed or if you enter text in a numeric field. You will have an opportunity to fix the problem.

**Related Topics**

- **Editing attributes in the Attributes window**

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**Applying the same attribute values to multiple features in a layer**

You can modify attribute values for multiple selected features in a layer at the same time. If you click the layer name and modify the attribute values, all selected features are updated; if you click multiple individual features or individual related records, only the highlighted features or records are updated.
Steps:
1. Click the Edit tool on the Editor toolbar and select the features.
2. Click the Attributes button on the Editor toolbar.
3. Click the layer name. If you want to update just certain selected features in the layer, hold down CTRL and click the features to highlight them.
4. Update the attribute values. Only change the values you want to apply to all the features.
5. You can also make bulk updates to the attributes of related features or tables this way. Expand the relationships so you can see the related records, hold down CTRL and click each of the related records at the top of the window, then change the values at the bottom of the window.
6. When you are finished, click the features to ensure that the values are updated as desired.

Related Topics
Editing attributes in the Attributes window

Copying and pasting attribute values

Copying and pasting is an easy way to edit the attributes of features on your map. You can copy and paste individual or all attribute values from feature to feature or to an entire layer.

For example, suppose you have a polygon representing a lake and you want to apply its attribute values to other lake polygons without typing them in manually. Simply open the Attributes window and copy the lake’s attributes. You can paste the values into either an individual cell or paste them all into a feature or into all the selected features in that layer.

Steps:
1. Click the Edit tool on the Editor toolbar and select the features.
2. Click the Attributes button on the Editor toolbar.
3. In the Attributes window, right-click the feature you want to copy from and click Copy Attributes.
   
   **Tip:** If you want to copy and paste an individual value, select the contents of the cell, right-click, then click Copy. Click the cell you want to paste into and click Paste.

4. Right-click the feature you want to paste into and click Paste Attributes.
   
   If the features you are copying between are in the same layer, all attribute values will be pasted. If they are in different layers, only values from matching fields will be pasted.

Editing features with raster attribute fields

A geodatabase feature class or table can have one attribute field that contains a raster dataset. Unlike a hyperlink that simply links a feature’s attribute field to an image, an attribute field of type Raster stores the raster data within or alongside the geodatabase. For example, you could add a photograph of the commercial property as an attribute of a parcel feature.

Another option for storing photographs and other files in a database is using attachments. Attachments are more flexible than raster attribute fields, because you can add multiple files to a single feature, whereas a raster field allows you to store only one image. In addition, the attached files can be different types, such as images, videos, documents, and so on. Attachments require an ArcEditor or ArcInfo license, since they use relationship classes to link the features to the files.

Steps:
You can add and update attachments during an edit session using either the Attributes window or the table window. To add attachments, this topic applies to ArcEditor and ArcInfo only.

- Navigate to the location of the input raster dataset and click Add.
- Set the Compression Type and, if applicable, the Compression Quality.
- Click OK.

Once the raster is loaded as an attribute, you can view and perform other edits on it. Click the drop-down arrow for the raster field and select one of the options in the menu.
- Click View to open the raster in a larger window.
- Click Load to load a different image as the raster attribute.
- Click Clear to delete the raster attribute.
- Click Save As to export the raster.
- Click Properties to view and edit the properties of the raster.

Related Topics
Adding raster datasets as attributes in a feature class
Enabling attachments

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Enabling attachments

This topic applies to ArcEditor and ArcInfo only.

Attachments provide a flexible way to manage additional information that is related to your features. Attachments allow you to add files to individual features and can be images, PDFs, text documents, or any other type of file. For example, if you have a feature representing a building, you could use attachments to add multiple photographs of the building taken from several angles, along with PDF files containing the building’s deed and tax information.

To add file attachments, you first need to enable attachments on the feature class. When you enable attachments, ArcGIS creates a new table to contain the attachment files and a new relationship class to relate the features to the attached files. You add attachments to the features during an edit session.

Attachments are similar to hyperlinks but allow you to associate multiple files to a feature, store the attached files in the geodatabase, and access the files in more ways. You can view attachments from the Identify window, from the Attributes window (when editing), in the attribute table window, and through HTML pop-ups.

Since relationship classes are used to maintain the linkage, and relationship classes require an ArcEditor or ArcInfo license, an ArcEditor or ArcInfo license is also required to enable attachments or edit feature classes with attachments. With ArcView, you can add and open attachments.

Steps:
1. In the Catalog window or ArcCatalog, right-click the feature class to which you want to add attachments, point to Attachments, then click Create Attachments. ArcGIS adds a new table to contain the attached files and a relationship class to manage the link between the features and their attachments.
2. To remove all the attached files and delete the table and relationship class that ArcGIS created when you enabled attachment functionality, click Delete Attachments.

Related Topics
Adding attachments to features
Viewing attachments

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Adding attachments to features

This topic applies to ArcEditor and ArcInfo only.

You can add and update attachments during an edit session using either the Attributes window or the table window. To add attachments, this topic must be supported on the feature class.

Steps:
1. Click the Editor menu on the Editor toolbar and click Start Editing. You can use either the Attributes window or the table window to add attachments.
2. To use the Attributes window, follow the following steps:
   a. Click the Edit tool on the Editor toolbar and click the feature.
   b. Click the Attributes button on the Editor toolbar.
   c. Click the Open Attachment Manager button—the paperclip icon just above the grid of attribute values.
3. To use the table window, right-click the gray cell to the left of the record for the feature you want to add attachments to and click Open Attachment Manager.
4. Click the Add button, browse to the file, then click Add. When a file is attached, the attachment is stored in the geodatabase table and no longer has a linkage to the original source file. If you update the source file, you need to re-add the attachment.
5. Once the attachment has been added, you can do the following:
   - To open the attachment, double-click it or click Open. The attachment is opened using the default Windows application for that file type. If no default application has been specified, you are prompted to choose the application to use when opening that type.
To save a copy of a file to disk, click **Save As** and browse to the location to save the attachment.

To save a copy of all the attached files to disk, click **Save All** and browse to or create the folder in which you want to save the attachments.

To remove an attachment, click **Remove**. This removes the file from the geodatabase. If you need to access the file again later, you need to re-add the attachment from disk.

6. Click **OK**.

**Related Topics**
- Enabling attachments
- Viewing attachments

---

**Viewing attachments**

To view and open attachments, you can either use the Identify window or table window or, when editing, use the Attributes window. The attachments open in the Windows default application for that file type.

**Note:** You need an ArcEditor or ArcInfo license to access the attachment in the Attributes window, since you are editing the layer.

**Steps:**

1. Click the **Identify** tool on the **Tools** toolbar and click the feature containing the attachments you want to view. If you are in an edit session and have an ArcEditor or ArcInfo license, you also can use the **Attributes** window to view the attachments. Select the feature and click the **Attributes** button on the **Editor** toolbar.

2. Click the **Open Attachment Manager** button—the paperclip icon just above the grid of attribute values. The number of files attached to the features is shown in parentheses.

3. Click the attachment in the list to open it.

4. You can also click **Open Attachment Manager** and open the attachment from the list of attached files.

**Tip:** To use the table window to view attachments, right-click the gray cell to the left of the record for the feature you want to add attachments to and click **Open Attachments Manager**.

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**Related Topics**
- Adding attachments to features
- Enabling attachments

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**About editing relationships in ArcMap**

This topic applies to ArcEditor and ArcInfo only.

**About relationships**

Relationship classes allow you to maintain associations between objects in your geodatabase. These relationships can be simple and passive, or they can be composite. Composite relationships imply parent-child relationships, or composition, and therefore have behavior, which is triggered through changes to objects on one side of the relationship to objects on the other side. Feature-linked annotation in the geodatabase uses composite relationships.

Relationships in a relationship class can be stored using primary and foreign keys in the object classes on either side of the relationship class. Alternatively, in the case of many-to-many (M–N) and attributed relationship classes, the relationships are rows stored in a separate table.

You can use the Attributes window or the table to find all objects related to any selected object. Once you have navigated to the related object, you can edit its attributes. You can also use the editing tools in ArcMap to break the relationship between any two objects or create new relationships between objects. When you edit objects and relationships in this way, all referential integrity is maintained.

**Adding and deleting relationships**

You can use the Attributes window to create and delete relationships between two objects. If the relationship is managed by primary and foreign keys (nonattributed 1–1 or 1–M relationships), the foreign key in the destination object is populated with the value of the primary key from the origin object. If a relationship between two objects is deleted, the value for the foreign key in the destination object is replaced with a null. The foreign key in the destination object must have fields that can be nulled.
If the relationship class is M–N or attributed, the relationships are stored on a separate table in the database. When a new relationship is created between two objects in this type of relationship class, a new row is added to that table. This new row is populated with the values from the primary keys in the origin and destination objects. If a relationship between two objects is deleted, the row corresponding to that relationship is deleted from the relationship table.

Editing objects in a simple relationship class

When an object that participates in relationships with other objects is deleted from the geodatabase, all its relationships are also deleted. If the object that is deleted is the origin object, the foreign key in all of the related destination objects is set to null. If the object deleted is a destination object, the origin object is not affected.

If the relationships are maintained as rows in a relationship table (M–N relationships or attributed relationships), then when either an origin or destination object and its relationships are deleted, the rows corresponding to those relationships are deleted from the relationship table.

Note: Since simple relationship classes set the foreign key to Null when an origin feature is deleted, orphaned objects can exist in the relationship's destination class. This is allowed because simple relationship classes are designed to related objects that can exist independently of each other. In order to identify orphaned destination objects in a simple relationship class, relationship rules must be setup to prevent orphaned destination objects. Once the rules are set up the Validate Features tool will identify any orphaned destination objects. To learn more about relationship rules see: Creating relationship rules.
Creating new related objects

In ArcMap, you can select an object, then use the Attributes dialog box to create a new nonspatial object in a related class. When this new object is created, all its attributes are populated with their appropriate default values, and a relationship is established back to the object from which it was created. You can only create nonspatial objects in this way; you cannot create new features.

If the relationships are maintained using primary and foreign keys, the foreign key in the destination object is populated with the primary key of the origin object, regardless of whether the origin or destination object is created using the Attributes dialog box. If the relationships are maintained as rows in a relationship table (M–N relationships, attributed relationships), a new row is added to the relationship class's table.

The following set of tables shows that when you use the Attributes window to create new related objects, a relationship is created back to the object from which it was created. If the relationships are maintained using primary and foreign keys, the foreign key in the destination object is populated with the primary key of the origin object.

Editing objects in a composite relationship class

Composite relationships have some specialized behavior. When editing the objects that participate in a composite relationship, this behavior carries over to the editing process. Edits made to the origin object in a composite relationship often directly affect its related destination objects. This behavior is partially dependent on relationship class messaging.

By default, composite relationship classes have forward messaging—that is, when the origin object in a composite relationship is edited, it sends messages to its related destination objects. The related objects will respond to that messaging in a standard way: If the destination objects are nonspatial objects, they will not change. However, if the destination objects are features, when the origin object is moved, the destination objects will also move the same distance. If the origin object is rotated, the destination objects will be rotated by the same angle. Editing individual vertices of a feature's geometry is considered an update, not a move of the feature's geometry. In that case, the related object is not moved.

Like simple relationships, composite relationships also maintain referential integrity when objects are deleted, but they do this in a different way. When the origin object in a composite relationship is deleted, all of the objects related to it through that composite relationship are also deleted. This cascade deletion will happen whether messaging is set to forward, back, both, or none.

In the example below, the selected pole is the origin object and the transformer is the destination object.
The set of tables below demonstrates that when an origin object in a composite relationship is deleted, all destination objects related to it through a composite relationship are also deleted.

When a destination object is deleted, the relationship between it and the origin object is deleted; the origin object itself is not deleted or modified.

With feature-linked annotation, the link between each piece of annotation and the feature that it annotates is modeled as a composite relationship. The parent (or origin) in the relationship is the regular feature, and the child (or destination) is the associated annotation.

If you have many-to-many relationships that are modeled using a Join table, you can use the Table To Relationship Class geoprocessing tool to convert the table that links values between two other tables into an attributed relationship class.

You can add your attributed relationship class to ArcMap as a table. Once it’s in ArcMap, you can open the table and edit it like other tables. However you cannot edit the Foreign Key fields or add new rows unless you use the attribute editor.

Splitting features that participate in relationships

Splitting a single geodatabase feature into two separate features will maintain the original feature (but will update the geometry) and create one new feature. When a feature is split, the larger part will maintain the ObjectID of the original feature and the smaller part will be the new feature. In the case where the feature is split 50-50, the side of the feature with the start point of the line will remain as the original feature (original ObjectID) and the second half will become the new feature. This has implications when the feature being split has relationships with other objects in the database.

With simple relationships, when an origin feature is split, the relationships between the original feature and its related destination objects are deleted. When the new features are created from the split operation, both features will have the same primary key value and, therefore, are both related to the associated destination objects or features.

In the case of a composite relationship, the behavior is different. When the origin feature in a composite relationship is split, it does not delete the objects related to it through the composite relationship class because the original feature is still present. It is only the geometry of the original feature that is altered in the split operation.

When splitting a destination feature in either a simple or composite relationship, the relationship between the original feature and the related origin objects is not deleted. New relationships are created between the origin objects and the new feature that was a result of the split.
The behavior of splitting objects with relationships described here is the default behavior. You can override this behavior at the class level by writing a class extension that implements the IFeatureClassEdit interface. The IFeatureClassEdit interface has a property called CustomSplitPolicyForRelationship that allows you to specify how relationships are handled when features are split.

Related Topics
- Creating a relationship between selected features
- Editing the attributes of related features
- Validating features and relationships in ArcMap

Creating a relationship between selected features

This topic applies to ArcEditor and ArcInfo only.

You can use the Attributes window to establish a relationship between two selected features (or records in a stand-alone table).

Before adding a relationship between two objects, you must first create a relationship class between the feature classes or tables containing the objects you want to relate. To learn more about how to create relationship classes, see Creating a simple relationship class and Creating a composite relationship class.

If you have feature-linked annotation, you can follow these steps to link annotation to a feature. You must select both a feature and a piece of annotation. The annotation must be stored in the feature-linked annotation feature class, but the annotation does not necessarily need to be linked to another feature. Add Selected links the selected annotation to the selected feature. If the annotation was previously linked to another feature, that link will be removed.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Select the features between which you want to create relationships. The origin and the related feature (or record in a stand-alone table) should both be selected.
3. Click the Attributes button on the Editor toolbar.
4. Click the origin feature in the Attributes window.
5. Double-click the origin and related features or tables to expand their nodes. You can click Expand All Relationships In Branch to view all the related items.
6. Right-click the related feature class or table listed in the tree under the origin feature and click Add Selected.

Related Topics
- About editing relationships in ArcMap
- Editing the attributes of related features
- Validating features and relationships in ArcMap

Editing the attributes of related features

This topic applies to ArcEditor and ArcInfo only.

You can use the Attributes window to edit the attributes of related features or records in a stand-alone table.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the origin feature to select it.
3. Click the Attributes button on the Editor toolbar.
4. Click the origin feature in the Attributes window.
5. Double-click the origin and related features or tables to expand their nodes. (These procedures also work for relationships with stand-alone, nonspatial tables.)
6. If the related feature’s layer or table is not currently in the map, the icon next to it is displayed in gray. If you want to add the layer or table to ArcMap, right-click the entry for the related feature or table and click Add to Map. When the layer or table is in the map, its icon is colored.
7. Right-click the related item to open a menu.
   - Click Copy Attributes to copy the attributes.
   - Click Paste Attributes to paste the attributes.
Click **Select** to select the feature, or click **Unselect** to deselect it if it is already selected.

Click **Remove From Relationship** to delete the relationship between the related feature and the origin. This only removes the relationship; it does not actually delete the feature from its table.

Tip: If you want to remove all related features from the relationship, right-click the related layer's node and click **Remove All**.

Click **Delete** to delete the actual feature from the attribute table.

Click **Open Attribute Table** (opens the table and shows all records) or click **Open Table Showing Selection** (opens the table to the view showing only selected records) to view the attribute table of the related feature.

Click **Layer Properties** to open the Layer Properties dialog box.

8. To update any attribute values, type them in the grid while the related feature is selected.

Related Topics

About editing relationships in ArcMap
Creating a relationship between selected features
Validating features and relationships in ArcMap

ArcGIS provides tools to help you maintain the quality of your attribute data. Geodatabase attribute domains, subtypes, default values, relationship classes, and validation techniques help you maintain realistic values for the attributes of the features in your geodatabase.

Using attribute domains

Attribute domains are rules that describe the permissible values of a field type and are used to constrain the values allowed for any particular attribute for a table, feature class, or subtype. Each feature class or table can have a set of attribute domains that apply to different attributes. A given attribute domain can be shared by various feature classes and tables in a geodatabase. If a feature class has subtypes, each subtype can have a different domain associated with a given attribute. For example, a water mains feature class and a water laterals feature class can use the same domain for their ground surface type fields.

When you edit a field with a coded value domain, a drop-down list of all the domain values appears. For example, in a water network database, you might have a feature class that stores water transmission main lines. The coded value domain states that water transmission mains can have a diameter of only 10, 24, or 30 inches.

A range domain specifies a valid range of values for a numeric attribute. For example, you could have three subtypes of water mains: transmission, distribution, and bypass. Each of these could have a different range of valid pressures. Distribution water mains can have a pressure between 50 and 75 psi. For a distribution main object to be valid, its pressure value must be between 50 and 75 psi. A range domain specifies this range of values.

When you edit a field with a coded value domain, you can only choose from a list of all the domain values so you know that you are assigning the field a valid value. When editing fields with range domains, you need to check that the attributes are valid after you have entered them to ensure the value you entered is within the range.

Result on attribute domains after splitting and merging features

Often when editing data, a single feature is split into two features or two separate features are combined, or merged, into a single feature. For example, in a landbase database, a land parcel may be split into two separate land parcels due to rezoning. Similar zoning changes may require two adjacent parcels to be merged into a single parcel.

The behavior of an attribute's values when a feature is split is controlled by its split policy, and when two features are merged, an attribute's value is controlled by its merge policy. Each attribute domain has both a split policy and a merge policy. When a feature is split or merged, ArcGIS looks to these policies to determine what values the resulting feature or features have for a particular attribute.

Editing subtypes

Subtypes are classifications within a feature class or table. They allow you to logically group features based on a unique characteristic or behavior of the data. This characteristic or behavior is represented by the values of one field in the table. For example, for a table of hydrology, you could have subtypes for different types of waterways, such as creeks, streams, channels, canals, and rivers. For each of these subtypes, you could apply different topology rules, connectivity rules, default values, and relationship rules.

Subtypes are implemented as coded values, where integer values each represent a feature in the subtype. For example, in a water network database, there might be a feature class of water distribution network fittings. Rather than make different feature classes for each type of fitting, you can create one feature class with different subtypes for cap, coupling, plug, tee, and so on. Each subtype can have its own default values and domains.

Default attribute values
Feature templates allow you to assign default attribute values to new features you create using that template. When feature templates are created, they use any default values that have been specified in the geodatabase. If your feature class has geodatabase default values, they are populated automatically as the feature template’s default values. For example, when working with transmission main lines, if most of the water lines you are going to create will be 24”, you could set 24” as a default value for the DIAMETER field. This way, the DIAMETER attribute for any new feature you create becomes 24”. However, feature template field values may differ from their geodatabase default values, in effect overriding the geodatabase default value.

You can use geodatabase default values to assign default attribute values when editing existing features as well. For example, when splitting a line feature, geodatabase default values are populated in the split feature.

Relationship classes

If you have created relationship classes between feature classes and tables in your geodatabase, you can use ArcMap editing tools to take advantage of the relationships. Using ArcMap editing tools, you can find all the objects related to a particular object and edit them. For example, you can select a parcel and find the owner of that parcel, then edit some of the attributes of that owner without ever having to add the table that stores the owners to your ArcMap session.

You can also use ArcMap editing tools to establish a new relationship between objects or to break existing relationships between objects. For example, if a parcel changes ownership, you can delete the relationship between the parcel and its original owner, then establish a new relationship with its new owner.

Relationships are also used with feature-linked annotation. Editing a feature affects its linked annotation because of the composite relationship between them. When the origin feature is moved or rotated, the linked annotation also moves or rotates with it. When an origin feature is deleted from the geodatabase, the linked annotation feature is also deleted. The annotation is also updated when you change an attribute of the feature that the annotation text is based on. When you create new features, you can have new annotation created automatically.

Validating features

Once you have edited your attributes, validate your edits. The Validate Features command on the Editor menu checks for valid subtypes and domains and for other integrity rules (such as geometric networks and relationships). If there are any invalid features, you can fix them as necessary.

Beyond topology a geodatabase supports three broad types of validation rules: attribute validation rules, geometric network connectivity rules, and relationship rules. It is important to understand that these validation rules can be broken; in certain cases, a geodatabase permits invalid objects to be stored in the database.

For example, if you have an attribute rule stating that the valid pressure range for a water distribution main in your water network is between 50 and 75 psi, the geodatabase will not prevent you from storing a value outside that range. However, a distribution main with a water pressure outside this range will be an invalid object in the geodatabase. ArcMap has many editing tools that help you identify invalid features so you can correct them.

The exceptions are edge-edge connectivity rules, edge-junction connectivity rules, and coded value attribute rules. In these cases, ArcMap takes a more active role when editing features with these rules associated with them.

The general approach to the issue of validating features is that the validation process should not result in valid features being flagged as invalid (false negatives); it is, however, allowable to have features that are invalid being reported as valid (false positives). If the geodatabase did not enforce any validation, every feature would effectively be valid. When performing validation on a particular feature, the validation occurs in five steps:

1. Validate the subtype.
2. Validate the attribute rules.
3. Validate the network connectivity rules (if network feature).
4. Validate the relationship rules.
5. Perform custom validation (using optional class extension).

This strategy means the least expensive validation is performed first. The validation process stops once a feature is found to be invalid. So, for example, if a feature fails the validity test for check number 1, then checks 2, 3, 4, and 5 are never executed.

When checking connectivity and relationship rules, all associated rules must be valid. With network connectivity rules, if you specify one rule, you must specify them all. Thus, if a type of connectivity exists that doesn’t have an associated connectivity rule, the network feature is deemed invalid.

Related Topics
About maintaining spatial integrity while editing
Editing attributes with subtypes and attribute domains

Editing attributes with subtypes and attribute domains

Subtypes and coded value domains provide drop-down lists in the Attributes window so you know that you are assigning the field a valid value. Any default attribute values can be populated when you choose a new subtype. Fields with subtypes or coded value domains that are being used to symbolize the layer are shaded in green in the Attributes window; any other subtype or coded value domain fields are shaded in gray.

The Attributes window does not actively assist you with entering valid values for range domains; you need to check that the attributes are valid after you have entered them.

Subtypes and attribute domains are available only for geodatabase data.
Steps:

1. Click the Edit tool on the Editor toolbar and select the features.
2. Click the Attributes button on the Editor toolbar.
3. Click the feature to edit at the top of the window and click the coded value domain or subtype field at the bottom of the window.
4. Click the value from the drop-down list. When the field is being used to symbolize the layer, click the ellipsis button to change the value and update the symbology.

   Note: When you change a feature’s subtype, you are prompted about whether to change the existing values to the default values of the new subtype. If a field does not have a default value associated with it for the new subtype, its value remains unchanged.

5. To update a field with a range domain, simply type the new value.

Related Topics
About maintaining attribute integrity while editing

Validating features and relationships in ArcMap

Validate Features checks to ensure that all the attributes and relationships are valid and gives you the opportunity to fix any issues that violate the rules of your geodatabase.

Steps:

1. Click the Edit tool on the Editor toolbar.
2. Select the features you want to validate. You can only validate features from a geodatabase.
3. Click the Editor menu and click Validate Features.
   If your selection contains any invalid features, a message box appears with the number of invalid features. Only those features that are invalid will remain selected.
4. Click OK.
5. Click one of the invalid features.
6. Validate the features again.
   A message box appears telling you why the feature is invalid.
7. Click OK.
8. Click the Attributes button on the Editor toolbar.
9. Correct the invalid attribute values. If you are validating relationships, make the necessary edits to the relationships or the related objects to make the feature valid. This may involve adding and deleting relationships or altering the subtype of one or all of the features.
10. Select the features, validate, and perform edits until all features are valid.

Related Topics
About editing relationships in ArcMap
Creating a relationship between selected features
Editing the attributes of related features

About updating data using SQL

After loading a large amount of data into your geodatabase, you might want to update many attribute values at once. In the case of an ArcSDE geodatabase, you can do this by versioning the data, then editing in ArcMap to perform the update. The problem with this approach is that all the updated features will be in the delta tables; you should compress your database to move the updated features into the base tables.

Another approach is to perform bulk attribute updates, which can be done using SQL before the data is versioned. Using this approach means that these bulk
networks. Although each component of the geodatabase can act independently, the true power of the geodatabase becomes evident when you bring all these things together. You can use ArcMap editing capabilities to take advantage of the aspects of a geodatabase that help you maintain a valid database.

There are some rules that apply to performing updates with SQL. It is important to understand your data models so the attributes you update don't affect other objects in the database through relationships or other behavior. Using SQL for this operation without a thorough understanding of your data model may result in data corruption. For example, if you use SQL to modify the attributes of a feature from which text is derived for feature-linked annotation, the annotation features will not be messaged to update themselves, so the annotation and feature will be out of sync. When these attributes are updated in ArcGIS, all necessary behavior is executed.

The following is a list of some important guidelines when performing updates with SQL outside the context of ArcGIS:

- Never update records in SQL after your data has been versioned.
- When updating data using SQL, do not modify attributes that, through geodatabase behavior, affect other objects in the database.
- Never update the ObjectID field with SQL.
- Never update the Enabled or AncillaryRole field or a weight field for a geometric network feature class using SQL. When these fields are updated through ArcGIS, it results in changes to the geometric network topology tables that SQL does not trigger.
- Never update the Element, SymbolID, TextString, FontName, FontSize, Bold, Italic, Underline, VerticalAlignment, HorizontalAlignment, XOffset, YOffset, Angle, FontLeading, WordSpacing, CharacterWidth, CharacterSpacing, FlipAngle, or Override fields of an annotation feature class. When these fields are updated through ArcGIS, it results in changes to the feature's BLOB element that SQL will not trigger. When you update these fields using SQL outside ArcGIS, the text symbol fields associated with each annotation feature for all of the updated rows won't update.

### About maintaining spatial integrity while editing

The ArcMap editing environment provides several ways to maintain the attribute integrity of your data. For example, you can use topology to edit shared geometry to maintain coincident borders. In addition, ArcMap is tightly integrated with the various special aspects of the geodatabase, such as topology and geometric networks. Although each component of the geodatabase can act independently, the true power of the geodatabase becomes evident when you bring all these things together. You can use ArcMap editing capabilities to take advantage of the aspects of a geodatabase that help you maintain a valid database.

### Editing shared geometry

You might find that you need to edit the geometry of multiple features at once. Using the topological association among features, you can move boundaries and vertices shared by multiple features. For example, you can move a border to update two forest polygons or, as seen in the graphic below, move a corner vertex and update several parcel polygons and a few lot boundaries at the same time.

Within the editing environment, you can create a map topology that enables you to edit the shared parts of features. A map topology is a temporary set of topological relationships between coincident parts of simple features on a map. The primary types of geometry that are acted on when editing a map topology are edges, which are line segments that define lines or polygons, and nodes/points at the end of an edge. When you move a node in a topology, all the edges that connect to it are stretched to stay connected to the node. When you move an edge, edge segments stretch to maintain the connection of shared endpoint nodes to their previous location. You can also move a node and a connected edge without stretching the other connected edge by temporarily splitting the topological relationship between the node and the other shared edges.

When creating a map topology, you need to specify which layers will participate in the topology and a cluster tolerance that is used to determine which parts of the features are coincident and which edges and nodes in the topology are shared.

### Maintaining spatial integrity in geodatabases

Beyond editing shared geometry, topology within a geodatabase allows you to maintain additional spatial integrity by specifying a set of rules to apply to your data, allowing you to find and fix any errors and validate relationships.

### Geodatabase topology

Topology is a collection of rules that, coupled with a set of editing tools and techniques, enables the geodatabase to more accurately model geometric relationships. ArcGIS implements topology through a set of rules that define how features may share a geographic space and a set of editing tools that work with features that share geometry in an integrated fashion. A topology is stored in a geodatabase as one or more relationships that define how the features in one or more feature classes share geometry. The features participating in a topology are still simple feature classes—rather than modifying the definition of the feature class, a topology serves as a description of how the features can be spatially related.

For example, in the graphic below, the coral-colored squares and lines indicate errors in topology, which is one way of ensuring spatial integrity. These may be locations where there is a line that does not connect to another line (known as a dangle), a polygon that does not contain a point within its boundary, or some other violation of a rule imposed on the geodatabase.
ArcGIS provides a set of editing tools that help find and fix topology rule violations. Violations of topology rules are initially marked as errors in the topology, but where appropriate, you can mark them as exceptions. Within the editing environment, you can use the tools on the Topology toolbar to locate errors, fix errors interactively or automatically, validate edits, and create new features from the geometry of existing features. Dirty areas track the places where topology rules may have been violated during editing. Depending on your workflow, you can validate topology rules and clean up dirty areas after each edit session or on a schedule.

**Geometric networks**

Geometric networks also store various mechanisms and behaviors that maintain the topological connectivity between their component features. Geometric networks consist of edge network features and junction network features. An example of an edge feature is a water main, and a junction feature might be a valve. Edges must be connected to other edges through junctions.

Geometric network connectivity rules constrain the type of network features that may be connected to one another and the number of features of any particular type that can be connected to features of another type. By establishing these rules along with other rules, such as attribute domains, you can maintain the integrity of the network data in the database. At any time, you can selectively validate features in the database and generate reports as to which features in the network are invalid—that is, are violating one of the connectivity or other rules.

Edit operations that involve adding, deleting, and moving geometric network features can all affect the connectivity of a geometric network. Connectivity between network features is maintained on the fly as you create, delete, and modify network features. For example, when a network edge or junction is moved, the network features to which it is connected respond by stretching and adjusting themselves to maintain connectivity. You can use the geometric network editing tools to modify, rebuild, and verify connectivity.

**Related Topics**

*About maintaining attribute integrity while editing*

*About editing shared geometry*

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**About editing shared geometry**

To work with shared geometry, you will need to have a map or geodatabase topology on your data. Then, you can select edges and nodes that may be shared by more than one feature, modify them, and have all the features that share the node or edge be updated.

The Topology Edit tool allows you to select and modify edges and nodes that may be shared by more than one feature. It also allows you to select and move the individual vertices that define the shape of edges. When you move vertices, edges, or nodes with the Topology Edit tool, all the features that share the node or edge are updated.

**Editing shared edges**

When editing topological features, you often have a choice of several ways of doing a particular task. For example, suppose you manage a forest and there are two polygon feature classes, Forest and Stands, in your forest dataset. The two images below show the forest and stand polygons.

Forest polygon

Stands polygons

The Forest and Stands polygons are related by three topology rules: Stands must not overlap, Forest must cover Stands, and Stands must cover Forest. These rules prevent Stands polygons from overlapping, since no area can be in two stands at once. They also prevent stands from extending outside the official boundary of the whole forest or the forest boundary from covering an area not in a stand.

Suppose you are editing the Stands feature class and need to change the boundary between two of the stands. You could start editing; use the Topology Edit tool to select the shared edge; double-click the edge to edit its vertices; then add, remove, and move vertices along that edge to shape it to fit the new boundary.

You could also use the Topology Edit tool to modify edges shared by the Stands and Forest polygons. For example, suppose the actual boundary of the forest has been determined to be 150 meters east and 20 meters north of the corner where two stand features meet at the edge of the forest. You could use the Topology Edit tool to select the topology node at this intersection of features and move it to the correct location, either manually or by right-clicking the node, clicking Move, and entering the delta x,y value. The stand and forest polygons will both have their boundaries updated.

**Modifying and reshaping shared edges**

In addition to editing topology elements with the Topology Edit tool, you can also modify and reshape a selected topology edge using an edit sketch. The Modify
Edge and Reshape Edge tools allow all features that share the edge to be updated at the same time. Modify Edge takes the selected edge and makes an edit sketch from it. You can use the standard editing tools to insert, delete, or move the vertices that make up the edge, although you cannot move the endpoints when modifying edges. With the Reshape Edge tool, you can use the basic editing tools to create a new line to replace an existing edge line.

Using regular editing tools to edit features in a topology

You can also use the regular editing tools to edit individual features that participate in a topology. When you edit topologically related features using the regular editing tools, you are only modifying one feature at a time. If this feature shares geometry with other features, the shared geometry is not updated. If the edits create a violation of the geodatabase topology rules, you can use the Error Inspector to find the error and the Fix Topology Error tool to fix the error. The Fix Topology Error tool allows you to right-click an error and choose which fix to use for the error.

For example, if you use the Reshape Feature tool to reshape a selected polygon's border, only that feature will be updated. Since the border of the adjacent polygon was not updated at the same time, you can end up with overlapping polygons. Such an error will be discovered when you validate your topology edits. You can then use the Fix Topology Error tool to merge the error with one of the features and remove the overlap.

When the topology is validated, the overlapping area is discovered as a topology error.

The overlap is removed by applying the Merge topology error fix. The overlap is merged into feature 1, and features 1 and 2 now are adjacent and share a border.

Related Topics

Editing shared geometry

About creating a map topology

A map topology is a topology that you can impose on simple features on a map during an edit session. Although you cannot create or edit geodatabase topologies with ArcView (only ArcEditor and ArcInfo), you can create and edit map topologies in ArcView.

A map topology allows you to simultaneously edit simple features that overlap or touch each other in ArcMap. You can use the Topology Edit, Modify Edge, and
Reshape Edge tools on the Topology toolbar to edit the features in a map topology. The features can be in one or more feature classes and may have different geometries. Line features and the outlines of polygon features become topological edges when you create a map topology. Point features, the endpoints of lines, and the places where edges intersect become nodes.

A map topology can be applied to simple features in a shapefile or simple feature classes in a geodatabase. The feature classes that participate in the map topology must be in the same folder or geodatabase. A map topology cannot be applied to feature classes that participate in a geometric network.

A map topology creates topological relationships between the parts of features that are coincident. You can specify the feature classes that you want to participate in the map topology. You can also choose the distance, or cluster tolerance, that defines how close together edges and vertices must be in order to be considered coincident. When you create a map topology, the cluster tolerance that you specify is used to determine which parts of the features are coincident and which edges and nodes in the topology are shared. The cluster tolerance is typically a small actual ground distance. Setting large cluster tolerances can result in features being collapsed or distorted when vertices with a given feature snap together.

There are two steps to creating a map topology:

1. Specify which feature classes on the map will participate in the topology.
2. Specify a cluster tolerance. The cluster tolerance is a distance within which features will be coincident.

When you have defined a map topology, it is shown on the Topology toolbar in the Topology drop-down list as an entry called <Map Layers>. Only one map topology can be defined for an edit session.

**Editing a map topology**

After you create a map topology, you can use the Topology Edit tool to edit the edges and nodes shared by the features. Editing an edge or node shared by two or more different features results in each feature being modified. This lets you move a border to update two forest polygons or move a corner vertex and update several parcel polygons and a few lot boundaries at the same time.

You do not specify any topology rules for a map topology. All edges or vertices of features in the map topology that fall within the cluster tolerance are considered to be topologically shared. You edit shared edges and vertices in a map topology in the same way and with the same tools as you would edit a geodatabase topology. Since there are no topology rules, there is no need to validate a map topology, and there is no creation of error features.

**Map topology versus geodatabase topology**

Geodatabase topology is a data object created and stored in a geodatabase. A geodatabase topology defines a set of rules about the relationships between feature classes in a feature dataset. Geodatabase topology is created in the Catalog window or ArcCatalog and can be added to ArcMap as a layer, just like any other data. After editing has been performed on the feature classes, you validate the geodatabase topology to see if the edits break any of the topology’s rules. Any errors can be fixed or marked as exceptions. An ArcEditor or ArcInfo license is required to create, edit, or validate geodatabase topology. To use geodatabase topology when you edit data from a geodatabase, the geodatabase topology in which the data participates must be in your map. If you are using an ArcView license, you can open a map containing a geodatabase topology, but you cannot start an edit session on feature classes that participate in a geodatabase topology.

Map topology is temporary and only lasts for the duration of your edit session. Unlike geodatabase topologies, map topologies are not stored permanently or represented as layers in the map. You do not specify any topology rules for a map topology. Since there are no topology rules, there is no need to validate a map topology, and there is no creation of error features.

**When to use a map topology**

Map topology is useful because it enables you to perform topological editing in situations where you cannot use geodatabase topology:

- Map topology can be defined for shapefiles, which cannot participate in a geodatabase topology.
- If you are using an ArcView license, you cannot create or edit geodatabase topology, but you can define map topology for any data on which you can start an edit session (such as shapefiles and simple feature classes in file and personal geodatabases). You cannot create map topology on feature classes that participate in a geodatabase topology because you need an ArcEditor or ArcInfo license to edit them.
- If you are using an ArcEditor or ArcInfo license, you can create a map topology for any shapefile or feature class data, including feature classes that participate in a geodatabase topology. For example, you might want to perform topological editing on two feature classes that participate in two separate geodatabase topologies. In this case, you can define a map topology containing both of these feature classes.

**Related Topics**

Creating a map topology

---

**Steps:**

1. Click the **Map Topology** button on the **Topology** toolbar.
2. Check the feature classes that will participate in the map topology. All the layers in your current edit session that can participate in the map topology are listed on the dialog box. Layers representing annotation and dimension feature classes and feature classes that participate in a geometric network cannot be included in a map topology and will not be listed.

   **Note:** You cannot edit layers that are projected on the fly using a map topology. To create a map topology, all the layers must have the same coordinate system, which must match the coordinate system of the data frame.

3. Optionally, set a cluster tolerance for the map topology. The default cluster tolerance is the minimum possible cluster tolerance. Increasing the cluster tolerance may cause more features to be snapped together and considered coincident, but this may reduce the spatial accuracy of your data.
4. Click **OK**.

**Related Topics**

About creating a map topology
Splitting a topology edge with the selection anchor

You can temporarily add new topology nodes to split edges. This simply splits the edge for the topology; it does not break the feature into two features. This can be useful when you want to move one part of an edge without affecting other parts of the edge or when you want to create a new node to which to snap.

**Steps:**
1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. Click the edge you want to split.
3. Hold down the CTRL key and drag the selection anchor to the place where you want to split the edge.
4. Right-click and click **Split Edge At Anchor**.

**Related Topics**
- Splitting a topology edge at a distance from an endpoint
- Merging connected edges within a feature
- Splitting a topology edge with the selection anchor

Splitting a topology edge at a distance from an endpoint

You can temporarily add new topology nodes to split edges. This simply splits the edge for the topology; it does not break the feature into two features. This can be useful when you want to move one part of an edge without affecting other parts of the edge or when you want to create a new node to which to snap.

**Steps:**
1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. Right-click the edge you want to split.
3. Right-click and click **Split Edge At Distance**.
   - Arrows appear along the edge to indicate the edge direction. The edge can be split at a distance or a percentage of its length, measured from the start point or the endpoint of the edge.
4. Optionally, click the button to specify a percentage of the edge length.
5. Type a distance or a percentage if you choose to make the split at a percentage of the edge length.
6. Optionally, click the button to indicate that you want the distance to be measured from the endpoint of the edge.
7. Click **OK**.

**Related Topics**
- Merging connected edges within a feature
- Splitting a topology edge at a distance from an endpoint
- Rebuilding the topology cache

Rebuilding the topology cache

When you select a topology element using the Topology Edit tool, ArcMap creates a topology cache. The topology cache stores the topological relationships between edges and nodes of the features that fall within the current display extent. If you are editing with the map zoomed in to a small area and you go back to a previous extent, some of the features in the new extent may not be in the topology cache. You can rebuild the topology cache to include these features. You can also rebuild the topology cache to remove temporary topology nodes that you created for snapping and editing.

**Steps:**
1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. You can select either edges or nodes. Selected topology elements are displayed in magenta.
   - Click the edge you want to select. You can ensure that nodes are not selected by holding down the E key while selecting the edge or dragging a box across it.
   - Click the node you want to select. You can ensure that edges are not selected by holding down the N key while selecting the node or dragging a box around it.
3. Drag a box to select multiple edges and nodes.

**Related Topics**
- Deselecting topology edges and nodes
- Rebuilding the topology cache

Selecting topology edges and nodes

**Steps:**
1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. You can select either edges or nodes. Selected topology elements are displayed in magenta.
   - Click the edge you want to select. You can ensure that nodes are not selected by holding down the E key while selecting the edge or dragging a box across it.
   - Click the node you want to select. You can ensure that edges are not selected by holding down the N key while selecting the node or dragging a box around it.
   - Drag a box to select multiple edges and nodes.
Deselecting topology edges and nodes

When you are editing topological edges and nodes, you may sometimes want to deselect some elements. You can deselect a given element by holding the SHIFT key and clicking the element, or deselect all selected edges or nodes by clearing all selected topology elements.

**Steps:**

1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. You can deselect a single element or all topology elements.
   - To deselect a single edge or node, hold down the SHIFT key and click a selected edge or node.
   - To deselect all elements, right-click and click **Clear Selected Topology Elements**. You can also click away from edges and nodes with the Topology Edit tool to clear the selection.

**Related Topics**

- Selecting topology edges and nodes

Moving a topology node

**Steps:**

1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. Click the node you want to move. You can ensure that edges are not selected by holding down the N key while selecting the node.
3. Drag the node.

**Related Topics**

- Moving a shared node without stretching all connected edges (split-move)
- Moving a topology edge
- Moving a topology element relative to its current location (delta x,y)
- Moving a topology element to an exact x,y location (absolute x,y)
- Snapping to topology nodes

Moving a topology edge

**Steps:**

1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. Click the edge you want to move. You can ensure that nodes are not selected by holding down the E key while selecting the edge.
3. Drag the edge to a new location. Edge segments stretch to connect the edge's endpoint nodes to their previous positions, where they are shared.

**Related Topics**

- Moving a shared node without stretching all connected edges (split-move)
- Moving a topology element relative to its current location (delta x,y)
- Moving a topology element to an exact x,y location (absolute x,y)
- Moving a topology node
- Snapping to topology nodes

Moving a topology element to an exact x,y location (absolute x,y)

You can move a node or edge to an exact x,y location using the **Move To** command.

You can specify the location as a longitude-latitude coordinate pair, a Military Grid Reference System (MGRS) location, a U.S. National Grid (USNG) location, or a Universal Transverse Mercator (UTM) coordinate. If you are entering a coordinate pair, you see two boxes on the dialog box, compared with one box for grid locations.

For more information on valid formats when entering locations, see About distance units and editing.

**Steps:**

1. Click the **Topology Edit** tool on the **Topology** toolbar.
2. Click the node or edge you want to move.
3. Right-click and click **Move To**. If you are moving an edge or more than one topology element, the Move To command moves the selection anchor to the specified location and moves the topology element to maintain its position relative to the selection anchor.
4. Click the **Units** button and click the unit you want to use to enter the location.
5. Type the coordinates or the grid location of the place you want to move the topology element and press ENTER.
Related Topics
About distance units and editing
Moving a shared node without stretching all connected edges (split-move)
Moving a topology edge
Moving a topology element relative to its current location (delta x,y)
Moving a topology node
Snapping to topology nodes

Moving a topology element relative to its current location (delta x,y)

One or more topology edges or nodes can be moved by specifying a delta x,y location.

Steps:
1. Click the Topology Edit tool on the Topology toolbar.
2. Click the node or edge you want to move.
3. Right-click and click Move. If you are moving an edge or more than one topology element, the Move command moves the selection anchor to the specified location and moves the topology element to maintain its position relative to the selection anchor.
4. Type an x and a y distance to move the topology element relative to its current location and press ENTER.

Related Topics
About distance units and editing
Moving a shared node without stretching all connected edges (split-move)
Moving a topology edge
Moving a topology element to an exact x,y location (absolute x,y)
Moving a topology node
Snapping to topology nodes

Moving a shared node without stretching all connected edges (split-move)

When you move a node, all the edges that connect to it are stretched to stay connected to the node. When you move an edge, edge segments stretch to maintain the connection of shared endpoint nodes to their previous location. Sometimes you may want to move a node and a connected edge without stretching the other connected edge. Moving a shared endpoint node of an edge requires you to temporarily split the topological relationship between the node and the other shared edges, then reestablish it. This is known as a split-move of the node.

Steps:
1. Click the Topology Edit tool on the Topology toolbar.
2. Click the edge to which you want to move the endpoint node.
3. Hold down the CTRL key and drag the selection anchor to the place where you want to snap the edge's endpoint node.
4. Right-click and click Split Edge At Anchor. Splitting the edge creates a new node to which you can snap the endpoint node of the edge.
5. Hold down the N key and drag a rectangle around the endpoint node you want to move. The N key limits the Topology Edit tool selection to nodes.
6. Hold down the S key and drag the node that you want to move to the node you created. The S key changes the pointer to the split-move pointer.

The endpoint node of the edge is moved to the new location, and the topology is maintained. If you do not snap the node to the new node or the edge, the split-move is canceled.

Turn on the option to stretch a feature's geometry proportionally (Editor > Options > General tab) to move all the vertices back to the last node.

Related Topics
Moving a topology edge
Moving a topology element relative to its current location (delta x,y)
Moving a topology element to an exact x,y location (absolute x,y)
Moving a topology node
Snapping to topology nodes

Reshaping a topology edge

When you edit edges with the Reshape Edge tool, all the features that share the edge are updated at the same time.

Steps:
You can also control whether or not the shared features are affected by edits you make to a given edge or node. By default, all features that share a topology using the Show Shared Features command.

Topology elements can be shared by multiple features. You can find out which features share a given topology edge or node by selecting the edge or node and element are updated when you edit that element with the Topology Edit tool. However, when you turn off a feature on the Shared Features dialog box, the feature is not modified if you edit the topology element.

When you edit vertices and segments on a topology edge with the Topology Edit tool, all the features that share the edge are updated at the same time. The Edit Vertices toolbar appears to help you edit the edge.

Steps:
1. Click the Topology Edit tool on the Topology toolbar.
2. Click an edge to select it.
3. Click the Reshape Edge tool on the Topology toolbar.
4. Click the map to create a line according to the way you want the feature reshaped. You can snap the sketch to the selected edge or cross it to indicate where to start and stop reshaping. The sketch must cross (or touch the edge) at least two times for it to be reshaped.
5. To change the shape of the sketch segment, click a construction method type on the Editor toolbar or on the Feature Construction mini toolbar.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insert a vertex</td>
<td>Click the Add Vertex tool on the Edit Vertices toolbar. You can also right-click a segment and click Insert Vertex, or hold down the A key and click.</td>
</tr>
<tr>
<td>Insert a vertex and move it in one step</td>
<td>Hold down A and click and drag the new vertex.</td>
</tr>
<tr>
<td>Delete a vertex</td>
<td>Click the Delete Vertex tool on the Edit Vertices toolbar and click the vertex to delete. You can also right-click a vertex and click Delete Vertex, or hold down the D key and click.</td>
</tr>
<tr>
<td>Delete multiple vertices</td>
<td>Click the Delete Vertex tool on the Edit Vertices toolbar and drag a box around the vertices to delete. You can also hold down D and drag a box, or press BACKSPACE, to delete selected vertices.</td>
</tr>
<tr>
<td>Move a vertex by dragging it</td>
<td>Select one or more vertices and drag and drop them to the new location.</td>
</tr>
<tr>
<td>Move a vertex by a relative x,y distance</td>
<td>Right-click the vertex and click Move To.</td>
</tr>
<tr>
<td>Move a vertex to an absolute x,y location</td>
<td>Select one or more vertices, right-click, then click Move.</td>
</tr>
<tr>
<td>Change the segment type</td>
<td>Right-click a segment; point to Change Segment; then click either Straight, Circular Arc, or Bézier.</td>
</tr>
<tr>
<td>Change the shape of an arc segment</td>
<td>Click and drag an arc segment, or press the R key and type a radius.</td>
</tr>
</tbody>
</table>

4. Right-click anywhere on the map and click Finish Sketch.

Related Topics
Excluding features from shared topological edits
Modifying a topology edge

Excluding features from shared topological edits

Topology elements can be shared by multiple features. You can find out which features share a given topology edge or node by selecting the edge or node and using the Show Shared Features command.

You can also control whether or not the shared features are affected by edits you make to a given edge or node. By default, all features that share a topology element are updated when you edit that element with the Topology Edit tool. However, when you turn off a feature on the Shared Features dialog box, the feature is not modified if you edit the topology element.

Steps:
1. Click the Topology Edit tool on the Topology toolbar.
2. Click an edge or node to select it.
3. Click Show Shared Features on the Topology toolbar.
4. Click the plus sign to show all the features in a given layer that are shared. You can hold down CTRL and click any check box to check or uncheck all the boxes. A given topology element can be shared by features in multiple layers, so more than one layer might be listed.
5. Click a feature in the list to make it flash on the map.
6. To exclude a feature from topological edits, uncheck a feature in the list to turn off topology element sharing. Edits that you make with the Topology Edit tool to the topology element do not update this feature. The unshared status of the feature is temporary and lasts only while the topology element is selected.
7. Close the Shared Features dialog box.

Related Topics
- Modifying a topology edge
- Reshaping a topology edge

Merging connected edges within a feature

If you have split a topology edge, use Merge Connected Edges to merge the edge and remove the inserted node.

Steps:
1. Click the Topology Edit tool on the Topology toolbar.
2. Click an edge of a feature that has been topologically split by adding nodes.
3. Right-click and click Merge Connected Edges. The selected edge is merged with the adjacent edge, and the topology node is removed.

Related Topics
- Splitting a topology edge at a distance from an endpoint

Changing the symbology for topology elements

You can change the way topology elements are drawn on the map. Topology nodes and edges are drawn with point and line symbols of a given color by default, and deselected topology nodes are not displayed. You can change the symbol for selected topology nodes and edges and for deselected nodes. Turning on the symbol for unselected nodes can make it easier to identify nodes to which you want to snap when you are editing topology elements.

Steps:
1. Click the Editor menu and click Options.
2. Click the Topology tab.
3. Click the topology elements symbology buttons to change the way topology elements look on the map.
4. To show the nodes in the topology cache that have not been selected, check Unselected Nodes.
5. Click OK.

Related Topics
- Changing symbology for topology dirty areas
- Changing the symbology for selected error features
- Changing topology error and exception symbology

Selecting the features that share a topology element

You can select a topology edge or node, then ArcMap can select the features that share the element.

Steps:
1. Click the Topology Edit tool on the Topology toolbar.
2. Right-click and click Select Shared Features.
The features that share the topology element are selected.

Geodatabase topology rules and topology error fixes

This topic applies to ArcEditor and ArcInfo only.

License: You can create simple, temporary topological relationships between features in ArcView. Creating or editing geodatabase topology requires an ArcEditor or ArcInfo license.

There are many topology rules you can implement in your geodatabase, depending on the spatial relationships that are most important for your organization to maintain. You should carefully plan the spatial relationships you will enforce on your features. Some topology rules govern the relationships of features within a given feature class, while others govern the relationships between features in two different feature classes or subtypes. Topology rules can be defined between subtypes of features in one or another feature class. This could be used, for example, to require street features to be connected to other street features at both ends, except in the case of streets belonging to the cul-de-sac or dead-end subtypes.

Many topology rules can be imposed on features in a geodatabase. A well-designed geodatabase will have only those topology rules that define key spatial relationships needed by an organization.

Most topology violations have fixes that you can use to correct errors. Some topology rules, however, have no predefined fixes. Once you have discovered the
### Polygon rules

<table>
<thead>
<tr>
<th>Topology rule</th>
<th>Rule description</th>
<th>Potential fixes</th>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td><strong>Must Be Larger Than Cluster Tolerance</strong></td>
<td>Requires that a feature does not collapse during a validate process. This rule is mandatory for a topology and applies to all line and polygon feature classes. In instances where this rule is violated, the original geometry is left unchanged.</td>
<td><strong>Delete:</strong> The Delete fix removes polygon features that would collapse during the validate process based on the topology’s cluster tolerance. This fix can be applied to one or more Must Be Larger Than Cluster Tolerance errors.</td>
<td>Any polygon feature, such as the one in red, that would collapse when validating the topology is an error.</td>
</tr>
<tr>
<td><strong>Must Not Overlap</strong></td>
<td>Requires that the interior of polygons not overlap. The polygons can share edges or vertices. This rule is used when an area cannot belong to two or more polygons. It is useful for modeling administrative boundaries, such as ZIP Codes or voting districts, and mutually exclusive area classifications, such as land cover or landform types.</td>
<td><strong>Subtractor:</strong> The Subtractor removes the overlapping portion of geometry from each feature that is causing the error and leaves a gap or void in its place. This fix can be applied to one or more selected Must Not Overlap errors.</td>
<td><img src="image1.png" alt="" /></td>
</tr>
<tr>
<td><strong>Must Not Have Gaps</strong></td>
<td>The rule requires that there are no voids within a single polygon or between adjacent polygons. All polygons must form a continuous surface. An error will always exist on the perimeter of the surface. You can either ignore this error or mark it as an exception. Use this rule on data that must completely cover an area. For example, soil polygons cannot include gaps or form voids—they must cover an entire area.</td>
<td><strong>Create Feature:</strong> The Create Feature fix creates a new polygon feature out of the error shape and removes the portion of overlap from each of the features, causing the error to create a planar representation of the feature geometry. This fix can be applied to one or more selected Must Not Overlap errors.</td>
<td><img src="image2.png" alt="" /></td>
</tr>
<tr>
<td><strong>Must Not Overlap With</strong></td>
<td>Requires that the interior of polygons in one feature class (or subtype) must not overlap with the interior of polygons in another feature class (or subtype). Polygons of the two feature classes can share edges or vertices or be completely disjointed. This rule is used when an area cannot belong to two separate feature classes. It is useful for combining two mutually exclusive systems of area classification, such as zoning and water body type, where areas defined within the zoning class cannot also be defined in the water body class and vice versa.</td>
<td><strong>Subtractor:</strong> The Subtractor removes the overlapping portion of each feature that is causing the error and leaves a gap or void in its place. This fix can be applied to one or more selected Must Not Overlap With errors.</td>
<td><img src="image3.png" alt="" /></td>
</tr>
<tr>
<td><strong>Must Be Covered By Feature Class Of</strong></td>
<td>Requires that a polygon in one feature class (or subtype) must share all of its area with polygons in another feature class (or subtype). An area in the first feature class that is not covered by polygons from the other feature class is an error. This rule is used when an area of one type, such as a state, should be completely covered by areas of another type, such as counties.</td>
<td><strong>Create Feature:</strong> The Create Feature fix creates a new polygon feature out of the portion of overlap from the existing polygon so the boundary of each feature from both feature classes is the same. This fix can be applied to one or more selected Must Be Covered By Feature Class Of errors.</td>
<td><img src="image4.png" alt="" /></td>
</tr>
<tr>
<td><strong>Must Cover Each Other</strong></td>
<td>Requires that the polygons of one feature class (or subtype) must share all of their area with the polygons of another feature class (or subtype). Polygons may share edges or vertices. Any area defined in either feature</td>
<td><strong>Subtractor:</strong> The Subtractor removes the overlapping portion of each feature that is causing the error so the boundary of each feature from both feature classes is the same. This fix can be applied to one or more selected Must Cover Each Other errors.</td>
<td><img src="image5.png" alt="" /></td>
</tr>
</tbody>
</table>
class that is not shared with the other is an error. This rule is used when two systems of classification are used for the same geographic area, and any given point defined in one system must also be defined in the other. One such case occurs with nested hierarchical datasets, such as census blocks and block groups or small watersheds and large drainage basins. The rule can also be applied to nonhierarchically related polygon feature classes, such as soil type and slope class.

<table>
<thead>
<tr>
<th>Polygon rules</th>
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<tbody>
<tr>
<td><strong>Must Be Covered By</strong></td>
</tr>
<tr>
<td><strong>Create Feature:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line rules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contains Point</strong></td>
</tr>
<tr>
<td><strong>Create Feature:</strong></td>
</tr>
</tbody>
</table>

The top polygon is an error because it does not contain a point.

<table>
<thead>
<tr>
<th>Polygon rules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contains One Point</strong></td>
</tr>
<tr>
<td><strong>Create Feature:</strong></td>
</tr>
</tbody>
</table>

The top polygon is an error because it contains more than one point. Points are errors when they are outside a polygon.
<table>
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<th>Topology rule</th>
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</thead>
<tbody>
<tr>
<td><strong>Must Be Larger Than Cluster Tolerance</strong></td>
<td>Requires that a feature does not collapse during a validate process. This rule is mandatory for a topology and applies to all line and polygon feature classes. In instances where this rule is violated, the original geometry is left unchanged.</td>
<td><strong>Delete:</strong> The Delete fix removes line features that would collapse during the validate process based on the topology’s cluster tolerance. This fix can be applied to one or more Must Be Larger Than Cluster Tolerance errors.</td>
<td>Any line feature, such as these lines in red, that would collapse when validating the topology is an error.</td>
</tr>
<tr>
<td><strong>Must Not Overlap</strong></td>
<td>Requires that lines not overlap with lines in the same feature class (or subtype). This rule is used where line segments should not be duplicated, for example, in a stream feature class. Lines can cross or intersect but cannot share segments.</td>
<td><strong>Subtract:</strong> The Subtract fix removes the overlapping line segments from the feature causing the error. You must select the feature from which the error will be removed. If you have duplicate line features, select the line feature you want to delete from the Subtract dialog box. Note that the Subtract fix will create multipart features, so if the overlapping segments are not at the end or start of a line feature, you might want to use the Explode command on the Advanced Editing toolbar to create single-part features. This fix can be applied to one selected Must Not Overlap error only.</td>
<td></td>
</tr>
<tr>
<td><strong>Must Not Intersect</strong></td>
<td>Requires that line features from the same feature class (or subtype) not cross or overlap each other. Lines can share endpoints. This rule is used for contour lines that should never cross each other or in cases where the intersection of lines should only occur at endpoints, such as street segments and intersections.</td>
<td><strong>Subtract:</strong> The Subtract fix removes the overlapping line segments from the feature causing the error. You must select the feature from which the error will be removed. If you have duplicate line features, select the line feature you want to delete from the Subtract dialog box. Note that the Subtract fix will create multipart features, so if the overlapping segments are not at the end or start of a line feature, you might want to use the Explode command on the Advanced Editing toolbar to create single-part features. This fix can be applied to one Must Not Intersect error only.</td>
<td></td>
</tr>
<tr>
<td><strong>Must Not Intersect With</strong></td>
<td>Requires that line features from one feature class (or subtype) not cross or overlap lines from another feature class (or subtype). Lines can share endpoints. This rule is used when there are lines from two layers that should never cross each other or in cases where the intersection of lines</td>
<td><strong>Subtract:</strong> The Subtract fix removes the overlapping line segments from the feature causing the error. You must select the feature from which the error will be removed. If you have duplicate line features, select the line feature you want to delete from</td>
<td></td>
</tr>
<tr>
<td>Must Not Have Dangles</td>
<td>Extends: The Extend fix will extend the dangling end of line features if they snap to other line features within a given distance. If no feature is found within the distance specified, the feature will not extend to the distance specified. Also, if several errors were selected, the fix will simply skip the features that it cannot extend and attempt to extend the next feature in the list. The errors of features that could not be extended remain on the Error Inspector dialog box. If the distance value is 0, lines will extend until they find a feature to snap to. This fix can be applied to one or more Must Not Have Dangles errors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requires that a line feature must touch lines from the same feature class (or subtype) at both endpoints. An endpoint that is not connected to another line is called a dangle. This rule is used when line features must form closed loops, such as when they are defining the boundaries of polygon features. It may also be used in cases where lines typically connect to other lines, as with streets. In this case, exceptions can be made where the rule is occasionally violated, as with cul-de-sac or dead-end street segments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trim: The Trim fix will trim dangling line features if a point of intersection is found within a given distance. If no feature is found within the distance specified, the feature will not be trimmed, nor will it be deleted if the distance is greater than the length of the feature in error. If the distance value is 0, lines will be trimmed back until they find a point of intersection. If no intersection is located, the feature will not be trimmed and the fix will attempt to trim the next feature in error. This fix can be applied to one or more Must Not Have Dangles errors.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snap: The Snap fix will snap dangling line features to the nearest line feature within a given distance. If no line feature is found within the distance specified, the line will not be snapped. The Snap fix will snap to the nearest feature found within the distance. It searches for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Must Not Have Pseudonodes</strong></td>
<td>Requires that a line connect to at least two other lines at each endpoint. Lines that connect to one other line (or to themselves) are said to have pseudonodes. This rule is used where line features must form closed loops, such as when they define the boundaries of polygons or when line features logically must connect to two other line features at each end, as with segments in a stream network, with exceptions being marked for the originating ends of first-order streams.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Merge To Largest:</strong> The Merge To Largest fix will merge the geometry of the shorter line into the geometry of the longest line. The attributes of the longest line feature will be retained. This fix can be applied to one or more Must Not Have Pseudonodes errors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Merge:</strong> The Merge fix adds the geometry of one line feature into the other line feature causing the error. You must pick the line feature into which to merge. This fix can be applied to one selected Must Not Have Pseudonodes error.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Must Not Intersect Or Touch Interior** | Requires that a line in one feature class (or subtype) must only touch other lines of the same feature class (or subtype) at endpoints. Any line segment in which features overlap or any intersection not at an endpoint is an error. This rule is useful where lines must only be connected at endpoints, such as in the case of lot lines, which must split (only connect to the endpoints of) back lot lines and cannot overlap each other. |
| | **Subtract:** The Subtract fix removes the overlapping line segments from the feature causing the error. You must select the feature from which the error will be removed. If you have duplicate line features, choose the line feature you want to delete from the Subtract dialog box. The Subtract fix creates multipart features, so if the overlapping segments are not at the end or start of a line feature, you might want to use the Explode command on the Advanced Editing toolbar to create single-part features. This fix can be applied to one selected Must Not Intersect Or Touch Interior error only. |
| | **Split:** The Split fix splits the line features that cross one another at their point of intersection. If two lines cross at a single point, applying the Split fix at that location will result in four features. Attributes from the original features will be maintained in the split features. If a split policy is present, the attributes will be updated accordingly. This fix can be applied to one or more Must Not Intersect Or Touch Interior errors. |

| **Must Not Intersect Or Touch Interior With** | Requires that a line in one feature class (or subtype) must only touch other lines of another feature class (or subtype) at endpoints. Any line segment in which features overlap or any intersection not at an endpoint is an error. This rule is useful where lines from two layers must only be connected at endpoints. |
| | **Subtract:** The Subtract fix removes the overlapping line segments from the feature causing the error. You must select the feature from which the error will be removed. If you have duplicate line features, choose the line feature you want to delete from the Subtract dialog box. The Subtract fix creates multipart features, so if the overlapping segments are not at the end or start of a line feature, you might want to use the Explode command on the Advanced Editing toolbar to create single-part features. This fix can be applied to one selected Must Not Intersect Or Touch Interior With error. |
command on the Advanced Editing toolbar to create single-part features. This fix can be applied to one selected Must Not Intersect Or Touch Interior With error only.

**Split**: The Split fix splits the line features that cross one another at their point of intersection. If two lines cross at a single point, applying the Split fix at that location will result in four features. Attributes from the original features will be maintained in the split features. If a split policy is present, the attributes will be updated accordingly. This fix can be applied to one or more Must Not Intersect Or Touch Interior With errors.

<table>
<thead>
<tr>
<th>Feature Class Of</th>
<th>Must Not Overlap With</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Must Not Overlap With</strong></td>
<td>Requires that a line from one feature class (or subtype) not overlap with line features in another feature class (or subtype). This rule is used when line features cannot share the same space. For example, roads must not overlap with railroads or depression subtypes of contour lines cannot overlap with other contour lines.</td>
</tr>
<tr>
<td><strong>Subtract</strong></td>
<td>The Subtract fix removes the overlapping line segments from the feature causing the error. You must select the feature from which the error will be removed. If you have duplicate line features, choose the line feature you want to delete from the Subtract dialog box. The Subtract fix creates multipart features, so if the overlapping segments are not at the end or start of a line feature, you might want to use the Explode command on the Advanced Editing toolbar to create single-part features. This fix can be applied to one selected Must Not Overlap With error only.</td>
</tr>
<tr>
<td><img src="image" alt="Where the purple lines overlap is an error." /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature Class Of</th>
<th>Must Be Covered By</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Must Be Covered By Feature Class Of</strong></td>
<td>Requires that lines from one feature class (or subtype) must be covered by the lines in another feature class (or subtype). This is useful for modeling logically different but spatially coincident lines, such as routes and streets. A bus route feature class must not depart from the streets defined in the street feature class.</td>
</tr>
<tr>
<td><strong>Subtract</strong></td>
<td>The Subtract fix removes line segments that are not coincident with the boundary of polygon features. If the line feature does not share any segments in common with the boundary of a polygon feature, the feature will be deleted. This fix can be applied to one or more Must Be Covered By Boundary Of errors.</td>
</tr>
<tr>
<td><img src="image" alt="Where the purple lines do not overlap is an error." /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature Class Of</th>
<th>Must Be Inside</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Must Be Inside</strong></td>
<td>Requires that a line is contained within the boundary of an area feature. This is useful for cases where lines may partially or totally coincide with area boundaries but cannot extend beyond polygons, such as state highways that must be inside state borders and rivers that must be within watersheds.</td>
</tr>
<tr>
<td><strong>Delete</strong></td>
<td>The Delete fix removes line features that are not within polygon features. Note that you can use the Edit tool and move the line inside the polygon feature if you do not want to delete it. This fix can be applied to one or more Must Be Inside errors.</td>
</tr>
<tr>
<td><img src="image" alt="Where the purple lines do not overlap is an error." /></td>
<td></td>
</tr>
</tbody>
</table>
### Line rules

<table>
<thead>
<tr>
<th>Topology rule</th>
<th>Rule description</th>
<th>Potential fixes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endpoint Must Be Covered By</strong></td>
<td>Requires that the endpoints of line features must be covered by point features in another feature class. This is useful for modeling cases where a fitting must connect two pipes or a street intersection must be found at the junction of two streets.</td>
<td><strong>Create Feature</strong>: The Create Feature fix adds a new point feature at the endpoint of the line feature that is in error. The Create Feature fix can be applied to one or more Endpoint Must Be Covered By errors.</td>
<td>The square at the bottom indicates an error, because there is no point covering the endpoint of the line.</td>
</tr>
<tr>
<td><strong>Must Not Self-Overlap</strong></td>
<td>Requires that line features not overlap themselves. They can cross or touch themselves but must not have coincident segments. This rule is useful for features, such as streets, where segments might touch in a loop but where the same street should not follow the same course twice.</td>
<td><strong>Simplify</strong>: The Simplify fix removes self-overlapping line segments from the feature in error. Applying the Simplify fix can result in multipart features, which you can detect using the Must Be Single Part rule. The Simplify fix can be applied to one or more Must Not Self-Overlap errors.</td>
<td>The individual line feature overlaps itself, with the error indicated by the coral line.</td>
</tr>
<tr>
<td><strong>Must Not Self-Intersect</strong></td>
<td>Requires that line features not cross or overlap themselves. This rule is useful for lines, such as contour lines, that cannot cross themselves.</td>
<td><strong>Simplify</strong>: The Simplify fix removes self-overlapping line segments from the feature in error. Note that applying the Simplify fix can result in multipart features. You can detect multipart features using the Must Be Single Part rule. This fix can be applied to one or more Must Not Self-Intersect errors.</td>
<td></td>
</tr>
<tr>
<td><strong>Must Be Single Part</strong></td>
<td>Requires that lines have only one part. This rule is useful where line features, such as highways, may not have multiple parts.</td>
<td><strong>Explode</strong>: The Explode fix creates single-part line features from each part of the multipart line feature that is in error. This fix can be applied to one or more Must Be Single Part errors.</td>
<td>Multipart lines are created from a single sketch.</td>
</tr>
</tbody>
</table>

### Point rules

<table>
<thead>
<tr>
<th>Topology rule</th>
<th>Rule description</th>
<th>Potential fixes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Must Be Coincident With</strong></td>
<td>Requires that points in one feature class (or subtype) be coincident with points in another feature class (or subtype). This is useful for cases where points must be covered by other points, such as transformers must coincide with power poles in electric distribution networks and observation points must coincide with stations.</td>
<td><strong>Snap</strong>: The Snap fix will move a point feature in the first feature class or subtype to the nearest point in the second feature class or subtype that is located within a given distance. If no point feature is found within the tolerance specified, the point will not be snapped. The Snap fix can be applied to one or more Must Be Coincident With errors.</td>
<td>Where a red point is not coincident with a blue point is an error.</td>
</tr>
<tr>
<td><strong>Must Be Disjoint</strong></td>
<td>Requires that points be separated spatially from other points in the same feature class (or subtype). Any points that overlap are errors. This is useful for ensuring that points are not coincident or duplicated within the same feature class, such as in layers of cities, parcel lot ID points, wells, or streetlamp poles.</td>
<td>None</td>
<td>Where a red point and a blue point overlap is an error.</td>
</tr>
<tr>
<td><strong>Must Be Covered By Boundary Of</strong></td>
<td>Requires that points fall on the boundaries of area features. This is useful when the point features help support the boundary system, such as boundary markers, which must be found on the edges of certain areas.</td>
<td>None</td>
<td>The square on the right indicates an error because it is a point that is not on the boundary of the polygon.</td>
</tr>
<tr>
<td><strong>Must Be Properly Inside Polygons</strong></td>
<td>Requires that points fall within area features. This is useful when the point features are related to polygons, such as wells and well pads or address points and parcels.</td>
<td><strong>Delete</strong>: The Delete fix removes point features that are not properly within polygon features. Note that you can use the Edit tool and move the point inside the polygon feature if you do</td>
<td></td>
</tr>
</tbody>
</table>
This topic applies to ArcEditor and ArcInfo only.

Validating a geodatabase topology

Once you have made edits to a feature that participates in a topology, the next step is to validate the topology. Validating the topology means checking the features to identify any violations of the rules that have been defined for the topology.

ArcMap allows you to validate a portion of a topology during an edit session. Use ArcCatalog or the Catalog window if you need to validate an entire topology, which may take awhile for complex or large datasets or where there are many topology rules. You may want to compact your file or personal geodatabase after validating to reduce its size and improve performance.

Steps:

1. You can validate a portion of a topology using the tools on the Topology toolbar.
   - Click Validate Topology In Specified Area and drag a box around the area you want to validate. The features that fall within the bounding box will be validated.
   - Click Validate Topology In Current Extent. Areas that are not currently visible on the map are not validated.
2. Continue fixing topology errors as needed.

Related Topics
Finding topology errors with the Error Inspector
Fixing topology errors
Generating a summary of the remaining topology errors
Getting a description of the rule that is violated for an error
Marking an error as an exception

Finding topology errors with the Error Inspector

This topic applies to ArcEditor and ArcInfo only.

The Error Inspector lets you view topology errors in a table that tells you the rules violated, the feature class or classes involved in the errors, the geometry of the errors, the feature IDs of the features involved in the errors, and whether or not the errors have been marked as exceptions. You can sort the errors by any of the fields in the table so that you can work with all the errors of a given type. You can also limit the errors shown in the table to errors of a given type, errors that occur in the currently visible map extent, or errors that have been marked as exceptions.

In addition to letting you view and sort errors, the Error Inspector lets you select errors, pan or zoom to selected errors, and apply topology fixes of various types to errors. The Error Inspector also allows you to use keyboard shortcuts.

<table>
<thead>
<tr>
<th>Keyboard shortcut</th>
<th>Editing function</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP and DOWN ARROWS</td>
<td>Move up and down through the rows</td>
</tr>
<tr>
<td>Z or SPACEBAR</td>
<td>Zoom to selected error</td>
</tr>
<tr>
<td>P</td>
<td>Pan to selected error</td>
</tr>
</tbody>
</table>
Steps:

1. Click Error Inspector on the Topology toolbar.
2. You can use the Error Inspector window to find errors and exceptions.
   - To find errors for all rules: Click the Show drop-down arrow, and click Errors from all rules.
   - To find errors for a particular topology rule: Click the Show drop-down arrow, and click the rule.
   - To find errors in the visible extent: Check Visible extent only.
   - To find exceptions: Check Exceptions, and uncheck Errors.
3. Click Search Now.

Related Topics

Fixing topology errors
Generating a summary of the remaining topology errors
Getting a description of the rule that is violated for an error
Marking an error as an exception
Validating a geodatabase topology

About fixing topology errors

This topic applies to ArcEditor and ArcInfo only.

Topology errors can be fixed quickly using the Fix Topology Error tool. This tool allows you to select a topology error and choose from a number of fixes that have been predefined for that error type. You can also use the tool to get more information about the rule that has been violated or mark the error as an exception.

There are several ways to correct topology errors once you have discovered them. You can select the error on the map with the Fix Topology Error tool or select the error from within the Error Inspector, right-click, and apply one of the fixes listed in the shortcut menu for that error type.

Different error types have different predefined fixes available for them. For example, a dangling line can be trimmed, extended, or snapped to another line. Errors caused by violations of the Must Be Covered By rules can be fixed by creating a new feature or deleting a feature. Errors caused by overlapping polygons can be merged into one of the polygons; subtracted from both; or turned into a separate, new polygon feature.

Each time you save your edits during an edit session, the contents of the Error Inspector window are cleared. You need to click the Search Now button on the Error Inspector to populate the list again. Doing this ensures that the Error Inspector always shows the most up-to-date errors and exceptions for your geodatabase.

Related Topics

Fixing topology errors
This topic applies to ArcEditor and ArcInfo only.

You can fix errors either through the Error Inspector or by clicking them on the map with the Fix Topology Error tool.

Steps:
1. Open the Error Inspector and search for errors, or click the Fix Topology Error tool on the Topology toolbar.
2. Click the error in the Error Inspector list or use the Fix Topology Error tool to click it on the map. The error is drawn in black on the map.
3. Right-click the error in the list or on the map and click one of the available fixes. The fixes listed depend on the type of error. For example, to fix a Must Not Overlap error by merging an overlapping polygon into another polygon, right-click the error, click Merge, then choose the feature into which to merge the error feature.
4. Validate the topology again to ensure the edit was correct.

Related Topics
About fixing topology errors
Finding topology errors with the Error Inspector
Generating a summary of the remaining topology errors
Getting a description of the rule that is violated for an error
Marking an error as an exception
Validating a geodatabase topology

---

Getting a description of the rule that is violated for an error

This topic applies to ArcEditor and ArcInfo only.

You can get more information and examples of geometries that cause topology errors by viewing a description of the violated rule on the Error Inspector.

Steps:
1. On the Error Inspector, click the error for which you want a description.
2. Right-click the error and click Show Rule Description, or press the D key to see a description of the selected error. A dialog box appears with a description of the error and some pictures of geometries that would and would not result in this error. The errors are marked in red.
3. Uncheck Show Errors to compare the feature geometries without the errors.
4. Click OK.

Related Topics
Finding topology errors with the Error Inspector
Fixing topology errors
Generating a summary of the remaining topology errors
Marking an error as an exception
Validating a geodatabase topology

---

Generating a summary of the remaining topology errors

This topic applies to ArcEditor and ArcInfo only.

Once you have edited the layers in the geodatabase topology, you can generate a report summarizing the number of topology errors remaining in the data.

Steps:
1. Right-click the topology in the table of contents and click Properties.
2. Click the Errors tab.
3. Click Generate Summary.
4. If you want to export the results to a text file, click Export To File, browse to a location to save the file, type a name for the output, then click Save.
5. Click OK.

Related Topics
Finding topology errors with the Error Inspector
Fixing topology errors
Getting a description of the rule that is violated for an error
Marking an error as an exception
Validating a geodatabase topology

---

About topology exceptions

This topic applies to ArcEditor and ArcInfo only.
Topology rules may represent an ideal situation, but geodatabases are flexible enough to handle exceptions to the rules found in real-world data. Violations of topology rules are initially stored as errors in the topology, but where appropriate, you can mark them as exceptions. Exceptions are thereafter ignored, although you can return them to error status if you decide that they are actually errors and that the features should be modified to comply with the topology rules.

Exceptions are a normal part of the data creation and update process. An assessor's geodatabase might have a topology rule requiring that building features not cross parcel lines as a quality control for the building digitizing effort. This rule might be true for 90 percent of the features in the city, but it could be violated by some high-density housing and commercial buildings.

If you create a condominium building feature that crosses parcel boundaries, it will be discovered as an error when you validate your edits, but you can mark it as a legitimate exception to the rule. Similarly, a street database for a city might have a rule that centerlines must connect at both ends to other centerlines. This rule would normally ensure that street segments are correctly snapped to other street segments when they are edited. However, at the boundaries of the city, you might not have street data. Here the external ends of streets might not snap to other centerlines. These cases could be marked as exceptions, and you would still be able to use the rule to find cases where streets were incorrectly digitized or edited.

**Related Topics**
- Marking an error as an exception

### Marking an error as an exception

*This topic applies to ArcEditor and ArcInfo only.*

Topology exceptions are valid cases of violation of a topology rule. You can mark errors as exceptions on the Error Inspector.

**Steps:**
1. On the **Error Inspector**, click the error you want to mark as an exception.
2. Press the X key or right-click the error and click **Mark as Exception**. Once the error is marked as an exception, it is no longer symbolized as an error in the topology layer on the map.

**Related Topics**
- About topology exceptions
- Finding topology errors with the Error Inspector
- Fixing topology errors
- Generating a summary of the remaining topology errors
- Getting a description of the rule that is violated for an error
- Validating a geodatabase topology

### Changing the symbology for selected error features

You can change the way selected error features are drawn on the map. Error features are drawn with point, line, and area symbols of a given color by default. When you select errors, for example, using the Fix Topology Error tool, the selected errors change color so you can more easily identify the errors you are fixing. You can change the symbology of selected topology errors to make them stand out better against a given map background.

**Steps:**
1. Click the **Editor** menu and click **Options**.
2. Click the **Topology** tab.
3. Click the **Active Errors Symbology** buttons to change the way error features look when they are selected.
4. Click **OK**.

**Related Topics**
- Changing symbology for topology dirty areas
- Changing the symbology for topology elements
- Changing topology error and exception symbology

### Changing topology error and exception symbology

Changing the symbology of error features and exceptions that relate to different topology rules can make it easier to understand what problems there are with your data. By default, a topology appears in the table of contents as a layer with area, line, and point errors—symbolized in a coral color. Exceptions are not drawn automatically.

**Steps:**
1. Right-click the topology layer in the table of contents and click **Properties**.
2. Click the **Symbology** tab.
3. Check the error types you want to see on the map.
4. Click the error type for which you want to change the symbol.
5. Choose a new symbol for this type of error feature. You can draw all the errors of this type with a single symbol or with unique values.
6. Click **OK**.
Changing symbology for topology dirty areas

Drawing dirty areas can make it easier to see the areas that have been affected by edits and that are yet to be validated.

**Steps:**
1. Right-click the topology layer in the table of contents and click **Properties**.
2. Click the **Symbology** tab.
3. Check **Dirty Areas** to draw dirty areas in the topology layer and set the symbology for dirty areas.
4. Click **OK**.

Related Topics
- Changing the symbology for selected error features
- Changing the symbology for topology elements

About spatial adjustment

GIS data often comes from many sources. Inconsistencies between data sources sometimes require you to perform additional work to integrate a new dataset with the rest of your data. Some data is geometrically distorted or rotated with respect to your base data.

Within the editing environment, the spatial adjustment tools provide interactive methods to align and integrate your data. Spatial adjustment supports a variety of adjustment methods and will adjust all editable data sources. It's often used when you've imported data from another source, such as a CAD drawing. Some of the tasks you can perform include converting data from one coordinate system to another, correcting geometric distortions, aligning features along the edge of one layer to features of an adjoining layer, and copying attributes between layers. Since spatial adjustment operates within an edit session, you can use existing editing functionality, such as snapping, to enhance your adjustments.

Spatial adjustment commands and tools are located on an additional editing toolbar called the Spatial Adjustment toolbar.

Along with the ability to spatially adjust your data, the Spatial Adjustment toolbar also provides a way for you to transfer the attributes from one feature to another. This tool is called the Attribute Transfer tool and relies on matching common fields between two layers.

Together, the adjustment and attribute transfer functions available on the Spatial Adjustment toolbar allow you to improve the quality of your data.

An overview of the spatial adjustment process

While each of the spatial adjustment functions is used for a different purpose, the steps for setting up and performing an adjustment are essentially the same:

1. Start ArcMap.
2. Create a new map or open an existing one.
3. Add the data you want to edit to your map.
4. Add the Editor toolbar to ArcMap.
5. Add the Spatial Adjustment toolbar to ArcMap.
6. Start your edit session.
7. Choose the input data for the adjustment.
8. Choose a spatial adjustment method.
9. Create displacement links.
10. Perform the adjustment.
11. Stop your edit session and save your edits.

There is no need to save the map—all edits made to the database will automatically be reflected the next time you open the map.

References used in the spatial adjustment help


Choosing the data to be adjusted

The first step in the spatial adjustment process is to choose the input data for the adjustment. You have the option to adjust selected features or all the features in...
the layer. For a transformation, it would make sense to adjust the whole layer, whereas for an edgematch, you might want to work with a selected set. Rubbersheet adjustments can switch between the two. These settings are available in the Choose Input for Adjustment dialog box.

The default setting is to work with selected features. The Adjust command will not become active until some features are selected.

**Steps:**
1. Click the Spatial Adjustment menu and click Set Adjust Data.
2. Choose whether to adjust selected features in a layer or all features in a layer.
3. Click OK.

---

Creating displacement links

Before you adjust your data, you must create displacement links to define the source and destination coordinates for the adjustment. Once created, links are simply a kind of graphic element represented as arrows with the arrowhead pointing toward the destination location. The effect that links have on your adjustment depends on the number and location of links as well as the adjustment method you are using.

Displacement links are created interactively using the New Displacement Link tool. The tool works with the snapping environment, allowing you to place links with greater precision in relation to existing data.

Using a magnifier window when you're performing spatial adjustment allows you to get a better view of the origin and destination locations so you can place links more accurately without changing the extent of the map. You can open a magnifier window above the start point of the link, add the link, then move the window to the destination location and add that link without having to zoom and pan the map.

**Steps:**
1. Click the New Displacement Link tool on the Spatial Adjustment toolbar.
2. Position the pointer over the source location and click once to start adding a link.
3. Position the pointer over the destination location and click once to finish adding the link.

A displacement link now connects the source location to the destination location.

**Related Topics**
- Creating displacement links from a control point file
- Creating displacement links from a file
- Creating multiple displacement links

---

Creating multiple displacement links

You can create multiple displacement links using the Multiple Displacement Links tool. The Multiple Displacement Links tool is useful for areas that require many links, such as curve features. This tool can also help you save time by allowing you to create many links at once.

**Steps:**
1. Click the Multiple Displacement Links tool on the Spatial Adjustment toolbar.
2. Position the pointer over the source feature and click once. Snap to the edges of features when creating multiple links. This helps you select the correct feature.

3. Position the pointer over the target feature and click once. The No. of Links dialog box appears. This dialog box allows you to specify how many links to create.

4. Choose the number of links and press ENTER. The default is 10. Based on the value you enter, multiple links are created and connect the source feature to the target feature.

Related Topics
- Creating displacement links
- Creating displacement links from a control point file
- Creating displacement links from a file

Creating displacement links from a control point file

Control point files are text files that contain destination coordinates that define part of an adjustment. Spatial adjustment supports tab-delimited control point files that contain either two or three columns. A two-column control point file consists of a pair of destination coordinate values. A three-column control point file consists of an ID column (string or numeric) that precedes a pair of destination coordinate values. Control points may represent known locations of features from GPS or ground survey and are displayed in the Control Points window. You can create a control point file in ArcMap or in any ASCII text editor, such as Microsoft Notepad.

Unlike link files, opening a control point file does not automatically create displacement links. You must manually create the links from the control points. This requires that you open the Control Points window with the View Control Points command and double-click each row to create a destination link in the map. Once the link is created at the destination location, you must finish adding the link to the source location. This connects the source feature to the target feature. Repeat this process until all the control point rows are removed from the Control Points window.

Steps:
1. Click the Spatial Adjustment menu, point to Links, then click Open Control Points File.
2. In the Open dialog box, click the Look in drop-down arrow and navigate to the folder in which the control point file resides.
3. Double-click the control point file to load it. The Control Points window appears.
4. Double-click a row in the Control Points window. This creates a link at the destination location.
5. Drag the endpoint of the link to the source location and click once to finish adding it. The row is now removed from the Control Points window.
6. Repeat the process until all the rows in the Control Points window are removed and converted to displacement links.

Related Topics
- Creating displacement links
- Creating displacement links from a file
- Creating multiple displacement links

Creating displacement links from a file

When you open a link file, spatial adjustment automatically creates displacement links in the map based on the source and destination coordinate values in the file. Link files can help you save time by automating the link creation process.

Steps:
1. Click the Spatial Adjustment menu, point to Links, then click Open Links File.
2. In the Open dialog box, click the Look in drop-down arrow and navigate to the folder in which the link file resides.
3. Double-click the link file to load it. Displacement links are automatically created in the map.

Related Topics
- Creating displacement links
- Creating displacement links from a control point file
- Creating multiple displacement links

Creating a text file to generate displacement links

Link files are text files that contain source and destination coordinates that define an adjustment. Spatial adjustment supports tab-delimited link files that contain either four or five columns. A four-column link file consists of two pairs of source and destination coordinate values. A five-column link file consists of an ID column (string or numeric) that precedes two pairs of source and destination coordinate values. You don't need to type the headers.

Steps:
1. Open an ASCII text editing program, such as Microsoft Notepad.
2. Type the link ID and the coordinates using the format below. You don't need to type the headers.
   <ID> <from_x> <from_y> <to_x> <to_y>
Each link should be on a separate line, and the delimiter should be either a space or a tab. The <ID> column is optional but should precede the coordinates if used.
3. Save the file to disk.
4. Start ArcMap and open the link file.

Related Topics
Saving displacement links to a file

When you open a link file, spatial adjustment automatically creates displacement links in the map based on the source and destination coordinate values in the file. Link files can help you save time by automating the link creation process.
You can create a link file from the existing displacement links in the map using the Save Links File command. This command opens a Save dialog box and allows you to navigate to the folder of your choice and name the new link file. You also have the option to save link IDs. The link file is saved as a tab-delimited text file.

Steps:
1. Click the Spatial Adjustment menu, point to Links, then click Save Links File.
2. In the Save Links dialog box, click the Look in drop-down arrow and navigate to the folder where you want to save the link file.
3. Type a name for the link file.
4. Click Save.
5. Choose whether to save link IDs.

Related Topics
Creating a text file to generate displacement links

You can customize the symbology of the displacement links, identity links, and the limited adjustment area. These settings are supported in the Adjustment Properties dialog box. When you click the Displacement Link, Identity Link, or Limited Adjustment Area symbol button, the Symbol Selector dialog box appears. Use this window to choose a new style, size, and color for the links and limited adjustment area. The Symbol Selector dialog box presents options to modify the symbols based on the graphic element's geometry type.

Steps:
1. Click the Spatial Adjustment menu and click Options.
2. Click the Displacement Link, Identity Link, or Limited Adjustment Area symbol button.
3. Choose a different symbol, change the symbol size, and/or specify a new symbol color, then click OK.
4. Click OK.

Modifying displacement links

Displacement links can be modified using the Modify Link tool. You must select them before you can modify them. Links can be modified in or outside an edit session. You can modify links at their source or destination location or move the entire link to a new location.

Steps:
1. Click the Select Elements tool on the Spatial Adjustment toolbar.
2. Position the pointer over the link you want to modify and click once. Selection handles appear at the endpoints of the link.
3. Click Modify Link on the Spatial Adjustment toolbar.
4. Position the pointer over the source or destination point of the link. The link pointer changes to an arrow pointer.
5. Move the endpoint of the link to the desired location.

Selecting displacement links

Displacement and identity links are selected with the Select Elements tool on the Spatial Adjustment toolbar. Links must be selected prior to modifying or deleting.
Steps:
1. Click the Select Elements tool on the Spatial Adjustment toolbar.
2. Position the pointer over the link you want to select and click once, or drag a box to select multiple links. Selection handles appear at the endpoints of the link.
3. To delete a link, press DELETE.

Viewing the spatial adjustment link table

The spatial adjustment link table displays displacement links in a tabular format. This table shows the source and destination coordinates of the links, the link IDs, and the residual error of the adjustment (residual errors will only be displayed for transformation adjustments).

You can select links by clicking a row in the table. Coordinate values can be edited for the selected links. You can select multiple links by holding down the SHIFT key and selecting rows. When a link is selected, right-click to flash links, pan and zoom to links, and delete them.

Steps:
1. Click the Spatial Adjustment menu, point to Links, then click View Link Table, or click the View Link Table button on the Spatial Adjustment toolbar.
2. Click a row in the link table to highlight a link.
3. With the link record highlighted, click the Delete Link button to edit the coordinates of the link or delete the link.
4. Right-click the highlighted link to pan to the link, zoom to the link, select the link, or delete the link.
5. Click Close to close the window.

About spatial adjustment transformations

Transformations move or shift data within a coordinate system. They are often used to convert data from unknown digitizer or scanner units to real-world coordinates. Transformations can also be used to convert units within a coordinate system, such as converting feet to meters. To convert data between coordinate systems, such as geographic to UTM, you should project the data instead.

The transformation functions are based on the comparison of the coordinates of source and destination points, also called control points, in special graphic elements called displacement links. For transformations, the from and to locations of links are used to construct the transformation formulas. You can create these links interactively, pointing at known source and destination locations, or by loading a link text file or control points file.

When creating links for transformations, you are trying to match the same location in the source and destination locations. For example, you may have a roads layer you are trying to transform or shift to the location of other data that may contain an aerial photograph. When you create displacement links, the from end could be placed at an intersection in the roads layer while the to end should be placed at the corresponding intersection on the image. Links do not have to start or end on features. Often, the distance between the from and to locations can be quite large.

By default, ArcMap supports three types of transformations: affine, similarity, and projective.

Affine transformation
An affine transformation can differentially scale the data, skew it, rotate it, and translate it. The graphic below illustrates the four possible changes.
The affine transformation function is

\[ x' = Ax + By + C \]
\[ y' = Dx + Ey + F \]

where \( x \) and \( y \) are coordinates of the input layer and \( x' \) and \( y' \) are the transformed coordinates. \( A, B, C, D, E, \) and \( F \) are determined by comparing the location of source and destination control points. They scale, skew, rotate, and translate the layer coordinates. This method requires a minimum of three links. This is the recommended choice for most transformations.

The affine transformation requires a minimum of three displacement links.

**Similarity transformation**

The similarity transformation scales, rotates, and translates the data. It will not independently scale the axes, nor will it introduce any skew. It maintains the aspect ratio of the features transformed, which is important if you want to maintain the relative shape of features.

The similarity transform function is

\[ x' = Ax + By + Cy' = -Bx + Ay + F \]

where

\[ A = s \cdot \cos t \]
\[ B = s \cdot \sin t \]
\[ C = \text{translation in x direction} \]
\[ F = \text{translation in y direction} \]

and

\[ s = \text{scale change (same in x and y directions)} \]
\[ t = \text{rotation angle, measured counterclockwise from the x-axis} \]

A similarity transformation requires a minimum of two displacement links. However, three or more links are needed to produce a root mean square (RMS) error.

**Projective transformation**

The projective transformation is based on a more complex formula that requires a minimum of four displacement links.

\[ x' = (Ax + By + C) / (Gx + Hy + 1) \]
\[ y' = (Dx + Ey + F) / (Gx + Hy + 1) \]

This method is used to transform data captured directly from aerial photography. For more information, refer to one of the photogrammetric texts listed in the Spatial Adjustment help references.

**Understanding residual and root mean square**

The transformation parameters are a best fit between the source and destination control points. If you use the transformation parameters to transform the actual source control points, the transformed output locations won't match the true output control point locations. This is called the residual error; it is a measure of the fit between the true locations and the transformed locations of the output control points. This error is generated for each displacement link.

A root mean square error is calculated for each transformation performed and indicates how good the derived transformation is. The following example illustrates the relative location of four destination control points and the transformed source control points:

The RMS error measures the errors between the destination control points and the transformed locations of the source control points.

\[ \text{RMS error} = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 + \ldots + e_n^2}{n}} \]

The transformation is derived using least squares, so more links can be given than are necessary. Specifying a minimum of three links is required to produce a
Blind transformations

Sometimes you will need to perform an adjustment, usually a transformation, where you have no data at the destination location and cannot interactively place the to end of a displacement link. For example, you may have digitized some data and want to transform it from digitizer units to real-world coordinates. In this case, you will probably know the real-world coordinates of some feature locations in your data such as a road intersection or well location. You can still set up the transformation by creating displacement links with the from end at known locations and the to end at temporary points in space. You can then use the link table to edit the destination coordinates of these links to be the corresponding real-world locations.

Steps:
1. Click the Spatial Adjustment menu and point to Adjustment methods.
2. Click one of the transformation methods listed.

Choosing a transformation method

Before performing a spatial adjustment transformation, you need to choose an adjustment method. ArcMap supports three types: affine, similarity, and projective.

About spatial adjustment edgematching

The edgematching process aligns features along the edge of one layer to features of an adjoining layer. It is mainly used when you want to merge separate adjacent layers, such as soils or contours sheets, and you need to ensure the features from those layers will meet at the join. The layer with the less accurate features is typically adjusted, while the adjoining layer is used as the control. Displacement links are used to adjust vertices or the ends of line features to the corresponding locations in the adjoining control layer. To support the edgematching process, you can use the Edge Match tool on the Spatial Adjustment toolbar to quickly create links between features that are supposed to adjoin along a sheet edge.

The Edge Match tool

The Edge Match tool allows you to create displacement links that connect the edges of two adjacent layers. To use this tool effectively, you need to first setup the parameters for the tool's properties, available from the Edge Match tab of the Adjustment Properties dialog box, and set an appropriate snapping tolerance. Once you have set these, use the tool to drag a box around the features you want to edgematch. This creates displacement links from the ends or vertices of features in the layer to be adjusted to the ends or vertices of features in the control layer that fall within the snapping tolerance distance. The only features that are adjusted are those that have displacement links at these locations.

You can use additional properties to enhance the link-creation process, such as specifying one link per destination point and preventing duplicate links. You can also use attributes to assist with the creation of links by ensuring they connect to features that share common attribute values such as road names and pipeline widths.

These properties, combined with the proper snapping settings, help ensure an accurate edgematch.

Related Topics
Choosing an edge snap method
Setting the edge snap properties
Using the Edge Match tool

Choosing an edge snap method

The edgematching edge snap method aligns features along the edge of one layer to features of an adjoining layer. Typically, the features from the less accurate layer are adjusted to the more accurate layer, which becomes the control layer. Displacement links are used to adjust vertices or the ends of line features to the corresponding locations in the adjoining control layer.

Edge snap supports two methods: Smooth and Line. When using the Smooth edge snap method, vertices at the link source point are moved to the destination point. The remaining vertices are also moved, giving an overall smoothing effect. The Smooth method is the default. When using the Line edge snap method, only the vertices at the link source point are moved to the destination point. The remaining vertices on the feature remain unchanged.

Edge snap also supports adjusting features from each layer to the midpoint of the displacement link. This is useful where you have a large distance between the two features to be joined. Rather than move the endpoint of one feature a large distance, you can move the endpoints of adjoining features an equal amount, thus giving an overall smoothing effect. To take advantage of this, the source and target layer should be specified in the Edge Match tool properties.

To support the edgematching process, you can use the Edge Match tool on the Spatial Adjustment toolbar to quickly create links between features that are
supposed to adjoin along a sheet edge.

**Steps:**

1. Click the **Spatial Adjustment** menu, point to **Adjustment methods**, then click **Edge Snap**.
2. Click the **Spatial Adjustment** menu and click **Options**.
3. Click the **Adjustment methods** drop-down arrow and click **Edge Snap**.
4. Click the **Options** button.
5. Click either the **Smooth** or **Line** method.
6. Check the check box if you want to adjust to the midpoint of links, then click **OK**.
7. Click **OK** to close the **Adjustment Properties** dialog box.

**Related Topics**

- About spatial adjustment edgematching
- Setting the edge snap properties
- Using the Edge Match tool

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**Setting the edge snap properties**

**Steps:**

1. Click the **Spatial Adjustment** menu and click **Options**.
2. Click the **Edge Match** tab.
3. Click the **Source Layer** drop-down arrow and choose a source layer.
4. Click the **Target Layer** drop-down arrow and choose a target layer.
5. If you only want one link for each destination point, check the check box.
6. If you want to prevent duplicate links, check the check box.
7. Check **Use Attributes** if you want to use attributes to enhance the edgematch. This can assist in the creation of links by ensuring they connect to features that share common attribute values.
8. If you chose to use attributes, click the **Attributes** button.
   a. Match the source and target layer fields.
   b. Click the **Add** button.
   c. Click **OK** when finished matching fields.
9. Click **OK** to close the **Adjustment Properties** dialog box.

**Related Topics**

- About spatial adjustment edgematching
- Choosing an edge snap method
- Using the Edge Match tool

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**Using the Edge Match tool**

The **Edge Match tool** allows you to create displacement links that connect the edges of two adjacent layers. To use this tool effectively, you need to first setup the parameters in the tool's properties, available from the **Edge Match** tab of the **Adjustment Properties** dialog box, and set an appropriate snapping tolerance. Once you have set these, use the tool to drag a box around the features you want to edgematch. This creates links between the closest source and target features that fall within the snapping tolerance distance.

![Image of Edge Match tool](image)

You can use additional properties to enhance the link-creation process, such as specifying one link per destination point and preventing duplicate links. You can also use attributes to assist with the creation of links by ensuring they connect to features that share common attribute values such as road names and pipeline widths. These properties, combined with the proper snapping settings, help ensure an accurate edgematch.

**Steps:**

1. Click the **Edge Match** tool on the **Spatial Adjustment** toolbar.
2. Drag a box around the features you want to edgematch. Links now connect the edges of the source layer to the edges of the target layer.

**Related Topics**

- About spatial adjustment edgematching
- Choosing an edge snap method
- Setting the edge snap properties
About spatial adjustment rubbersheeting

Geometric distortions commonly occur in source maps. They may be introduced by imperfect registration in map compilation, lack of geodetic control in source data, or a variety of other causes. Rubbersheeting is used to make small geometric adjustments in your data—usually to align features with more accurate information.

In rubbersheeting adjustments, you are usually trying to align one layer with another that is often in close proximity. The source layer (drawn with solid lines) is adjusted to the more accurate target layer. During rubbersheeting, the surface is literally stretched, moving features using a piecewise transformation that preserves straight lines. During this process, you place links to stretch or warp the data you are trying to align to the underlying datasets.

Similar to transformations, displacement links are used in rubbersheeting to determine where features are moved. The key difference between rubbersheeting and transformations, however, is that the distance features move depends on their proximity to a link and the length of that link. The closer features are to displacement links, the farther they will move.

In some cases, you may not want some features to move at all as they may already be aligned. Locations that are known to be accurate, such as those that already match the target layer, can be held in place with another type of link called an identity link. Identity links "nail" down the surface at the specified point. Additionally, you can define a polygonal area with the Limited Adjustment Area tool to limit a rubbersheet to just that area.

Rubbersheeting is commonly used after a transformation to further refine the accuracy of the features to an existing layer or raster dataset. Conflation applications use rubbersheeting to align layers in preparation for transferring attributes.

How rubbersheeting works

Rubbersheeting uses two temporary triangulated irregular networks (TINs) to interpolate changes in x (dX) and changes in y (dY) for feature coordinates along user-specified links. Each TIN has the same triangulation structure. The from end of the displacement links and all identity links are used as the TIN triangle corners (nodes). A node is defined by its x,y location and a z-value.

The z-value of each node is used to interpolate the amount of x,y adjustment applied to each feature coordinate. The z-value is the amount of change between the from-end and to-end of a link. For example, if the change in x for a link is 10 map units, the z-value of the TIN node at the from-end of that link will be 10. Since identity links represent no change, the z-value is zero. Once each node of a TIN triangle has a z-value, the corresponding z-value of any point falling on that triangle can be interpolated.

The interpolated z-value from the x-shift TIN is added to the x-ordinal of the feature's coordinate. The z-value interpolated from the y-shift TIN is added to the y-ordinal of the coordinate. For example, if an input feature coordinate is 1000,1500; the interpolated dX for this point is 20; and the interpolated dy is -100, the output coordinates after adjusting will be 1020,1400 (1000 + 20 = 1020 and 1500 + (-100) = 1400).
The rubbersheeting adjustment has two options: linear and natural neighbor. These options refer to the interpolation method used to create the temporary TINs. You can read about these well-known mathematical models online or in the reference texts.

The linear method creates a quick TIN surface but does not really take into account the neighborhood. The linear option will be slightly faster and produces good results when you have many links spread uniformly over the data you are adjusting.

Natural neighbor (similar to inverse distance weighting) is slower but is more accurate when you don’t have many displacement links and they are scattered across your dataset. Using linear in this case will be less accurate.

Rubbersheeting data in a geometric network

You can perform spatial adjustments on data participating in a geometric network. For example, you can use rubbersheeting to update utility data in a geometric network to reflect changes in the underlying land base data. It is important to note that the spatial adjustment process will only work against geometric network junctions, so you should place your displacement links appropriately.

During the rubbersheet adjustment, junctions will move and drag any connected lines with them. To preserve the shape of linear features during the adjustment, you should open the Editing Options dialog box, click the General tab, and turn on the option to Stretch geometry proportionately when moving a vertex. For more information about this option, see Moving a vertex without changing a feature's general shape.

Related Topics
Choosing a rubbersheet method
Creating identity links
Using the Limited Adjustment Area tool

Steps:
1. Click the Spatial Adjustment menu, point to Adjustment methods, then click a transformation method.
2. Click the Spatial Adjustment menu and click Options.
3. Click the Adjustment methods drop-down arrow and click Rubbersheet.
4. Click the Options button.
5. Click either the Natural Neighbor or Linear method and click OK.
6. Click OK to close the Adjustment Properties dialog box.

Related Topics
About spatial adjustment rubbersheeting
Creating identity links
Using the Limited Adjustment Area tool
Creating identity links

Identity links can be used to hold features in place at specified locations. Identity links can serve as “anchors” because they prevent the movement of features during an adjustment. Identity links are only available when using the Rubbersheet adjustment method. Like displacement links, identity links are represented as graphic elements in the map.

Steps:
1. Click the New Identity Link tool on the Spatial Adjustment toolbar.
2. Position the pointer over the source location and click once.
3. Add additional identity links to locations to prevent the movement of features during an adjustment.

Related Topics
About spatial adjustment rubbersheeting
Choosing a rubbersheet method
Using the Limited Adjustment Area tool

Using the Limited Adjustment Area tool

You can limit the scope of an adjustment area by using the Limited Adjustment Area tool. This tool is only available for the Rubbersheet adjustment method. This tool allows you to draw a polygon shape around only the features you want to adjust. Any features that are outside this polygon area will not be affected by the adjustment, regardless of whether they are selected. The Limited Adjustment Area tool provides similar anchoring as identity links. However, in cases where you must add many identity links, using the Limited Adjustment Area tool may save you time.

Steps:
1. Click the New Limited Adjustment Area tool on the Spatial Adjustment toolbar.
2. Draw a polygon around the area you want to rubbersheet and double-click to complete the polygon. Features outside this polygon will not be affected during the adjustment. You can create multiple limited adjustment areas with the Limited Adjustment Area tool.
3. Click Clear Limited Adjustment Area to remove the limited adjustment area polygon.

Related Topics
About spatial adjustment rubbersheeting
Choosing a rubbersheet method
Creating identity links

Previewing the spatial adjustment
You can preview an adjustment using the Adjustment Preview window. This window allows you to view the results of an adjustment prior to performing it. You can use standard zooming and panning tools in this window to closely examine how the adjustment affects your features. This allows you an opportunity to go back in the map and make modifications before you adjust your data. In addition, the Adjustment Preview window supports its own display commands from a shortcut menu, such as zooming to and tracking the data frame's extent.

The Adjustment Preview window can help you save time and unnecessary edits by giving you a glimpse of the result of the adjustment.

**Steps:**
1. Click the **Spatial Adjustment** menu and click **Adjustment Preview**.
2. Examine the adjustment more closely by using the zoom and pan navigation tools. You can access additional commands by right-clicking inside the Adjustment Preview window.

**Related Topics**
- Performing the spatial adjustment

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Performing the spatial adjustment

Once you have chosen which data to adjust, selected an adjustment method, set the adjustment properties, created links, and previewed the result, you can perform the adjustment. Clicking the Adjust command executes the spatial adjustment.

Once an adjustment has been performed, displacement links are removed from the document. You can undo an adjustment to return to the original state if the results are not what you intended. You can also save links to a text file through the link table.

**Steps:**
1. Click the **Spatial Adjustment** menu.
2. Click **Adjust**.

**Related Topics**
- Previewing the spatial adjustment

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About spatial adjustment attribute transfer

Attribute transfer is typically used to copy attributes from a less accurate layer to a more accurate one. For example, it can be used to transfer the names of hydrological features from a previously digitized and highly generalized 1:500,000-scale map to a more detailed 1:24,000-scale map. In ArcMap, you can specify what attributes to transfer between layers, then interactively choose the source and target features.

The Attribute Transfer Mapping functions support the interactive transfer of attributes between features. The Attribute Transfer Mapping dialog box allows you to set the source and target layers and specify which fields to use as criteria for the attribute transfer.

Once you have identified the common fields in the source and target layers, they can be matched. These matched fields will define which attributes are transferred when using the Attribute Transfer tool. You also have the option to transfer the geometry of the feature.

![Attribute Transfer Mapping](image)

**Note:** When one layer has m-values or z-values and the other does not, you can only transfer attributes between them. You will not be able to transfer geometry.

**Related Topics**
- Transferring attributes between features

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Transferring attributes between features

![Transferring attributes between features](image)
Steps:
1. Click the Spatial Adjustment menu and click Attribute Transfer Mapping.
2. Click the Source Layer drop-down arrow and choose a layer.
3. Click the Target Layer drop-down arrow and choose a layer.
4. Click a field in the source layer's Field list box and click a corresponding field in the target layer's Field list box.
5. With both fields highlighted, click the Add button.
6. Repeat the process for all other fields that are to be used as criteria for the attribute transfer. You can use the Auto Match command to match multiple fields at once based on common field names.
7. Click OK.
8. Click the Attribute Transfer tool on the Spatial Adjustment toolbar.
9. Position the pointer over the source feature and click once. This is the feature that contains the desired attribute data.
10. Position the pointer over the target feature and click once to transfer the attribute data of the source feature. You can transfer attributes to multiple features by holding down SHIFT.

The target feature is now updated with the source feature's attribute data. When the transfer is complete, you can verify the target feature's attributes by clicking it with the Identify tool on the Tools toolbar.

Related Topics
About spatial adjustment attribute transfer

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What is parcel editing?

This topic applies to ArcEditor and ArcInfo only.
Parcel editing involves working with and updating land parcel boundaries, land records, and utility features. When editing parcels, you are working with polygon features, which represent the parcel, line features, which represent the parcel boundary and point features, which store coordinates for the parcel corners. Many utilities such as roads, pipeline networks and wastewater networks are defined in relation to the parcel boundary and are thus dependent on the parcel boundary. If parcel boundaries are updated, dependent utilities should be updated as well.
The parcel editing environment in ArcGIS 10 provides an intelligent editing environment that is tailored specifically for working with land parcels.

Parcel fabric
The parcel editing environment works with a parcel fabric dataset. A parcel fabric dataset is created as a new node under a feature dataset in the Catalog window. The parcel fabric dataset is a set of polygons or land parcels that are defined by a network of connected parcel lines. Connection lines and radial lines connect isolated groups of parcels to ensure a seamless boundary network.

Parcels in the parcel fabric are defined by points and lines as well as polygons. Lines store the dimensions of the parcel boundaries and points coordinate (x, y) the parcel on the ground. Parcel corner points are coincident with the ends of parcel lines and are common between adjacent parcels. Each parcel has its own set of lines, which means that neighboring parcels will each have their own line to represent the common boundary. The common boundary has two end points, and multiple lines connect between the same two points.
Lines can be boundary lines (the boundary of the polygon) as well as connection lines, radial lines, and so on.
Methods of creating parcels

The parcel fabric editing environment provides a comprehensive and flexible set of parcel editing tools. Parcel editing is efficient and simple. Editing workflows are designed for working with different types of parcels such as tax parcels, easement parcels, subdivision blocks, and so on.

Parcels in the parcel fabric can be created using the following methods:

**Parcel traverse**

Parcels in the parcel fabric are created using the traverse method. Parcel boundary dimensions are entered or digitized in a sequenced loop. Lines can also be created using COGO tools.

**Parcel construction**

Parcels are created from linework entered in the parcel construction environment. Linework can be traversed in, pasted in, and created using COGO tools.

**Parcel division**

Parcels are created from the division of an existing parcel. The parcel division tool can be used to divide existing parcels into equal areas, into equal widths or by proportional areas. Existing parcels can also be split using construction line work using the Construct from parent tool.

**Parcel merge**

Adjacent parcels are merged to create new parcels. The original parcels remain as historic parcels.

**Remainder parcel**

If a new parcel is added to overlay an existing parcel, a remainder parcel can be created from the existing underlying parcel.

Spatial accuracy and parcel fabric adjustment

Corner points in the parcel fabric store x, y, z coordinates, which spatially locate parcels on the ground. These corner point positions are updated by processing parcel line data in a fabric adjustment process. The process requires survey control points, which are also stored in the fabric. Control points define and publish accurate, surveyed coordinates for physical features on the surface of the earth. When parcel lines are processed with survey control points in a fabric adjustment process, the result is more accurate parcel corner positions (x, y, z coordinates).
Parcel corner changes (coordinate changes) are stored and subsequently used to update other layers, thereby maintaining spatial coincidence with the parcel fabric base-map. This process is called feature adjustment; it is a distinct and separate task from the parcel fabric adjustment, since it adjusts features that are not part of the parcel fabric dataset, but that are associated with the fabric.

**Adjustment of dependent features**

Coordinate changes in parcel corner points resulting from fabric adjustments are stored as vectors and subsequently used to update features that are dependent on parcel boundaries such as sewer and water lines. Spatial coincidence of dependent features can be maintained with the parcel fabric basemap. This process is called feature adjustment; it is a distinct and separate task from the parcel fabric adjustment, since it adjusts features that are not part of the parcel fabric dataset, but that are associated with the fabric.

**Related Topics**

- About the parcel fabric layer
- What is editing?

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**A quick tour of parcel editing in the parcel fabric**

This topic applies to ArcEditor and ArcInfo only.

**Parcel Editor toolbar**

The Parcel Editor toolbar contains the tools and menu commands needed to access and work with your parcel fabric, for example, the Select Parcel Features tool, the Parcel Explorer window, the Parcel Details window, and the Maintain control points dialog box. Other commonly used parcel editing tools and commands, such as the Job Book command and Create Connection Line tool, are also available on the Parcel Editor menu and toolbar. You can also start and stop an edit session from the Parcel Editor toolbar. The Parcel Editor toolbar is required to edit parcels in a parcel fabric in ArcMap.

**Parcel Editor Options dialog box**

The Parcel Editor Options dialog box is used to set parcel fabric editing options such as the type of edit mode, the parcel view, and snapping and joining tolerances. You can choose to edit parcels directly in the map in automatic mode, or you can choose to edit parcels in parcel fabric jobs in manual mode. If editing in manual (jobs) mode, you are using job-workflow commands and functionality to edit your parcel fabric.

**Parcel Details window**

The Parcel Details dialog box is used when editing and creating parcels. The Parcel Details dialog box can be opened by clicking the Parcel Details button on the Parcel Editor toolbar. Parcel polygon attributes of a selected or opened parcel are displayed under the Properties tab of the Parcel Details window. Under the
Properties tab, you can also specify the parcel’s related plan or record of survey. Parcel polygon feature templates can also be set for new parcels. The Lines tab displays parcel traverse and misclose information. When a parcel is open for editing or when a new parcel is being created, several parcel editing commands become available on the Parcel Details dialog box such as COGO commands and Build parcels (from line work) commands.

Parcel Explorer window

The Parcel Explorer window can be opened by clicking the Parcel Explorer window button on the Parcel Editor toolbar. The Parcel Explorer window lists selected parcels by their plan or record of survey name. If you are working in a fabric job, all parcels are grouped by their plan or record of survey name in the open job. If the current parcel fabric has unjoined parcels, these parcels are listed under Unjoined Parcels. You can select and right-click parcels either in the map or in the Parcel Explorer window to access various parcel editing commands and tools.

Select Parcel Features tool

The Select Parcel Features tool can be accessed from the Parcel Editor toolbar. You use this tool to select and interact with parcels in the parcel fabric. For example, click the Select Parcel Features button and right-click a parcel to open it and access various editing tools. Use the Select Parcel Features tool to drag a box to select multiple parcels that can be modified in a fabric adjustment or opened in a fabric job if you choose to work with job-workflow functionality.

The Plan Directory dialog box

The Plan Directory dialog box can be accessed from the Parcel Editor menu on the Parcel Editor toolbar. The Plan Directory dialog box can also be accessed from the Parcel Details window when editing parcels. In the Plan Directory dialog box, you can find a list of all available plans existing in the parcel fabric. A plan or record of survey, which is prepared by a surveyor, is the legal recorded document that defines and describes a parcel or parcels. Plan information is stored in the nonspatial plans table of the parcel fabric. You can create a new plan from the Plan Directory dialog box, or you can migrate plan information into the parcel fabric when migrating parcels. If no plan exists or you choose not to work with plans, a default system map plan is used when editing parcels.
Job Book dialog box

The Job Book dialog box tracks and displays edits to parcels in the parcel fabric. If editing parcels directly in the map in automatic mode, mini jobs are saved and tracked for each edit in the job book. Each edit or mini job is date and time stamped. You can zoom to the extent of each edit or mini job. If editing parcels in fabric jobs in manual mode, the fabric job is saved and stored in the job book. You can reopen the parcel fabric job and edit the job properties. The Job Book dialog box can be accessed by clicking the Open Parcel Job Book button on the Parcel Editor toolbar.

Parcel editing tools

In an edit session or in an open fabric job, right-click a parcel to open it for attribute and dimension editing. When right-clicking a parcel, you can also access commands such as Parcel Division, Construct from parent, and Parcel Remainder.

Data migration

You can build a parcel fabric by migrating existing parcel datasets to a parcel fabric. To migrate existing parcel data, you can do either of the following:

- Use geodatabase topology on existing polygons or lines and migrate the topology to the parcel fabric. This method is useful for migrating sections of parcel data at a time.
- Build a fabric source from your existing parcel datasets and migrate the fabric source to the parcel fabric. This method is useful for migrating entire datasets.

When using a geodatabase topology, a geometry-based topology with rules is validated against a subset of lines and/or polygons or optionally points. If there
are no errors, the data can be migrated directly into the parcel fabric. The `Load A Topology To A Parcel Fabric` geoprocessing tool in the Parcel Fabric toolbox can be used to migrate a geodatabase topology to a parcel fabric.

Tutorial: Getting started with parcel fabric editing

This topic applies to ArcEditor and ArcInfo only.

A parcel fabric is built from either data migration of existing parcel datasets or data entry into an empty parcel fabric. Data migration of existing parcels into a new parcel fabric is the most common method that you will use to build a parcel fabric. Learn more about data migration into the parcel fabric

Editing the parcel fabric in automatic edit mode

Once a parcel fabric is loaded into ArcMap, you can choose to either directly edit parcels in the map (automatic edit mode) or work with job workflow functionality (manual edit mode).

Before beginning this exercise, make sure that the Parcel Editor toolbar has been added to ArcMap. To load the toolbar, click Customize on the main menu, point to Toolbars, then click Parcel Editor. In this exercise, you will become familiar with editing in automatic edit mode.

Steps:

1. Start ArcMap and load the ParcelEditing map document (ParcelEditing.mxd) from the `\ArcGIS\ArcTutor\Parcel Editing\` folder.
2. Make sure the map is zoomed to the Parcel Editing Area bookmark. Click Bookmarks > Parcel Editing Area. You will now set the parcel fabric edit mode.
3. Click the Parcel Editor arrow on the Parcel Editor toolbar and click Options.
4. On the Parcel Editor Options dialog box, choose the Automatic option. Using this option, parcels are edited directly in the map and each edit is tracked automatically in the job book.
5. Click the Automatically zoom to extent of parcels when editing check box and click OK.

When you open a parcel, the map automatically zooms to the extent of the parcel. If you do not check this option, the map remains at its current zoom extent.

You will now open a parcel in the map.

6. Click Parcel Editor and click Start Editing. Close the Create Features window.
7. Click the Select Parcel Features tool on the Parcel Editor toolbar and click on parcel 142 to select it.

8. Right-click the parcel and click Open. You can also double-click the parcel to open it. The parcel is opened in the map, and curved radial lines are visible. The Parcel Details dialog box also becomes visible.
9. If the **Parcel Details** dialog box is not visible, click the **Parcel Details** tool on the **Parcel Editor** toolbar to display the dialog box. The **Parcel Details** dialog box shows the attribute information for the open parcel under the **Properties** tab. The **Name**, **Type**, **Unclosed**, **Stated Area**, **Legal Start Date**, **Legal End Date**, **Accuracy**, **Compiled**, and **Historical** attribute values are editable. The remaining attributes are system attributes maintained internally. The **Plan** list displays the parcels' associated plan or record of survey. The **Template** button is unavailable. You can only set feature templates for newly created parcels in the parcel fabric, not for existing parcels.

Tip: The **Name**, **Type**, **Stated Area**, **Legal Start Date**, **Legal End Date**, **Accuracy**, and **Compiled** attribute values are also editable when the parcel is selected in the map in an edit session. You do not have to open the parcel to edit these attributes.

10. Click the **Plan** button to open the **Plan Directory** dialog box. The plan directory lists all available plans or records of survey defined for the current parcel fabric. On the **Plan Directory** dialog box, you can set a different plan for the parcel or create a new plan. For this exercise, you will not change the parcel's plan. Close the **Plan Directory** dialog box.

Tip: If you choose not to work with plans, the system default <map> plan is used for parcels that are not associated with any plans.

Tip: The **Plan Directory** dialog box can also be opened from the **Parcel Editor** menu. When doing so, you can right-click a plan and click **Construction** to open the construction environment for the plan. In the construction environment, you can paste line work or traverse in construction lines. Parcels can be built from a network of construction lines and joined as new parcels to the parcel fabric.

11. Click the **Lines** tab on the **Parcel Details** dialog box. The parcel traverse lines are displayed with misclose information. You can edit line dimensions or add additional lines such as connection lines.
12. With the parcel still open, click the Parcel Editor arrow and click Parcel Measurement View to display the parcel using its COGO dimensions, scale, and rotation in the parcel fabric.

Notice that the parcel has a $4^\circ19'48''$ rotation. The parcel's rotation value is displayed in the Rotation attribute field under the Properties tab on the Parcel Details dialog box.

If parcel measurement view is toggled off, the parcel is displayed using its parcel fabric coordinates. Displaying a parcel in parcel measurement view displays a parcel using coordinates derived from its COGO dimensions, scale, and rotation. Displaying the parcel using parcel measurement view displays the true parcel shape according to its current COGO dimensions, scale, and rotation. This command is useful for finding erroneous parcels. Inaccurate or incorrect COGO dimensions will be reflected in the parcel shape when a parcel is displayed using parcel measurement view.

In the case of parcel 142, there are no differences in the parcel shape when the parcel is displayed using its COGO dimensions, but there is a rotation on the parcel.

Learn more about parcel measurement view

13. Toggle off parcel measurement view: click Parcel Editor > Parcel Measurement View.

14. Click the Exit Without Saving command on the Parcel Details dialog box to close the parcel and switch back to the parcel fabric layer.

Now you will open the same parcel, but this time, you will open it in a local coordinate system.

15. Open the Parcel Editor Options dialog box (Parcel Editor > Options) and choose View and edit parcels individually in a local coordinate system. Click OK.

16. Using the Select Parcel Features tool, double-click on parcel 142 to open it.

The parcel is opened in a stand-alone local coordinate data frame instead of the map. Editing parcels in a local coordinate data frame is useful for individual parcel editing and when using the map as a background reference is not necessary.
17. Click the **Exit Without Saving** command on the **Parcel Details** dialog box to close the parcel and switch back to the parcel fabric layer.

18. Click the **Parcel Explorer Window** tool on the **Parcel Editor** toolbar to open the **Parcel Explorer** window. The **Parcel Explorer** window lists selected parcels by their plan. Parcels that are not yet part of the parcel fabric and unjoined parcels are also listed. By default, the parcel explorer lists the last parcel that was opened.

19. Using the **Select Parcel Features** tool, drag a box to select a group of parcels in the map. The **Parcel Explorer** window refreshes to display a list of the selected parcels, grouped by their plan.

20. Click **Parcel Editor > Job Book** to open the parcel fabric job book. The job book displays two jobs for both times that parcel 142 was opened.

21. Close the **Job Book** dialog box to complete the exercise in familiarizing yourself with the parcel fabric automatic edit mode.

**Editing the parcel fabric in manual edit mode**

In this exercise, you will become familiar with editing the parcel fabric in manual edit mode using fabric jobs.

**Steps:**

1. In ArcMap, make sure the ParcelEditing map document (ParcelEditing.mxd) is open and zoomed to the **Parcel Editing Area** bookmark.
You will now set the edit mode to manual.

2. Open the **Parcel Editor Options** dialog box and choose **Manual** as the edit mode. You can choose to leave **View and edit parcels individually in a local coordinate system** checked or unchecked. Click **OK**.

In manual edit mode, parcels are selected and opened in a fabric job for editing. After edits are complete, the job is posted back to the parcel fabric layer.

3. Click the **Select Parcel Features** tool on the **Parcel Editor** toolbar and drag a box to select a group of parcels in the map.

4. Click the **Parcel Editor** arrow and click **Modify** to extract the selected parcels into a job. Notice that job workflow commands are now available on the **Parcel Editor** menu, for example, **Modify**, **Finish Job**, and **Create Job**.

The selected parcels are opened in a job and are available for editing. The surrounding parcels are inactive.

The **Parcel Explorer** window also becomes active, listing all parcels in the fabric job by their plan.
Learn more about versioning and edit locks in the parcel fabric

You can now double-click a parcel in either the Parcel Explorer window or in the map to open the parcel for editing. You can also right-click parcels to access commands for parcel division, parcel remainder, and so on.

5. Click Parcel Editor > Finish Job.

The fabric job is saved and posted back to the parcel fabric layer. Any edits made in the job will be updated in the parcel fabric and committed to the geodatabase once the edit session is saved. If the edit session is not saved, the edits posted from the job are lost. You can also click the Undo command on the Standard toolbar to undo the creation of the fabric job.

6. Click Parcel Editor > Job Book to open the Job Book dialog box. The job you just created has a description of Modify selected.

7. Right-click the job and click Properties.

The job creation properties dialog box is displayed and the parcels that are part of the job are colored in blue. If a parcel was edited in the job, it would be colored in red. You can edit the properties of the job in the job creation dialog box. You can also reopen the job for continued editing.
8. Click Cancel on the job creation dialog box to complete the exercise in familiarizing yourself with the parcel fabric manual edit mode and complete the tutorial.

**Tip:** If you are editing in automatic mode (without using manually created jobs), you can also view the properties of the mini jobs or tracked edits; however, you cannot reopen the edits or mini jobs for editing. You need to be working in manual mode to reopen a job from the Job Book dialog box.

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### Tutorial: Creating new parcels in the fabric

**This topic applies to ArcEditor and ArcInfo only.**

In this exercise, you will explore the various methods of creating and adding new parcels to a parcel fabric. You can create new parcels in existing plans or create new plans. Parcels can be traversed in the parcel traverse environment or can be built from a network of connected line work in the parcel construction environment. You will also learn how to enter new parcels into an empty fabric.

#### Creating a new plan

In this exercise, you will create and add a new plan to an existing fabric of parcels and plans.

**Steps:**

1. Open ArcMap and load the ParcelEditing map document (ParcelEditing.mxd) from your `\ArcTutor\Parcel Editing\` folder.
2. Make sure the map display is zoomed to the parcel editing overview area. Click the Bookmarks menu and click Parcel Editing Area.
3. Click the Parcel Editor arrow on the Parcel Editor toolbar and click Start Editing. If the Parcel Details dialog box is not visible, click the Parcel Details tool on the Parcel Editor toolbar.
4. Close the Create Features window.
5. Make sure the parcel fabric edit mode is set to automatic. Open the Parcel Editor Options dialog box (Parcel Editor > Options) and choose Automatic under Edit Mode on the General tab. Click OK.
6. Click the Parcel Editor arrow on the Parcel Editor toolbar and click Plan Directory.

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**Tip:** Click the Create New Parcel On A New Plan tool on the Parcel Editor toolbar to create a new parcel in a new plan. You can also open the Plan Directory dialog box, right-click a plan, then click New Parcel to create a new parcel in an existing plan.

**Tip:** Right-click a parcel in the map or in the Parcel Explorer window to access parcel editing commands such as Parcel Division and Parcel Remainder.

**Tip:** Right-click a plan on the Plan Directory dialog box to create or paste lines as parcel construction lines. Parcels can be built from a network of construction lines.

**Tip:** Click the Maintain Control Points tool on the Parcel Editor toolbar to insert control points into the parcel fabric. Control points can also be imported into the parcel fabric.

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The **Plan Directory** dialog box opens and displays a list of plans existing on this parcel fabric.

7. Click **Create Plan** to create a new plan.

![Plan Directory dialog box]

The **Plan Properties** dialog box is opened.

8. On the **Plan Properties** dialog box, click the **General** tab and enter a name new for your new plan. For this tutorial, type **Map 9000** as a plan name. You can also optionally enter a plan description.

![Plan Properties General tab]

9. Click the **Record Format** tab to specify the units that you will be working with in this plan.
   You will be working with a plan that displays directions in quadrant bearing format in degrees/minutes/seconds and distance in U.S. feet. Choose **Quadrant Bearing** from the **Direction or Angle Type** drop-down list, **Degrees Minutes Seconds** from the **Direction and Angle Units** drop-down list, and **US Survey Feet** from the **Distance and Length Units** drop-down list.

10. Leave the default for **Area Units**.

![Plan Properties Record Format tab]

11. Optionally, click the **Circular Curve Parameters** and **Circular Curve Direction** drop-down lists to specify circular curve parameters for this plan.

![Circular Curve Parameters and Direction]

**Tip:** You will be able to identify which curve parameters a plan uses by looking at the curve dimensions on the plan. Curve dimensions are sometimes displayed in a curve table for labeled curves on the plan.

12. Click the **Corrections** tab on the **Plan Properties** dialog box.
   Under this tab, you would click the **Uses true mid-bearings** option if the bearings of your parcel lines in the plan are the bearings from true north at the midpoint of the parcel. This option is typically used for very long parcel lines.

13. Click **Apply** on the **Plan Properties** dialog box to apply your changes.

14. Click the **Attributes** tab.
   On this tab, you can enter information in the plan attributes such as survey date, surveyor, and **accuracy**.

**Tip:** You can add other attributes to the plans table, and these attributes will become available on the **Attributes** tab on the **Plan Properties** dialog box. Learn how to add additional attributes to tables in the parcel fabric.

15. Click the drop-down list next to the **Accuracy** field and choose accuracy level **3 - 1908 to 1980**.
   All new parcels created under this plan inherit the plan accuracy level of 3.

[Learn more about accuracy levels in the parcel fabric](#)

16. Click **OK** on the **Plan Properties** dialog box to create the plan and complete the exercise.
   The new plan is listed on the **Plan Directory** dialog box. Close the plan directory.

17. Click **Parcel Editor > Stop Editing** to stop the edit session. Make sure to save your edits.

Creating feature templates
Before creating a new parcel, you will create a feature template for fabric parcel polygons. Feature templates define all the information required to create a new feature, such as the attributes that are populated with the feature and the layer that the feature is stored in. Feature templates can be added at any time during editing and can be based on existing layer symbology such as parcel line type.

Learn more about feature templates and the parcel fabric

You will create a feature template for parcels created in the plan Map 9000.

**Steps:**

- Before creating the feature template, you are going to add a new attribute to the fabric parcels table:
  1. In ArcMap, click the **Catalog Window** tool on the **Standard** toolbar to open the Catalog window.
  2. In the **Catalog** window, navigate to the location of your tutorial data, right-click the parcel fabric named FABRIC, then click **Properties**.
  3. On the **Parcel Fabric Properties** dialog box, click the **Fabric Classes** tab and choose **Parcels** from the **Classes** drop-down list.
  4. On the field list grid, scroll down to the first empty **Field Name** row to type a new field name. Type **PlanName** as the field name and set **Data Type** to **Text**.
  5. Click **OK** to add the field and close the **Parcel Fabric Properties** dialog box.

**Tip:** New fields can only be added outside an edit session in ArcMap.

- Close or dock the **Catalog** window.
- Back in ArcMap, click **Parcel Editor > Start Editing** to start an edit session to create the feature template. Close the **Create Features** window.
- In the **Table Of Contents** window, right-click the parcels sublayer, point to **Edit Features**, then click **Organize Feature Templates**.
  
  On the **Organize Feature Templates** dialog box, notice the default template for fabric parcel features. Add a new template for creating fabric parcels in the Map 9000 plan.

- Click the **New Template** command.
- With the Parcels sublayer checked, click **Finish** on the **Create New Templates Wizard** dialog box. A second template named **Parcels** is added to the list of templates on the **Organize Feature Templates** dialog box.
- Right-click the second Parcels template in the list and click **Properties**.
- On the **Template Properties** dialog box, rename the template **Plan_Map9000**. Type **24** in the **Type** field, type **3** in the **Accuracy** field, and **Map 9000** in the **PlanName** field.

- Click **OK** to apply the template properties. Close the **Organize Feature Templates** dialog box.
Each time a fabric parcel is created using the Plan_Map9000 template, its type attribute is set to 24 (which is a Lot parcel for this data), its PlanName attribute is set to Map 9000, and its accuracy category is set to 3. Internally, parcels inherit their accuracy from the plan accuracy as well. You can override the plan accuracy by setting a different accuracy category on the parcel.

14. Save the edit session to complete the exercise.

The above exercise is an example of how templates can be used to automate the creation of new fabric features.

Creating a new parcel in automatic edit mode

In the parcel fabric, you can either create and edit parcels directly in the map in automatic edit mode or create edit parcels in fabric jobs in manual edit mode. In this exercise, you will create a new parcel in automatic edit mode.

Steps:

1. In ArcMap, click the Parcel Editor menu and click Options to open the Parcel Editor Options dialog box.
2. Under Edit Mode, make sure Automatic is selected.
3. Under Parcel view behavior, click the Automatically zoom to extent of parcels when editing option.

   In this exercise, you will create a parcel in the projected map. You also have the option to create and edit parcels in a stand-alone local coordinate data frame. To work in a local coordinate frame, click the View and edit parcels individually in a local coordinate system option.

4. Click OK to apply your changes and close the Parcel Editor Options dialog box.

5. If necessary, start an edit session and close the Create Features window.

6. Click the Select Parcel Features tool on the Parcel Editor toolbar, right-click parcel 97 in the map, then click Unjoin.

The Parcel Explorer window becomes visible, and the parcel you unjoined is listed under Unjoined Parcels.

Tip: If the Parcel Explorer window is not visible, click the Parcel Explorer Window tool on the Parcel Editor toolbar.

You are going to enter a new traverse for parcel 97. You can leave the existing parcel 97 as unjoined. Unjoined parcels are not part of the fabric layer.
but can be opened at any time and joined back to the parcel fabric at any time.

**Tip:** To delete a parcel instead of unjoining it, right-click the parcel in the map and click **Delete**. You can also delete unjoined parcels by right-clicking the parcel in the **Parcel Explorer** window and clicking **Delete**.

7. Zoom to the area where the new parcel will be added to the fabric layer.

![Zoom to the area where the parcel will be added to the fabric layer.](image)

8. Click **Parcel Editor** > **Plan Directory** to open the **Plan Directory** dialog box.

9. Right-click the plan you created in the exercise above (Map 9000) and click **New Parcel**.

![Plan Directory dialog box with New Parcel option highlighted.](image)

The **Construction** tool becomes available in the map, and the **Parcel Details** dialog box becomes visible.

**Tip:** If you do not want to work with plans, you can right-click the `<map>` plan, which is a system default plan. All parcels will simply have `<map>` as their associated plan.

**Tip:** If the **Parcel Details** window is not visible, click the **Parcel Details** tool on the **Parcel Editor** toolbar.

10. Click anywhere in the map to add the starting point of the parcel traverse.
11. On the Parcel Details dialog box, make sure the Properties tab is active.
12. Click the Template button and choose the Plan_Map9000 template on the Select Feature Template dialog box. Click OK.
   Notice under the Properties tab that the Plan_Map9000 template has the Type field set to 24, the PlanName field to Map 9000, and the Accuracy field to 3 - 1908 to 1980.
13. Type 97 for the parcel Name field.
14. Click the Lines tab on the Parcel Details window to begin entering the parcel traverse.
   Templates have been defined for fabric line types in the tutorial data. The lines sublayer was displayed and symbolized by line type, and templates were created for each type so that line symbology could easily be applied to parcel traverse lines in the lines grid.
15. On the Lines grid, click the Template field and choose the Frontage template for the first line in the parcel traverse.
16. Type 32-30-0-2 (SE quadrant bearing shortcut) in the Bearing field and 69.00 in the Distance field. Press ENTER to create the first line.
17. Type a Bearing value of 57-30-0-3 (SW) and a Distance value of 114.00 for the second traverse line.
18. Type a Bearing value of 32-30-0-4 (NW) and a Distance value of 69.00.
19. For the last traverse line, type a Bearing value of 57°30'0"-1 (NW) and a Distance value of 114.00'.
   Typing an asterisk (*) after the distance value indicates that this is the last traverse line and that the line's to-point should be the same as the starting from-point of the traverse, which is 1. Once the traverse is closed onto its starting point, misclose information for the traverse is displayed at the bottom of the Parcel Details dialog box.

20. On the Parcel Details dialog box, click the Keep changes to parcel data and join command to save the parcel and begin joining the parcel to the fabric.

   **Tip:** You can also click the Keep changes to parcel data command to save the parcel as unjoined. In the Parcel Explorer window, you can right-click the parcel and click Join to join the parcel to the fabric at any time.

   Parcel joining is an interactive process where the parcel points of a floating parcel or group of parcels are matched with their corresponding points in the parcel fabric.

21. With the Join Parcel dialog box open, drag the new, floating parcel and position it such that join lines can be easily established.

22. Click the Create Join Link Using a Dragbox Around a Fabric Point and a Join Point tool on the Join Parcel dialog box and drag a box around the joining parcel's top left point and the corresponding fabric point to create your first join link.

23. Repeat step 22 to join the joining parcel's bottom right point.

   **Tip:** You can also use the Construction tool to manually snap on the joining parcel's point and snap on the corresponding fabric point to create a join link.

24. Click Auto Join on the Join Parcel dialog box to detect the remaining join lines.

   Notice that there are join residuals displayed in the Join Parcel dialog box.
   Join residuals are computed from a transformation between the joining parcel's points and the corresponding points in the parcel fabric. If only two points are joined, a Helmert transformation is used. If more than two points are joined, a least-squares transformation is used. Each time another point is joined, join residuals scale, and rotation are recalculated. Join residuals are an indication of how well the joining parcel fits with the surrounding fabric.

25. Click OK on the Join Parcel dialog box to complete the join.
26. Save the edit session to complete the exercise.

Creating a new parcel in manual edit mode

In manual edit mode, parcels are created and edited in fabric jobs. Jobs are tracked in the job book and can be saved and reopened at any time. In this exercise, you will create the same parcel that was created in the above exercise, but this time you will work in a fabric job.

Steps:
1. On the Parcel Editor Options dialog box, choose the Manual edit mode. Leave View and edit parcels individually in a local coordinate system unchecked. You will now create and open a job to enter your new parcel:
   1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor toolbar.
   2. Drag a box to select the parcels shown in the graphic below that will be part of the job. When creating a new parcel in a fabric job, the appropriate reference parcels should be added to the job so that the new parcel can be joined to the fabric layer.
   3. Click the Parcel Editor menu and click Modify to open the parcels in a job.

   Note: Job workflow commands, such as Modify and Finish Job, are available under the Parcel Editor menu when the fabric edit mode is set to manual.

The parcels are opened in a fabric job with the selected parcels displayed as active and the surrounding, nonjob parcels dimmed. The Parcel Explorer window becomes visible and lists all the parcels in the open job, grouped by their plans.

Tip: You can also open an empty fabric job. With no parcels selected, click Parcel Editor > Modify. You would create an empty fabric job when adding parcels to an empty parcel fabric.

Tip: You can also formally create a job with a name and description by clicking Parcel Editor > Create Job. On the Create New Job dialog box, you can specify the parcels that will be edited as well as the surrounding reference or job parcels.

Learn more about the Create New Job dialog box.
Before adding the new parcel, you need to unjoin and delete the existing parcel 97.
5. Using the Select Parcel Features tool, right-click parcel 97 and click Unjoin.
The parcel is listed as an unjoined parcel in the Parcel Explorer window.

6. Click the Create A New Parcel In A New Plan tool on the Parcel Editor toolbar.

7. On the Parcel Details dialog box on the Properties tab, click the Plan button, choose Map 9000 on the Plan Directory dialog box, then click Set as Active Plan.

8. Click the Template button, choose the Plan_Map9000 template on the Select Feature Template dialog box, then click OK.
The template is applied to the new parcel.

9. On the Property Details dialog box, type 97 as the parcel name.

10. Click in the map to add the starting point of the parcel traverse.

11. Follow steps 17 to 25 under the Creating a new parcel in automatic mode exercise to create and join your parcel.

12. Once you have joined your new parcel to the surrounding job parcels, click Parcel Editor > Finish Job to post your job changes back to the parcel fabric layer.
Once the edit session is saved, the job changes are committed to the geodatabase.

Tip: To reopen the job, click Parcel Editor > Job book and double-click the job listed on the Job Book dialog box.

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Tutorial: Running a fabric least-squares adjustment

This topic applies to ArcEditor and ArcInfo only.

This tutorial describes a workflow for a parcel fabric least-squares adjustment. The fabric adjustment uses the stored bearings and distances on the parcel lines, together with the control point coordinates, to obtain a best-fit solution of all the spatial information. In this tutorial, the control points have already been entered and linked to their corresponding fabric points. After the adjustment completes, an adjustment summary is presented. The adjustment summary is used to better understand attribute information on the lines and to identify any problems with the data that may need to be corrected. Once the problems have been fixed, the fabric point data is adjusted. The adjustment is run repeatedly until the maximum displacement in the northings and eastings are close to zero, meaning that the adjustment has converged onto an optimal solution.

Steps:

1. Open ArcMap and load the Parcel Editing map document (ParcelEditing.mxd) from your \ArcTutor\Parcel Editing\ folder.
2. Zoom to the fabric adjustment area shown below or click the Bookmarks menu and click Fabric Adjustment Area.
3. Click the **Parcel Editor** arrow and click **Start Editing**.
4. Close the **Create Features** window. You will not work with this window in this tutorial. Before running a fabric adjustment, you will do a check fit of the control network. The check fit process checks how well the parcel network fits with the control network.

   **Note:** It is always good practice to run a check fit on your control points before running a fabric least-squares adjustment. The check fit residuals indicate how well the parcel network will fit with its control network. Parcel lines are going to have to adjust at least by the amount of the check fit residuals in the least-squares adjustment. Therefore, check fit residuals can be used as a guideline for setting adjustment tolerances on the Adjust Coordinates dialog box. If check fit residuals are large and inconsistent with each other, it makes no sense to run a least-squares adjustment. Parcel lines are going to have to adjust at least by that amount, and the result will be an unstable adjustment. The reasons for the large and inconsistent residuals should be identified first, and the problems should be rectified. In most cases, very large check fit residuals are caused by control points that are linked to the wrong fabric point.

5. Click the **Maintain Control Points** tool on the **Parcel Editor** toolbar. All visible control points in the map extent are listed on the **Control** dialog box.
6. Click the **Check Fit** button. Check fit residuals are displayed next to each control point.

Since all residuals are 0, the parcel network fits very well with the control network. Check fit residuals don’t need to be 0 to run a fabric adjustment but should be within an acceptable range. In this case, residuals of 2 feet and above would be investigated before a fabric adjustment is run.

7. Close the **Control** dialog box.
8. Click the **Select Parcel Features** tool on the **Parcel Editor** toolbar and drag a box to select all the parcels in the fabric adjustment area.

9. Click the **Parcel Editor** arrow and click **Adjust**. When first doing an adjustment on a new set of parcel data, the initial step is to use the adjustment summary displayed in the **Least Squares Adjustment Summary** dialog box to understand how good the COGO attributes are and to understand if there are any potential problems in the data that need to be fixed. The adjustment process will compute coordinates that are the best-fit position for all the fabric points; this computation uses all the bearing and distance values on the lines.
The adjustment summary compares the new positions of the parcel lines with the original observed or recorded COGO values and reports the differences between the computed and observed values. These numbers are called residuals, or computed minus observed (c-o) values. Any residuals that are large compared with the check tolerance you specify are outliers, meaning that they fall outside your expected range. This means that the check tolerance you specify defines your tolerance for outliers in the data. If you choose a higher check tolerance, it means that you are willing to accept larger differences between the adjusted end points of lines and the associated COGO values. The report will only show (c-o) values that are greater than the distance or bearing check tolerance that you specify. Until you get to know the data, you will not know what to use as check tolerances. The approach described in this tutorial shows how to interpret results in the adjustment summary, allowing you to get to know your parcel data and choose appropriate check tolerances for the parcels that you are adjusting.

Learn more about check tolerances on the Adjust Coordinates dialog box.

The distance check tolerance is the best tolerance to use when getting to know the parcel record data.

10. On the Adjust Coordinates dialog box, change the Check Tolerance for Distances. Type a value of 0.100 US Survey Feet.

In this example, you start with the assumption that the data is very good, and you expect the adjustment to succeed with all residuals less than 0.3 feet (3 times the distance check tolerance).

Note: A fabric adjustment fails if any residual is greater than three times the bearing or distance check tolerance.

11. Accept all other defaults on the Adjust Coordinates dialog box and click Run.

The Least Squares Adjustment Summary dialog box appears and reports that the adjustment fails.

12. Scroll down the report to find the heading Parcel Lines Report - Difference between Computed and Observed/Recorded (c-o).

The screen shot below displays part of the parcel lines report.

Outliers are indicated in the report with a # symbol. Note that there are five lines in the report with this symbol, and also that the last line of the report explains that the problem with these lines are that the difference between their recorded distance values and the new computed position exceed three times the tolerance that you specified. In other words, the differences between the computed distances and the recorded distances for these five lines are all greater than 0.30 feet.

Note: The residuals are determined by a preliminary adjustment; none of the points have had their positions changed in the database at this stage.

These five outliers in the lines occur in two parcels, called LS 269 / LS 269 and ROS 692/ROS 692. (These parcels have been stored to represent the plan boundaries, and so the plan name and parcel name are the same. The convention for naming in the report is [parcel name]/[plan name].)

The largest outlier of these five lines is 0.622 feet. This means that for the adjustment to succeed, the Distances check tolerance should be at least one-third of this value—in other words, after rounding to two decimals, at least 0.21 feet.

One simple approach to have the adjustment succeed is to increase the check tolerance. However, if the check tolerance required for the adjustment to be successful is very large (10 feet or more), then this is a strong indication of a mistake in the data. In these cases, it is important to check that the values recorded for these reported problem lines match the original record values, as found on the legal description for the parcel.

Notice that there are also two points with the object ID’s 876 and 881 that are very close to each other. These two points are listed under the Close.
Points Report. Close points are fabric points that are closer than the specified Close Points tolerance and that do not have a line between them.

Close points indicate that it is very likely the points should be the same point, that there is a topological inconsistency, and that these points should be merged. It is important to merge close points, because by doing so you are increasing the redundancy in the network; this is good for helping the adjustment succeed. For example, if there are two points close together that each have two lines defining their positions, you can merge the points and increase the redundancy by having four lines defining the position of just one point.

The least-squares adjustment summary has provided you with information about the actions needed to make this adjustment successful: first, to increase the check tolerance, and second, to merge some close points. It is important to note that increasing the check tolerance to 0.21 feet will make this adjustment succeed for this particular set of parcel data. However, after the points are merged, the data will have been changed, and different adjustment summary results will be expected. A good rule of thumb, if the previous adjustment was not successful, is to use three times the previously used value. In this case, use 0.3 feet. First, however, the close points need to be merged.

The fabric is not editable when the Least Squares Adjustment Summary dialog box is open; however, the information in the adjustment summary is also available in the results file.

13. Click the Results File button to access the results file of the adjustment summary.
14. Click Cancel to close the Least Squares Adjustment Summary dialog box.
15. Click Cancel to close the Adjust Coordinates dialog box.
16. Using the Select Parcel Features tool and drag an empty box on the map display to clear the selection of the parcels that were adjusted. You will now merge the close points. To locate the points, you will use the point reporting tool located on the Parcel Editor toolbar.
17. Click the Point Reporting on 1, 2 or 3 Points tool located on the Parcel Editor toolbar.
18. If necessary, move the Point Report dialog box such that all the adjustment parcels are visible.
19. On the Point Report dialog box, click the one point button and type 876 in the Point ID text box.
20. Click the Report button. Coordinate information, point scale, and convergence are displayed for the point.
21. Click the Map Location button. The map is panned to center on the point that is reported, and the point location flashes briefly in the map.
22. In the Table Of Contents window, right-click the points sublayer and click Label Features to turn on point ID labels for the points.
23. With the Point Report dialog box open, click the Zoom In tool located on the Tools toolbar and drag a box to zoom to the location of point ID 876. You will need to zoom in several times to locate the point. As you zoom in to the point, you may need to click the Map Location button several times to get an idea of where the point is in the map.
24. Close the **Point Report** dialog box.

25. Click the **Merges Unconnected Points Inside a Given Rectangle** tool located on the **Parcel Editor** toolbar.

26. Drag a box around the close points.

27. Click **OK** on the **Mean Points** dialog box to accept the default mean point tolerance. The points are meaned (averaged) and merged into a single point.

28. Close the adjustment results file.

29. Zoom back to the extent of the adjustment parcels. Click the Bookmarks menu and click **Fabric Adjustment Area**.

30. Open the job book. Click the **Parcel Editor** arrow and click **Job Book**. Notice that there is a job with a “Mean Points” description. Each edit is tracked automatically in the job book, and the job book provides an audit of edits on the fabric.


32. Click the **Select Parcel Features** tool on the **Parcel Editor** toolbar and drag a box to select all the parcels in the fabric adjustment area as you did in step 6.

33. Click **Parcel Editor > Adjust**. Since the adjustment data has been edited by the merging of two points, you should expect the behavior and results for the adjustment summary to be slightly different. It was previously determined that a distance tolerance of 0.21 feet should be used for the adjustment to succeed. To be assured that the adjustment succeeds, you will use three times the previously used number, and use 0.3 as the tolerance.

34. Type **0.3** for the **Distances** check tolerance on the **Adjust Coordinates** dialog box.

35. Click **Run**.
The adjustment completes successfully. Notice that there is now information displayed about the maximum shift of the adjustment.

Maximum shift, which is the largest coordinate shift in the adjustment, is displayed above the Accept button for quick access. The same maximum shift information is displayed in the adjustment summary with the point ID. In this adjustment, the point with an ID of 884 moved more than any other point in the adjustment and had a shift in easting of -0.55 feet and a shift in northing of 0.139 feet.

In the fabric least-squares adjustment, the goal is to rerun or iterate the adjustment until the points are no longer changing and the maximum shift becomes 0.00 feet for both easting and northing. The fabric adjustment needs to be manually iterated—iteration is not automatic.

36. Click Accept on the Least Squares Adjustment Summary dialog box.

37. On the Adjust Coordinates dialog box, click Run to perform the second iteration of the adjustment. Notice that the maximum shift is now at point ID 1018, and it has moved less than one hundredth of a foot.

Since the shift value approached closer to zero after the second adjustment, the fabric adjustment is converging. If the shift values become higher after the first iteration, this indicates that the adjustment is diverging. A diverging solution happens when one of two things has occurred:

a. There is a large blunder in the dataset, and no solution is possible until the blunder is corrected.

b. The best solution for the given dataset has already been reached, and the solution converges only to diverge on the next iteration. This occurs when 0.00 easting and 0.00 northing convergence is too stringent for the quality and precision of the dataset.

If the data is good quality and there are no major blunders, a fabric least-squares adjustment will usually converge after three iterations.

38. Click Accept and run the adjustment for the third iteration.

The maximum shift of 0.001 easting and 0.000 northing shows that the adjustment has converged.

39. Click Accept for the third time on the Least Squares Adjustment Summary dialog box and click OK.

40. Click OK on the Adjust Coordinates dialog box to apply and complete the adjustment.

41. Click Parcel Editor > Save Edits to save the edit session and complete the tutorial.

Tip: Once a fabric adjustment has converged, you can run the adjustment one more time to perform the postprocessing options under Plan Structure Constraints on the Adjust Coordinates dialog box. An adjustment should be converged first; plan structure constraints are performed afterwards.

Related Topics
About the parcel fabric feature adjustment

Plans and the survey record

This topic applies to ArcEditor and ArcInfo only.

The parcel fabric organizes parcel data based on the form in which the data was originally recorded. In most cases, parcel data is recorded on plans, or records of survey. Plans/Plats, or records of survey, are legal documents used by surveyors and engineers to describe and map the findings of their fieldwork. In addition to a drawing of the survey measurements, plans contain other information such as the following:

- The legal description of the surveyed area
- Easement and right-of-way description
- Landownership information
- Approval statements
- Name of the surveyor
- Legal date the plan was recorded
A parcel in the parcel fabric can be associated with one plan or record of survey. Parcels are usually entered into the parcel fabric directly from subdivision plans or digital submissions of plans.

Plans are the transactional model in the parcel fabric; parcel entry and editing are based on submitted plans. Parcels are created and edited in response to changes in the legal record. Changes in the legal record are typically reflected in the submission of a new plan or record of survey.

**Related Topics**

Working with the plan directory

This topic applies to ArcEditor and ArcInfo only.

The Plan Directory dialog box stores and displays a list of plans/plats or records of surveys existing on the parcel fabric. A plan, plat, or record of survey is the legal document that defines and describes the parcel. Surveyors and engineers record and describe their fieldwork on a plan, plat, or record of survey. For example, once the survey of a subdivision is complete, the survey is recorded on a plan, plat, or record of survey for registration. In the parcel fabric, parcels should ideally match their definition (dimensions, area) on the plan, plat, or record of survey.

In the fabric, parcels can be grouped by their plan, plat, or record of survey. Plan information is stored in the Fabric_Plans table. Each parcel has a PlanID attribute field containing the ID of the plan in the plans table. Plan information can be migrated into the parcel fabric or created during editing.

A new plan can be created directly in the Plan directory by clicking the Create Plan command.

A new parcel is created in a plan or can be created in a system default <map> plan if you do not want to work with plans. New parcels are created from parcel traverse, construction, split, division, merge, and so on. When creating a new parcel, a plan is selected from the Plan Directory.

In the Plan Directory dialog box, you can display plans by a date range, an attribute query, or the current map extent or search for plans.
About the parcel fabric layer

This topic applies to ArcEditor and ArcInfo only.

The parcel fabric is added as a group layer to ArcMap. A group layer organizes a set of related layers under a single layer in the table of contents in ArcMap. The group layer can be expanded or collapsed to show or hide the related sublayers. The internal feature classes that comprise a parcel fabric are represented as sublayers under the parcel fabric group layer.

The parcel fabric group layer is composed of the following set of sublayers:
- Control points
- Line points
- Points
- Lines
- Parcels

A parcel fabric group layer works just like a regular group layer in ArcMap, but layers cannot be added to, or removed from, the parcel fabric group layer.

Parcel fabric sublayers

Each sublayer of the parcel fabric layer can be queried and displayed like normal feature layers in ArcMap. You can right-click each sublayer to display its attribute table. In each sublayer's attribute table, all non-system managed attributes are editable. System-managed attributes, such as FromPointID and ToPointID on the lines table, are locked and are not editable.

**Control sublayer**

The control sublayer displays control points in the parcel fabric. By default, control points are displayed by their active status. A control point is active if it is checked on the Control dialog box and is connected to a fabric point. The following attributes are visible in the control sublayer attribute table:

<table>
<thead>
<tr>
<th>Attribute field</th>
<th>Description</th>
<th>Editable in attribute table</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X-coordinate; held fixed</td>
<td>No</td>
</tr>
<tr>
<td>Y</td>
<td>Y-coordinate; held fixed</td>
<td>No</td>
</tr>
<tr>
<td>Z</td>
<td>Z-coordinate; held fixed</td>
<td>No</td>
</tr>
<tr>
<td>Name</td>
<td>Control point name; automatically populated if no name is specified</td>
<td>No</td>
</tr>
<tr>
<td>PointID</td>
<td>Corresponding fabric point (a control point needs to be connected to a fabric point to be used in the fabric adjustment.)</td>
<td>No</td>
</tr>
<tr>
<td>AccuracyXY</td>
<td>Horizontal positional accuracy; metadata only</td>
<td>Yes</td>
</tr>
<tr>
<td>AccuracyZ</td>
<td>Vertical accuracy; metadata only</td>
<td>Yes</td>
</tr>
<tr>
<td>Survey Date</td>
<td>The date the control point was surveyed/established</td>
<td>Yes</td>
</tr>
<tr>
<td>Active</td>
<td>True if control point is active and can be used in a fabric adjustment</td>
<td>No</td>
</tr>
<tr>
<td>Type</td>
<td>Used for adding subtypes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Line points sublayer**

The line points sublayer displays line points. Line points are those parcel points that sit on the boundary lines of adjacent parcels without splitting the boundary lines. Attribute fields in the line points table are all system managed. The following attributes are visible in the line points sublayer attribute table:

<table>
<thead>
<tr>
<th>Attribute field</th>
<th>Description</th>
<th>Editable in attribute table</th>
</tr>
</thead>
<tbody>
<tr>
<td>ParcelID</td>
<td>ID of the parcel containing the boundary line on which the line point sits</td>
<td>No</td>
</tr>
<tr>
<td>FromPointID</td>
<td>From-point of the boundary line on which the line point sits</td>
<td>No</td>
</tr>
<tr>
<td>ToPointID</td>
<td>To-point of the boundary line on which the line point sits</td>
<td>No</td>
</tr>
<tr>
<td>LinePointID</td>
<td>ID of the parcel point that is a line point</td>
<td>No</td>
</tr>
</tbody>
</table>
Points sublayer
The points sublayer displays parcel points in the parcel fabric. The following attributes are visible in the points sublayer attribute table:

<table>
<thead>
<tr>
<th>Attribute field</th>
<th>Description</th>
<th>Editable in attribute table</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X-coordinate; adjusted in fabric adjustment</td>
<td>No</td>
</tr>
<tr>
<td>Y</td>
<td>Y-coordinate; adjusted in fabric adjustment</td>
<td>No</td>
</tr>
<tr>
<td>Z</td>
<td>Z-coordinate</td>
<td>No</td>
</tr>
<tr>
<td>Type</td>
<td>Used for adding subtypes</td>
<td>Yes</td>
</tr>
<tr>
<td>Category</td>
<td>System-managed point type, for example, center point</td>
<td>No</td>
</tr>
<tr>
<td>Name</td>
<td>Name of corresponding control point if there is one</td>
<td>No</td>
</tr>
<tr>
<td>Historical</td>
<td>True if all lines sharing the point are historic</td>
<td>No</td>
</tr>
<tr>
<td>SystemStartDate</td>
<td>Date of database transaction that created the point</td>
<td>No</td>
</tr>
<tr>
<td>SystemEndDate</td>
<td>Date of database transaction that retired the point</td>
<td>No</td>
</tr>
<tr>
<td>LegalStartDate</td>
<td>Date of legal transaction that created the point</td>
<td>Yes</td>
</tr>
<tr>
<td>LegalEndDate</td>
<td>Date of legal transaction that retired the point</td>
<td>Yes</td>
</tr>
<tr>
<td>CenterPoint</td>
<td>True if the point is a center point</td>
<td>No</td>
</tr>
<tr>
<td>MaxDN</td>
<td>Maximum northing shift resulting from a fabric adjustment</td>
<td>No</td>
</tr>
<tr>
<td>MaxDE</td>
<td>Maximum easting shift resulting from a fabric adjustment</td>
<td>No</td>
</tr>
</tbody>
</table>

Lines sublayer
The lines sublayer displays parcel boundary lines. By default, parcel lines in the lines sublayer are displayed by their line categories. The following attributes are visible in the lines sublayer attribute table:

<table>
<thead>
<tr>
<th>Attribute field</th>
<th>Description</th>
<th>Editable in attribute table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated</td>
<td>True if dimensions are inverted from shape geometry</td>
<td>Yes</td>
</tr>
<tr>
<td>ParcelID</td>
<td>ID of parcel that contains the line</td>
<td>No</td>
</tr>
<tr>
<td>Sequence</td>
<td>Sequence order number of the line in the parcel traverse</td>
<td>No</td>
</tr>
<tr>
<td>FromPointID</td>
<td>ID of the from-point of the line</td>
<td>No</td>
</tr>
<tr>
<td>ToPointID</td>
<td>ID of the to-point of the line</td>
<td>No</td>
</tr>
<tr>
<td>Bearing</td>
<td>Direction of the line</td>
<td>No</td>
</tr>
<tr>
<td>Distance</td>
<td>Length of the line</td>
<td>No</td>
</tr>
<tr>
<td>Type</td>
<td>Used for adding subtypes</td>
<td>Yes</td>
</tr>
<tr>
<td>Category</td>
<td>Category of the line, for example, connection or radial line</td>
<td>Yes</td>
</tr>
<tr>
<td>Radius</td>
<td>Curved line parameter</td>
<td>No</td>
</tr>
<tr>
<td>ArcLength</td>
<td>Curved line parameter</td>
<td>No</td>
</tr>
<tr>
<td>Delta</td>
<td>Curved line parameter</td>
<td>No</td>
</tr>
<tr>
<td>CenterPointID</td>
<td>ID of the point that is the center point of the curve</td>
<td>No</td>
</tr>
<tr>
<td>Historical</td>
<td>True if the line's associated parcel is historic</td>
<td>No</td>
</tr>
<tr>
<td>Radial Bearing</td>
<td>Bearing of a radial line generated by a curved line</td>
<td>No</td>
</tr>
<tr>
<td>Tangent Bearing</td>
<td>Bearing of the curve tangent</td>
<td>No</td>
</tr>
<tr>
<td>Line Parameters</td>
<td>Specifies whether line is curved or straight</td>
<td>No</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Accuracy level of the line</td>
<td>Yes</td>
</tr>
<tr>
<td>ComputedMinusObserved</td>
<td>Difference between the distance of the recomputed line shape from the least-squares adjustment and the recorded distance</td>
<td>No</td>
</tr>
<tr>
<td>Internal Angle</td>
<td>Populated when parcel traverse is defined from internal angles instead of bearings</td>
<td>No</td>
</tr>
<tr>
<td>Reference Object</td>
<td>Populated when parcel traverse is defined from internal angles instead of bearings</td>
<td>No</td>
</tr>
<tr>
<td>IsMajor</td>
<td>System-managed field, reserved for storing curves greater than 180 degrees</td>
<td>No</td>
</tr>
<tr>
<td>Hide</td>
<td>True if line dimension is duplicate of overlapping line (Duplicate label will be hidden.)</td>
<td>Yes</td>
</tr>
<tr>
<td>SystemStartDate</td>
<td>Date of database transaction that created the line</td>
<td>No</td>
</tr>
<tr>
<td>SystemEndDate</td>
<td>Date of database transaction that retired the line</td>
<td>No</td>
</tr>
<tr>
<td>LegalStartDate</td>
<td>Date of legal transaction that created the line</td>
<td>Yes</td>
</tr>
<tr>
<td>LegalEndDate</td>
<td>Date of legal transaction that retired the line</td>
<td>Yes</td>
</tr>
<tr>
<td>DensifyType</td>
<td>System-managed field used for storage of natural boundaries</td>
<td>No</td>
</tr>
</tbody>
</table>

Parcels sublayer
The parcels sublayer displays the parcel polygons. The following attributes are visible in the parcels sublayer attribute table:

<table>
<thead>
<tr>
<th>Attribute field</th>
<th>Description</th>
<th>Editable in attribute table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joined</td>
<td>True if the parcel is joined to the fabric</td>
<td>No</td>
</tr>
</tbody>
</table>
Symbolizing the parcel fabric layer

When a parcel fabric layer is loaded into ArcMap, the Points and LinePoints layers are turned off for display simplicity. Parcel fabric sublayers layers behave in the same way as normal feature class layers and can be turned on and off at any time by clicking the check boxes next to each sublayer. Parcel fabric sublayers can be symbolized, identified, and labeled like regular layers in ArcMap. For example, the lines sublayer can be displayed by line type, and the parcels sublayer can be queried by parcel PIN.

Querying and displaying the parcel fabric layer

The parcel fabric group layer allows powerful query and display of the parcel fabric. Because parcel fabric feature classes and tables are internally related to each other, the parcel fabric sublayers can be queried with respect to each other. For example, parcels can be queried by their related lines. The following list describes some examples of querying parcels in the parcel fabric:

- Parcels can be queried and displayed by plan (record of survey).
- Parcels can be queried and displayed by line type, for example, road frontage or back lot boundary.
- Parcels can be queried and displayed by accuracy level.
- Parcels can be queried and displayed by their misclose information, such as MiscloseRatio and MiscloseDistance.

Related Topics

- A quick tour of map layers
- Adding new attributes to parcel fabric tables
- Labeling and annotating parcel fabric sublayers

Adding a parcel fabric as a layer to ArcMap

Follow these steps to add a parcel fabric layer to ArcMap:

1. In ArcMap, click the Add Data button on the Standard toolbar.
2. On the Add Data dialog box, navigate to and select the parcel fabric that you want to add to the map and click Add. The parcel fabric is added as a group layer and is listed in the Table of Contents window in ArcMap.
3. Click the plus sign next to the parcel fabric layer to expand the layer and show the sublayers.

Feature templates and the parcel fabric

This topic applies to ArcEditor and ArcInfo only.

What are feature templates

In ArcGIS 10, features are created through the use of feature templates. Feature templates define all the information required to create a feature: the layer

<table>
<thead>
<tr>
<th>PlanID</th>
<th>ID of the parcel's associated plan</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Parcel name or parcel identification number (PIN)</td>
<td>Yes</td>
</tr>
<tr>
<td>Type</td>
<td>Used for adding subtypes</td>
<td>Yes</td>
</tr>
<tr>
<td>Stated Area</td>
<td>Area of parcel polygon; automatically calculated if misclose is small; can be edited to reflect recorded plan value</td>
<td>Yes</td>
</tr>
<tr>
<td>Compiled</td>
<td>True if parcel polygon is generated from inverted dimensions</td>
<td>Yes</td>
</tr>
<tr>
<td>Historical</td>
<td>True if parcel is historic; automatically true if Construct from parent or Merge is used</td>
<td>No</td>
</tr>
<tr>
<td>SystemStartDate</td>
<td>Date of the database transaction that created the polygon</td>
<td>No</td>
</tr>
<tr>
<td>SystemEndDate</td>
<td>Date of the database transaction that retired the polygon</td>
<td>No</td>
</tr>
<tr>
<td>LegalStartDate</td>
<td>Date of the legal transaction that created the parcel; should match the plan date</td>
<td>Yes</td>
</tr>
<tr>
<td>LegalEndDate</td>
<td>Date of the legal transaction that retired the parcel; should correspond to the plan date of the replacing parcel(s)</td>
<td>Yes</td>
</tr>
<tr>
<td>GroupID</td>
<td>Populated with an ID if the parcel is part of an unjoined group</td>
<td>No</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Accuracy level of the parcel</td>
<td>Yes</td>
</tr>
<tr>
<td>Rotation</td>
<td>Automatically calculated from the joining process</td>
<td>No</td>
</tr>
<tr>
<td>Scale</td>
<td>Automatically calculated from the joining process</td>
<td>No</td>
</tr>
<tr>
<td>Unclosed</td>
<td>True if the parcel is an unclosed polygon</td>
<td>No</td>
</tr>
<tr>
<td>MiscloseRatio</td>
<td>Ratio of parcel misclose distance to parcel perimeter; system managed</td>
<td>No</td>
</tr>
<tr>
<td>Misclose Bearing</td>
<td>Bearing needed to close the parcel; system managed</td>
<td>No</td>
</tr>
<tr>
<td>Construction</td>
<td>True if the parcel is a construction; system managed</td>
<td>No</td>
</tr>
<tr>
<td>ShapeStdErrorE</td>
<td>Easterly shift/distortion in parcel shape after fabric adjustment; system managed</td>
<td>No</td>
</tr>
<tr>
<td>ShapeStdErrorN</td>
<td>Northerly shift/distortion in parcel shape after fabric adjustment; system managed</td>
<td>No</td>
</tr>
<tr>
<td>BacksightBearing</td>
<td>Populated when parcel is defined from internal angles instead of bearing</td>
<td>No</td>
</tr>
</tbody>
</table>
where a feature will be stored, the attributes a feature is created with, and the default tool used to create that feature. If templates are not present when you start editing, they are automatically created for each layer in the current editing workspace. Templates are saved in the map document (.mxd) and the layer file (.lyr).

Learn more about feature templates

Feature templates and the parcel fabric

Feature templates are created for parcel fabric sublayers in the current editing workspace. When defining feature templates for a parcel fabric sublayer, you do not need to set a default tool, as parcels are created and edited with only one tool in the parcel fabric.

Feature templates are useful additions to your parcel fabric data model. Templates can help maximize editing efficiency and minimize attribution error. For example, when creating parcels, you might use templates on your lines sublayer that set different accuracy and category values for different line types that you have defined. Any additional attributes that you add to fabric tables can also be automatically populated with specific values through a feature template.

**Note:** Feature templates in the parcel fabric can only be applied to new parcels created through the New Parcel, Parcel Division, Parcel Merge, Parcel Remainder, and Construction tools.

In the screen shot below, feature templates have been defined on the lines sublayer, which has been displayed by line type in ArcMap. The Boundary template sets the line category to 0 (Boundary) and the line accuracy to 3.

In the parcel traverse grid, when the Boundary template is specified for a parcel traverse line, the line category is automatically set to 0 and the accuracy set to 3.

**Caution:** When digitizing parcel traverse lines, the accuracy level is always set to 6 regardless of the value used by the template.

Related Topics

Defining feature templates for fabric sublayers

This topic applies to ArcEditor and ArcInfo only.

A default template is always created for any layers or sublayers in ArcMap. To define a new template for a parcel fabric sublayer, symbolize the layer into the types for which you want to define templates. For example, in the screen shot below, the fabric parcels and lines sublayers are symbolized and displayed by line and parcel type.
Steps:
To define templates for your symbolized fabric sublayer, follow these steps:

1. Right-click the fabric sublayer for which you want to define templates and click **Edit Features > Organize Feature Templates.**
2. On the **Organize Feature Templates** dialog box, click the **New Template** command.
3. On the **Create New Templates Wizard** dialog box, make sure the sublayer you are working with is checked and click **Next.**

The symbolized layer types are displayed in the next page of the Create New Templates wizard

4. Select those types that you want to create templates for and click **Finish.**

The layer types that you selected are now available as templates for the selected layer under the **Layers** list on the **Organize Feature Templates** dialog box.

5. Select a layer type and click **Properties** to define the template properties for that layer type.
6. In the **Template Properties** dialog box, enter values in the available attribute fields that you would like to be automatically populated the next time you create a parcel or line using this type.

**Tip:** You can define templates on fabric sublayers that have been symbolized using any field from the attribute table. For example, when the fabric layer is added to ArcMap, the Lines sublayer is symbolized by Category by default. You can define templates on any of the symbolized line categories.

**Tip:** If you add any additional attributes to any of the fabric sublayers, these attributes will be available in the **Template Properties** dialog box.

Related Topics

- About feature templates
- Best practices for using feature templates
- Creating new feature templates
- Organizing feature templates
- Setting feature template properties

Labeling and annotating parcel fabric sublayers
This topic applies to ArcEditor and ArcInfo only.

You can label or annotate features in parcel fabric sublayers using the same methods that are used to annotate normal feature layers in ArcMap.

You can also create feature-linked annotation for features in the parcel fabric. Feature-linked annotation is a special type of geodatabase annotation that is directly linked to features. Feature-linked annotation moves and updates with the feature to which it is linked. For example, if the distance on a parcel line is updated, feature-linked annotation will update to show the new distance value.

Feature-linked annotation can be created for the following parcel fabric feature classes:
- Control points
- Lines
- Parcels
- Points

Feature-linked annotation links to parcel fabric feature classes through a composite relationship. The parcel fabric feature classes are the origin feature classes in the relationship.

When editing parcels in the parcel fabric, any feature-linked annotation is updated when edits are made to the data referenced by the annotation. For example, if you change the dimension of a parcel boundary (bearing, distance), the feature-linked annotation will update to reflect the change once the parcel changes are saved.

If parcels are edited in an open parcel fabric job, the feature-linked annotation will be updated once the job is posted back to the parcel fabric and the edit session is saved.

Running a fabric adjustment can result in a large number of parcel fabric features being moved. Feature-linked annotation will automatically be repositioned for adjusted parcel fabric features.

**Note:** A fabric adjustment does not alter the dimension values of a parcel. Only parcel fabric point coordinates (x,y,z) are updated in a fabric adjustment. Parcel boundary lines are updated to fit between the newly adjusted points.

Adjusting associated features using the **Feature adjustment tool** can also result in a large number of standard features being moved. If a feature class is associated with the parcel fabric, it is recommended that its corresponding annotation also be associated with the parcel fabric. In this way any annotation, whether it is feature linked or not, is repositioned consistently with its feature classes when its feature classes are adjusted using the **Feature adjustment tool**.

**Steps:**
1. Right-click the feature dataset containing the parcel fabric for which you want to create feature-linked annotation. Click **New > Feature Class**.
2. Type the name you want to use for your annotation class in the **New Feature Class** dialog box.
3. Click the drop-down arrow and click **Annotation Features** for the feature type.
4. Check the **Link the annotation to the following feature class** box.
5. Click the drop-down arrow and choose the parcel fabric feature class that will be linked to the new annotation feature class.
6. Click **Add**. Continue with these steps for creating a feature-linked annotation feature class in a feature dataset.

**Related Topics**
- Converting labels to annotation
- Essential annotation and graphic text concepts
- Essential labeling concepts

Managing duplicate labeling on fabric parcels

This topic applies to ArcEditor and ArcInfo only.

In ArcGIS 10, the Hide field is available on the parcel fabric lines table for the management of duplicate labeling for common parcel boundaries. In many cases, overlapping lines in the parcel fabric have the same bearing and distance and thus result in duplicate labels for a common parcel boundary.

For example, in parcel 7 below, the top, or northern, boundary line needs to be labeled on either side. This is because two slightly different dimensions were recorded for the same boundary in adjacent parcels. In the parcel fabric data model, each parcel has its own set of lines resulting in overlapping lines for a common parcel boundary. The benefit of this model is that differing dimensions can be displayed for a common parcel boundary.

The bottom or southern boundary line of parcel 7 has only one label for each dimension. This is because both overlapping lines have the same bearing and distance, and thus, it is only necessary to label one of the overlapping lines and hide the other duplicate labels.
Applying the Hide field

In the fabric, the Hide field on the parcel lines table will automatically be flagged to 1 (true) when dimensions are inversed and detected as duplicates for a common parcel boundary. For example, if data is migrated to the parcel fabric and dimensions are inversed for parcel lines, and if duplicate dimensions are detected for a common parcel boundary, the Hide field will be flagged to 1 (true) for one of the parcel lines. Another example is when parcels are built from line work in the parcel construction environment. If duplicate dimensions are used for a common parcel boundary, the Hide field will automatically be flagged to 1 (true) for one of the parcel lines.

When labeling dimensions on the parcel lines sublayer, the Hide field is then used in a label expression to remove duplicate labels. For example, in the following label expression function, only those parcel lines with a Hide value of 0 (false), are labeled with a bearing and distance.

Label Expression

```vbnet
Function FindLabel ([Bearing], [Distance], [Hide], [Category])
  if(([Hide]=0) and (((Category)=5) or ([Category]=0))) then
    FindLabel = [Bearing] & " " & [Distance]
  End if
End Function
```

Note: If your fabric was created in a previous version of ArcGIS, you need to upgrade the fabric to an ArcGIS 10 parcel fabric so that the Hide field is added to your parcel lines table.

If you are entering dimensions on your parcels, or if you have an existing fabric created prior to ArcGIS 10, you can manually set the Hide field to 1 (true) for duplicate dimensions and use the same label expression described above.

Related Topics
Building label expressions

Identifying parcel fabric features in ArcMap

You can use the Identify tool on a parcel in the fabric to explore the fabric data model structure. For example, when you click a parcel with the Identify tool, the parcel’s attributes are displayed as well as its internal relationships. You can expand the parcel node to view the parcel’s related lines, linepoints, and plans. Expanding the Lines node reveals the related points for the line (from and to) and so on.
Steps:
To identify a parcel in the fabric, follow these steps:
1. Click the Identify button on the Tools toolbar in ArcMap.
2. With the Identify pointer, click on a parcel in the parcel fabric.
   The Identify dialog box appears, displaying the results of your identify query.

History in the parcel fabric layer

This topic applies to ArcEditor and ArcInfo only.
In many cadastres, the chain of title is essential to the security of the present holder of the title. It is this evidence that validates a claim. A parcel database must not only provide an accurate representation of the current parcel boundaries but also a historic record of changes to the parcel boundaries. In the United States, the validity of title or rights on a parcel of land is based on evidence of previous land surveys and documents (a chain of evidence). Even in countries that guarantee title, the chain of records and boundary delineation is fundamental. New parcel surveys cannot be undertaken unless surveyors have access to previous survey information; survey data and past deeds or titles should never be discarded.

Parcel history and fabric least-squares adjustments
In the parcel fabric, historic parcels are important for both their legal role and their value in fabric adjustments. Historic parcels contain valid dimension data that provides increased measurement redundancy in a fabric least-squares adjustment.
Continued adjustment of the parcel fabric means the point coordinates will change over time. Coordinates are simply the current best estimates of parcel corner locations. To track parcel lineage, the spatial relationship between current and historic parcels must be retained. Therefore, all parcel boundaries, both current and historic, will be part of any least-squares adjustment. Historic parcel boundaries will adjust with current parcel boundaries.

Parcel history and plans
The fabric tracks parcel history by both plan date (date of record of survey) and system date (date parcel changes were entered into the database). When an existing parcel in the parcel fabric is replaced by parcels defined in a new plan or record of survey, the existing parcel and its lines become historic. Parcel corner points don’t necessarily become historic when a parcel becomes historic, because adjacent parcels that share the point may still be current. The fabric stores two start date (legal date and system date) and two end date attributes on parcels and lines. The legal start date corresponds to the date of record of the current parcel’s associated plan, and the legal end date corresponds to the date of record of the new, superseding parcels’ associated plan. The legal start and end date are user defined and managed. The system start and end dates correspond to the dates parcels were entered into and replaced in the system, respectively.

Historic parcels
In the fabric, historic parcels have their Historic attribute field value set to 1 (true). Active or current parcels have their Historic attribute field value field set to 0 (false).

The Historic field is automatically set to 1 in the following cases:
- Parcel merge. Parcels being merged are flagged as historic.
- Parcel division. The parcel being divided is flagged as historic.
Parcel Remainder. The original parcel is flagged as historic.

New from parent. The parent parcel is flagged as historic.

The Historic attribute on a parcel can manually be set to 1 (true) in the Parcel Details dialog box or by right-clicking a parcel and clicking Historic.

Parcel fabric history and database archiving

Since historic parcel boundaries participate in continued adjustments of the parcel fabric, history in the parcel fabric is dynamic. This contrasts with an archive of static information that is not edited or altered but simply retained. This is static history. Cadastres and the parcel fabric have both types of information. The recorded parcel dimensions on a historic parcel and any related title records are never altered and are considered static. Coordinates for these parcels change in a least-squares adjustment and are considered dynamic.

Displaying parcel history in the parcel fabric layer

This topic applies to ArcEditor and ArcInfo only.

The History tab on the parcel fabric Layer Properties dialog box lets you display parcel history in the fabric layer. On the History tab, you can choose to either display all parcels in the layer, or display parcels by legal or system date.

To display parcel line history, you can either use definition queries on the lines layer to display parcel lines by date or Historic value or you can create a feature template for a historic line.

In the graphic below, both definition queries achieve the same goal, which is to display only current parcel lines. The first query displays only those lines that have no system end date and the second query displays only those lines with a History attribute field value of 0 (false). You can use other definition queries to display lines by legal date, date ranges, and so on.

Instead of hiding historic lines from the map display, you can define a historic line subtype and display parcel lines by their line type. For example, subdivision line, boundary line, historic line and so on.

In the Lines attribute table, if the Historic attribute field value is 1 (true) then you can set the subtype to a historic line.

Steps:

1. Right-click the parcel fabric group layer in the Table of Contents window in ArcMap and click Properties.
2. On the Layer Properties dialog box, click the History tab.
3. To show all parcels both current and historic, leave the default Show all parcels option checked.
4. To show a view of current parcels, click the Show a view of the fabric parcels option and select one of the following options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>that have no system end-date (active parcels)</td>
<td>Shows all active, current parcels</td>
</tr>
<tr>
<td>that had no system end-date on:</td>
<td>Shows parcels that were current on the system end-date you specify (that is, they had no system end-date on the date you specified)</td>
</tr>
<tr>
<td>that had no legal end-date on:</td>
<td>Shows parcels that were current on the legal end-date you specify (that is, they had no legal end-date on the date you specified)</td>
</tr>
</tbody>
</table>

Tip: To display parcels that were current in a system or legal date range, specify a definition query on the parcels layer that queries the system and legal start/end dates.

Related Topics
About the parcel fabric layer

About the parcel fabric editing environment

This topic applies to ArcEditor and ArcInfo only.

In ArcGIS 10, parcels in the fabric can be edited directly in a standard edit session in automatic edit mode or in a fabric job in manual edit mode. When working in automatic edit mode, parcels are interacted with and edited directly in ArcMap. Edits are tracked as "mini" jobs in the job book.

When working in manual edit mode, parcels are interacted with and edited in open fabric jobs. Jobs are saved in the parcel fabric job book and can be reopened for continued work at any time. Jobs can be automatically created using the Modify command on the Parcel Editor menu on the Parcel Editor toolbar, or they can be manually created and customized using the Create Job command on the Parcel Editor menu.

You can specify the type of edit mode you would like to work with on the Parcel Editor Options dialog box, which can be accessed by clicking Parcel Editor > Options on the Parcel Editor toolbar.
You can change your edit mode at anytime. For example, if you want to start creating jobs for your edits, simply turn on manual mode by clicking Manual (allows edits to be managed through the Job book) on the Parcel Editor Options dialog box.

Related Topics
Displaying parcels using dimension vs. shape values
Editing the parcel fabric directly in automatic mode
Editing the parcel fabric in manual mode using fabric jobs
Viewing parcels in projected (map) vs. local coordinate systems

This topic applies to ArcEditor and ArcInfo only.

In ArcGIS Desktop 10, the parcel fabric can be edited directly in a standard edit session in ArcMap. Prior to ArcGIS Desktop 10, parcels in the parcel fabric needed to be extracted into parcel fabric jobs using the Modify command or the manual Create Job command.

To directly edit parcels in a standard edit session, the parcel fabric edit mode needs to be set to Automatic. This setting can be found on the Parcel Editor Options dialog box. You can open the dialog box by clicking the Parcel Editor arrow and clicking Options.

To open and edit a parcel in automatic mode, start an edit session in ArcMap and make sure the Parcel Editor toolbar is loaded. Click the Select Parcel Features tool on the Parcel Editor toolbar and either right-click the parcel and click Open or double-click the parcel to open it.

The selected parcel is opened and displayed as active for editing, and all other parcels are dimmed.
In addition to opening a parcel for editing, you can do the following:

- Unjoin the parcel.
- Flag the parcel as historic.
- Open the parcel as a parent parcel for subdivision (Construct from parent).
- Duplicate the parcel.
- Merge adjacent selected parcels.

If you are using the automatic edit mode, job workflow commands, such as Modify and Finish job, will be unavailable. To turn on job workflow commands, click Manual on the Parcel Editor Options dialog box.

**Job book**

When editing parcels directly in a standard edit session (automatic), the parcel data is extracted into job XML streams in memory in the background. These XML streams are saved as mini jobs and are visible on the Job Book dialog box. However, you cannot reopen these mini jobs. You can pan and zoom to the parcels edited in them.

To reopen jobs in Job Book, you need to switch to manual edit mode to enable the job workflow functionality.

**Related Topics**

- Editing the parcel fabric in manual mode using fabric jobs
- The fabric job XML file
- Viewing and displaying jobs in the parcel fabric job book

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**How to edit the parcel fabric in automatic edit mode**

_This topic applies to ArcEditor and ArcInfo only._

To edit and open parcels directly in automatic mode, follow these steps:

**Steps:**

1. Click the Parcel Editor menu and click Options to open the Parcel Editor Options dialog box.
   - If the Parcel Editor toolbar is not visible in ArcMap, click the Customize menu, point to Toolbars and click Parcel Editor.
2. Click the Automatic (edits are tracked and managed automatically) option and click OK.
3. Click the Parcel Editor menu on the Parcel Editor toolbar and click Start Editing.
   - If you are not editing standard feature classes, close the Create Features dockable window.
4. Click the Select Parcel Features tool on the Parcel Editor toolbar and select the parcel you want to edit.
5. Double-click the parcel to open it or right-click the parcel and click Open.
   - You can also right-click a parcel or parcels and use other tools that are available such as Parcel Division, Parcel Remainder, and Construct From Parent.
   - See how to create a new parcel in automatic edit mode.

**Related Topics**

- Editing the parcel fabric directly in automatic mode
Editing the parcel fabric in manual mode using fabric jobs

This topic applies to ArcEditor and ArcInfo only.

Parcel fabric jobs are containers for one or more parcels being edited. Manually created parcel fabric jobs are often used to represent tasks, for example, creating a parcel fabric job for a block subdivision or parcel merge. Parcel fabric jobs track parcel edits with a date and time stamp and can be saved and reopened for continued work.

To edit parcels in fabric jobs, the parcel fabric edit mode needs to be set to Manual. This setting can be found on the Parcel Editor Options dialog box. You can open the dialog box by clicking the Parcel Editor menu and clicking Options. Once the edit mode is set to Manual, job-workflow commands such as Modify and Finish Job are enabled on the Parcel Editor menu on the Parcel Editor toolbar.

Automatically created jobs

A fabric editing job is automatically created for you when you select a parcel or group of parcels, click the Parcel Editor menu, then click Modify. The selected parcels are opened in a job and are available for editing. The surrounding parcels are dimmed.

Once editing is complete, the job is posted back to the fabric layer by clicking Parcel Editor > Finish Job. The job is then available in the Job Book and can be reopened for continued editing.

Creating a fabric job manually

If using job-workflow functionality to edit the parcel fabric, you can also manually create parcel fabric jobs that have titles, operator names, descriptions, and so on. Manually created jobs behave like automatically created fabric jobs, except you can explicitly define which parcels are to be edited without having to open the job.

In manually created jobs, you can specify the parcels you want to edit and, optionally, the surrounding job parcels. Surrounding job parcels can be used for reference when joining new parcels to the parcel fabric. When creating new parcels in jobs, you need to ensure that you have added a sufficient number of reference or surrounding parcels to the job so that your new parcel can be joined in the appropriate location.

When adding parcels as edit parcels to a manually created job, parcels neighboring your edit parcels are added to the job by default. You can add parcels using a radius buffer or by manual selection on the map.

Finishing/Posting parcel fabric jobs

After you have finished editing in a fabric job, you post the job back to the parcel fabric layer. All updates and edits performed in the fabric job are applied to the parcel fabric as a single edit when the job is finished. You need to save the edit session to commit the changes from the fabric job to the geodatabase. You can discard the changes made to the latest extract of a parcel fabric job by clicking the Discard Changes command on the Parcel Editor menu. The parcel fabric job reverts to the last submitted version of the job.

Job book
All automatically and manually created jobs are saved in the Job Book and can be reopened for continued edits. To open the Job Book, click Parcel Editor > Job Book. To open a job on the Job Book dialog box, you can either double-click the job row or right-click the job row and click Open. You can also right-click a job row and click Properties to view the parcels in the job and customize the job with a description, title, and so on.

### Related Topics
- Editing the parcel fabric directly in automatic mode
- The fabric job XML file
- Viewing and displaying jobs in the parcel fabric job book

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### Editing the parcel fabric using fabric jobs (manual mode)

This topic applies to ArcEditor and ArcInfo only.

#### Opening parcels in a fabric job using Modify

To open a parcel or group of parcels in an automatically created job, follow these steps:

**Steps:**

1. Click the Parcel Editor arrow and click Options to open the Parcel Editor Options dialog box. If the Parcel Editor toolbar is not visible in ArcMap, click Customize > Toolbars and click Parcel Editor.
2. Click the Manual (Allows edits to be managed through the Job Book) option and click OK.
3. Click the Parcel Editor arrow on the Parcel Editor toolbar and click Start Editing. If you are not editing standard feature classes, close the Create Features dockable window.
4. Click the Select Parcel Features tool on the Parcel Editor toolbar and drag a box to select the parcel(s) you want to open in a fabric job.
5. Click Parcel Editor > Modify to open the parcels in a job. The Parcel Details and Parcel Explorer windows become visible. The parcel explorer lists all parcels in the open job by their plan.

**Tip:** If either the Parcel Details or Parcel Explorer window is not visible, click the Parcel Details or Parcel Explorer commands, respectively, on the Parcel Editor toolbar to turn them on.

6. When you want to save the job, click Parcel Editor > Finish Job. The job is listed in the job book and can be opened for continued editing.

#### Creating jobs using the Create Job dialog box

You can manually create a parcel fabric job that has a title, operator name, description, and so on. Manually created jobs behave like automatically created fabric jobs, except you can explicitly define which parcels are to be edited before opening the job.

To manually create a fabric job, follow these steps:

**Steps:**

1. In an edit session, click Parcel Editor > Create Job. The Create New Job dialog box appears.
2. Enter a job name, description, and so on. A job name is required to open a fabric job from the Create New Job dialog box.
3. Click the Select Parcel Features tool on the Parcel Editor toolbar and select the parcels you want to edit in the fabric job.
4. Click the Add button next to the Edit Job Parcels list. The selected parcels are added to the Create Job dialog box as edit parcels and are colored in red. The default surrounding neighboring parcels or reference parcels are colored in blue.

**Tip:** Edit parcels are edit locked, which prevents any overlapping jobs on an ArcSDE multiuser geodatabase from editing their dimension attributes. Neighboring parcels are unlocked.

5. To add additional surrounding parcels using a radius buffer, click the Parcels within option and type a radius in the empty box below the Parcels within option. Click the drop-down arrow to specify the radius units.
6. Click the Get button to add surrounding parcels that lie within the radius you specified. A buffer line is drawn on the map, and all parcels intersecting the buffer line are added as surrounding job parcels.
7. To add parcels manually, click the Choose parcels manually option and select your parcels using the Select Parcel Features tool.
8. Click the **Add** button next to the **Job Parcels** list.

9. Click the **Include parcels to fill gaps in the selection** option if there are reference parcels that have not been added to the fabric job separating the parcels that are part of the fabric job. The parcels that have not been added to the fabric job are added during the extraction process.

10. If you want to open the fabric job, check the **Open job when I click OK** option. Leave this option unchecked if you want to save the job to the job book and not open the job.

11. Click **OK** to either save or open the job.

12. If you have opened the job and want to save your job edits, click **Parcel Editor > Finish Job**. The job is listed in the job book and can be opened for continued editing.

**Related Topics**

- Editing the parcel fabric in manual mode using fabric jobs
- Viewing and displaying jobs in the parcel fabric job book

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**Viewing and displaying jobs in the parcel fabric job book**

*This topic applies to ArcEditor and ArcInfo only.*

If you are editing parcels directly (automatic mode), edits to parcels are tracked as mini jobs in the parcel fabric job book. These edits or mini jobs are date and timestamped. In automatic mode, you can pan and zoom to the parcels in the edit job, but you cannot reopen the jobs. To reopen a job in the job book, switch to manual edit mode.

If you are editing parcels in parcel fabric jobs (manual mode), jobs are saved and stored in the parcel fabric job book. You can reopen the job, zoom to the job, and edit the properties of the job such as title and parcels being edited.

**Steps:**

1. In ArcMap, make sure the **Parcel Editor** and **Editor** toolbars are present. To load a toolbar, click the **Customize** menu, point to **Toolbars**, then click the toolbar you want to load.

2. Click the **Parcel Editor** menu on the **Parcel Editor** toolbar and click **Job Book**. The **Job Book** dialog box appears.

3. Click the drop-down arrow next to **Show** and choose the appropriate time period by which to display your jobs. Choosing a time period from the menu also refreshes the display of jobs in the job book.

4. To display jobs by your own specified date range, click **Date Range** from the **Show** drop-down menu.

5. On the **Date Range** dialog box, click the drop-down arrows next to the From and To fields to specify from and to dates.

6. Click **OK** to close the dialog box.

**Tip:** To reopen existing jobs in the job book, make sure that you start an edit session first.

**Related Topics**

- Editing the parcel fabric directly in automatic mode
- Editing the parcel fabric in manual mode using fabric jobs
- The fabric job XML file

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**The fabric job XML file**

*This topic applies to ArcEditor and ArcInfo only.*

A parcel fabric job XML stream is created in memory when parcels are edited. Job XML streams are created for both automatic and manual edit modes. If parcels are extracted into a job, all the parcel data in the job is extracted to the XML stream. The parcel fabric job XML stream is stored in memory but can be stored on your hard drive if a CadastralEditLogs folder exists under your TEMP directory. Two parcel fabric job XML files are written to the CadastralEditLogs folder. The CFPacketExtract.xml file is an XML file representation of the parcel(s) when they were extracted or opened from the parcel fabric, and the CFPacketUpdate.xml file is an XML file representation of the parcel(s) containing edits and updates.

**Tip:** You can find where your system TEMP directory is by clicking **Windows Start > Run**. Type `%TEMP%` in the **Open** drop-down list on the **Run** dialog box and click **OK**. Your system TEMP folder will be opened. You can also locate your system TEMP directory by going to **Control Panel > System**, clicking the **Advanced** tab on the **System Properties** dialog box, then clicking the **Environment Variables** button. TEMP is defined as a user variable.

**Save as XML**

You can also manually save an open fabric job or open parcels to a permanent .xml file by clicking the **Save as XML** command on the **Parcel Editor** menu. This functionality is useful for making edits and jobs portable. For example, new parcels can be added in a local coordinate system in a remote job that is saved as an XML file. This job can then be appended and joined to the main parcel fabric layer.

**Related Topics**

- About joining parcels to the parcel fabric
- Viewing and displaying jobs in the parcel fabric job book
Viewing parcels in projected (map) vs. local coordinate systems

This topic applies to ArcEditor and ArcInfo only.

Parcels can be edited in the projected map coordinate system or in a local coordinate system.

To edit parcels in a local coordinate system, check the View and edit parcels individually in a local coordinate system option on the Parcel Editor Options dialog box.

Editing parcels against the projected map is beneficial when a background frame of reference is needed, for example, a natural boundary on an orthophoto.

Related Topics
About the parcel fabric editing environment
Displaying parcels using dimension vs. shape values

Displaying parcels using dimension vs. shape values

This topic applies to ArcEditor and ArcInfo only.

When opening and editing parcels in the projected map, you can choose to display parcel geometry using coordinates derived from the COGO dimensions on the parcel lines (including scale and rotation) instead of using the fixed, joined coordinate locations in the parcel fabric layer. When opening a parcel in the local coordinate frame, the parcel is always displayed using the COGO dimensions (including scale and rotation) on parcel lines. To edit parcels in the projected map rather than in a local coordinate system, leave the View and edit parcels individually in a local coordinate system option unchecked on the Parcel Editor Options dialog box.

When opening a parcel in the projected map, the parcel is displayed using the fixed, joined coordinates by default. To display the parcel using coordinates derived from COGO dimensions on the parcel lines, click the Parcel Editor arrow on the Parcel Editor toolbar and click Parcel Measurement View.

Displaying parcels using coordinates derived from the line's COGO dimensions is a useful way to check the correctness of the COGO dimensions. You will also see the scale and rotation of the parcel. If a bearing, distance, or curve parameter on a parcel traverse is incorrect or inaccurate, the error or inaccuracy will become visually apparent when the parcel is displayed using coordinates derived from these values. For example, in the graphics below, parcels displayed using coordinates derived from measurements are different from their display using their joined location coordinates.
Related Topics

About the parcel fabric editing environment

Viewing parcels in projected (map) vs. local coordinate systems

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Editing the parcel fabric and versioning

This topic applies to ArcEditor and ArcInfo only.

The parcel fabric supports editing on one version level below the default version. The parcel fabric does not support editing on child versions of versions. If editing parcels in manual mode using fabric jobs, multiple parcel fabric jobs can be created both on the default version and on a child version.

Editing the parcel fabric and version states

The parcel fabric needs to be registered as versioned before it can be edited on an ArcSDE geodatabase. Once a parcel fabric is registered as versioned, you can create a version to edit the parcel fabric. Versions are a sort of “view” of the geodatabase that allows you to edit that view and immediately see your changes. Other users connected to the version will see your changes when you refresh. However, users connected to other versions will not see your changes until you post your version to the default version.

When a dataset is registered as versioned, two delta tables are created: the A (or Adds) table for inserts and updates and the D (or Deletes) table for deletes. Each time you update or delete a record in the dataset, rows are added to one or both of these tables and a new state of the version is created. A versioned dataset, therefore, consists of the original table (referred to as the base table) plus any changes in the delta tables.

Learn more about versioning

When editing parcels in automatic mode, each edit is made to a job XML stream. When the edit session is saved, the XML stream is posted to the parcel fabric as a single edit and a new state of the version is created.

If editing the parcel fabric in manual mode using fabric jobs, edits are saved to the job XML stream. When the parcel fabric job is posted back to the parcel fabric (Parcel Editor > Finish Job), all edits to the job XML stream are posted to the parcel fabric as one single edit. Once the edit session is saved, a new state of the version is created.

Parcel fabric versions and edit locking

When parcels in the fabric are edited, they become edit locked. When a parcel is edit locked, it cannot be opened on the same version or another version until the edit lock is released. However, in the locked parcel’s attribute tables, non-system managed fields in the parcels, lines, points, and control tables can still be edited. If the same field is edited across different versions, conflict resolution will be required when the versions are reconciled.

See which fields are editable in a locked parcel’s attribute tables.

If parcels are being edited on a different version from the one you are editing, those parcels are displayed with an edit locked icon in the Parcel Explorer.
window. Likewise, the parcels you are editing will be locked from edits in any other versions. Parcel edit locks are released once the version on which the parcel was being edited is posted.

The list below summarizes the rules governing the behavior of locked parcels in a multiuser environment:

- You cannot open parcels being edited in another version. You can only gain access to edit locked parcels from another version once that version is posted.
- When a version is posted, all updates and changes in the version are merged with the default version and edit locks on parcels are released.
- If a parcel has previously been edited on the version you are working with, the parcel is displayed with an edit unlocked icon in the Parcel Explorer window.
- If a parcel has previously been edited on another version that is now posted, the parcel is displayed with an edit unlocked icon in the version you are working with.
- If parcels have been edited in a different version and that version has been posted to default, you can edit those same parcels in your version once you reconcile with the default version.
- If a parcel is listed as locked in the Parcel Explorer window, you can click the parcel in the Parcel Explorer window to see which version and user are editing the parcel. The user and version name are displayed in the bottom right status bar of the ArcMap window.

### Summary of edit lock status icons

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Parcel is available for editing.</td>
</tr>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Parcel is currently being edited.</td>
</tr>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Parcel has been previously edited and is available.</td>
</tr>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Parcel is being currently edited on the same version or has been edited on a different version.</td>
</tr>
</tbody>
</table>

### Edit locking in manual mode using fabric jobs

If working in manual mode using fabric jobs, the same parcel locking rules apply:

- Fabric jobs can overlap each other on the same version and on different versions. If a parcel is being edited in a job overlapping yours on the same version, the parcel is displayed with an edit locked icon in your Parcel Explorer window. When the overlapping job is closed (Parcel Editor > Finish Job), the edit lock is released and the parcel is displayed with an edit unlocked icon in your Parcel Explorer window.
- If a parcel is being edited in a job overlapping yours on a different version, the parcel will be displayed with an edit unlocked icon in your Parcel Explorer window. Once a version is posted, all jobs on the version are marked as committed and the edit locks on parcels are released. You need to reconcile your version with the default version to edit those parcels.
- If a parcel is listed as locked in the Parcel Explorer window, you can click the parcel in the Parcel Explorer window to see which version and user are editing the parcel. The user and version name are displayed in the bottom right status bar of the ArcMap window.
- You can manually add edit locks to parcels in a fabric job even if you don’t intend to edit the parcels right away. Edit locks can be added through the Create New Job dialog box when the parcel is added as an edit job parcel. Edit locks can also be added in an open job by right-clicking a parcel(s) in the Parcel Explorer window and clicking Lock Selected parcels. These parcels will be locked across versions; however, on the same version, the parcel is always unlocked when the job is closed.
- By refreshing the Parcel Explorer window, parcel lock symbols will be updated to show edit locked icons next to parcels in your job that have since become edit locked in your job.

### Reconciling versions and the parcel fabric

Once you have finished editing on a version, you can merge the changes made on the version with the default version. This is done through a reconcile and post process. Reconciliation detects conflicts between your version and the default version. Conflicts occur if the default version has changed since you created your version and the changes conflict with your edits. For example, on a parcel fabric, least-squares adjustments run in overlapping areas will produce conflicting coordinates. Conflict resolution on the parcel fabric always takes place in favor of the child version.

**Note:** The parcel fabric jobs table is not a versioned table and thus is not subject to reconciliation on parcel fabric versions.

### Learn more about reconciling versions

Frequent reconciling of versions with parcel fabrics against the default version is recommended. When a child version is reconciled with the default version, the child version receives any updates that have since been posted to the default version from other child versions.

Edits and updates to parcel data are typically in the form of long transactions. In the parcel fabric, parcel edits can span long periods of time. Reconciling versions will update versions with new and current data from the default version. This is important for continued editing of a versioned parcel fabric.

The following lists some examples of updates that could be received when reconciling a versioned parcel fabric with the default version:

- Updated coordinates for parcel points (least-squares adjustment run on the default version or posted from another version)
- New parcel created on the default or posted from another version
- Updated or new control points created on the default or posted from another version

### Conflict resolution

When reconciling a version with a parcel fabric against the default version, conflicts will be detected in these cases:

- Point coordinates have changed between the default version and the child version.
- Attribute values in non-system managed fields have changed between the default version and the child version.

Conflicts in point coordinates can occur in the following circumstances:

- A least-squares adjustment was run on the default version and on the child version.
- A least-squares adjustment was run on the child version being reconciled and on another child version that has been posted to the default.

In the parcel fabric, coordinate conflicts are always resolved in favor of the latest set of adjusted coordinates. Thus, when reconciling a child version that has been adjusted, the following are true:

- Adjusted coordinates in the default version versus adjusted coordinates in child version: child version wins.
- Conflicting control point coordinates are resolved in favor of the child version.

### Posting versions and the parcel fabric

- When posting your version, you will be prompted to reconcile with the default version. This ensures that all edits are merged with the default version.
- Once you have reconciled, you can post your version. Posting your version will release edit locks on parcels and allow other users to edit parcels in your version.
- Posting a version will update the version information associated with the parcel, including dates and users.

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Learn more about reconciling versions.
When a version with a parcel fabric is posted, all edit locks to parcels are released. If there are jobs created on the version, the job status is changed to Committed. A committed job cannot be reopened, but the job properties, such as what parcels were used in the job, are still visible.

To pan and zoom to a committed job, you need to add the following empty BLOB fields to the jobs table:
- CommittedObjs
- LocalControl

Once these fields are present in the jobs table, you will be able to zoom and pan to parcels of committed jobs.

Permissions, versions, and the parcel fabric

When a parcel fabric is created within a versioned database environment, the permissions granted for the parcel fabric and for any database version in which parcel edits might take place need to be considered carefully. This is because processes enacted on the version, such as reconciling or deleting the version, could trigger processes on the parcel fabric. Since the permissions granted on a version are independent from those on a parcel fabric, a user could have permissions to reconcile, post, or delete a version without having permissions to edit a parcel fabric contained within that version. Where such a permission mismatch occurs, either the version operation would fail (reconcile and post version) or the parcel fabric data would be compromised in some way (delete version).

Any multiversion system containing a parcel fabric must be set up such that the following statement is always true: Any user performing an operation on a version that affects a parcel fabric within that version must have update permissions on that parcel fabric and any associated feature classes.

Note: When applied to the version, the term permission is used to describe users’ access; when applied to tables and datasets within the database, the term privilege is used.

Version permissions

A version can be created with one of three permission settings. These act in addition to the privilege settings on the individual datasets; for example, a user can only edit the features of a dataset within a version if he or she has update capability on both the version and the dataset itself.

These are the three permission settings:
- **Private**: Only the version’s owner can view and edit the datasets within the version. Only the version’s owner can perform operations on the version (such as deleting and reconciling).
- **Protected**: Any user can view the datasets within the version, but only the version’s owner can edit them. Only the version owner can perform operations on the version.
- **Public**: All users can view and edit datasets within the version. All users can perform operations on the version.

Privileges and parcel fabrics

Each parcel fabric must be created within a feature dataset. The owner of the fabric automatically has update privileges. Other users can be granted privileges for the parcel fabric by changing the privileges on the feature dataset containing the parcel fabric. In this way, parcel fabrics behave exactly like other feature classes contained within feature datasets.

For feature classes that are not created within a feature dataset, privileges can be granted for specific users directly on that feature class.

The privileges that can be granted on a particular dataset are as follows:
- **None** (default): The user cannot view or edit the dataset.
- **Select**: The user can read and query the dataset.
- **Select, Update, Insert, Delete**: The user has full read/write privileges on the dataset.

Types of edits in the parcel fabric

Parcel fabric edits take two forms:
1. The parcel fabric classes themselves (for example, parcels, lines, and control points) can be edited via Parcel Editor.
2. Other feature classes can be associated with the parcel fabric. The system can then be used to propagate the results of least-squares adjustments to these feature classes, thereby editing their geometries.

In the first case, the user performing the edits must have update privileges on the feature dataset containing the parcel fabric being edited. In the second case, the user must have update privileges on both the parcel fabric and the associated feature classes.

It is not necessary to have update privileges on a parcel fabric or its associated feature classes if no edits have been made to the parcel fabric or to any feature classes associated with the parcel fabric within the version being reconciled, posted, or deleted.

The graphic below summarizes the permissions and privileges that must be granted to a user performing an operation on a version where the parcel fabric and its associated feature classes have been edited in either the parent version or the child version being considered.
Related Topics
A quick tour of registering and unregistering data as versioned
A quick tour of the version editing process
About the parcel fabric editing environment
Changing versions in ArcMap
Creating versions and setting permissions
Refreshing a version

Working with the parcel fabric traverse tool

This topic applies to ArcEditor and ArcInfo only.

The parcel traverse is the primary method for entering parcel data in the parcel fabric. For a single parcel on a survey plan or record of survey, dimensions for each parcel boundary are entered in sequence such that a closed polygon is formed.

The parcel traverse environment in the parcel editor facilitates the data entry of parcels using information from plans and records of survey. Recorded dimensions are entered directly from the plan as well as other parcel information, such as the PIN, stated area, and parcel accuracy.

Parcels can be entered either outside the parcel fabric in their own local coordinate system or in the projected map. The Parcel Editor Options dialog box lets you select whether or not to enter parcels in a local coordinate system. To open the Parcel Editor Options dialog box, click the Parcel Editor menu on the Parcel Editor toolbar and click Options.

When entering a parcel traverse in a local coordinate system, no set of coordinates or knowledge of a spatial reference is needed. All that is required are the parcel dimensions, which are on the plat or record of survey.
Once the parcel traverse is complete, the new parcel can either be saved as unjoined or immediately joined to the parcel fabric. An unjoined parcel resides in local coordinate space outside the parcel fabric layer. When joining a new parcel, parcel corner points are matched with the corresponding points in the parcel fabric.

When entering a parcel traverse in the projected map, you can start entering the parcel anywhere within the map extent or you can snap to existing fabric points. You would snap to existing fabric points for reference purposes when entering a parcel traverse.

![Parcel Details](image)

**Parcel traverse in a local coordinate system**

![Parcel Details](image)

**Parcel traverse in the projected map**

**Caution:** If snapping to existing points in the fabric layer when traversing a parcel, the parcel still needs to be joined to the fabric, where new parcel points are matched with corresponding points in the fabric.

An incomplete parcel traverse can be saved as unjoined at any time by clicking the *Keep changes to parcel data* command on the *Parcel Details* window. After completing a parcel traverse, you can choose to save the traverse and immediately join the parcel to the fabric by clicking the *Keep changes to parcel data and Join* command on the *Parcel Details* window.

**Parcel traverse units**

The parcel traverse environment supports most of the common units used for representing recorded information on a plat or record of survey. Units are set on the *Plan Properties* dialog box, and each plan can have a different set of units.

The following direction, angle, distance, and area units are supported:

**Direction or angle type**

- Quadrant Bearing
- North Azimuth
- South Azimuth
- Polar
- Internal Angle

When entering bearings using the Quadrant Bearing format, you can use numbers to specify the quadrant instead of having to type the required letters. This allows you to work solely with the numeric keypad and speeds up the data entry process. The following numbers represent the quadrants in the Quadrant Bearing format:

- 1 = NE
- 2 = SE
- 3 = SW
- 4 = NW

For example, N 45-59-59 E can be entered as 45-59-59-1.

**Direction and angle units**

- Degrees Minutes Seconds
- Decimal Degrees
- Radians
- Gradians
- Gons

**Distance and length units**

- Meters
- U.S. Survey Feet
- International Feet
• Chains
• Links
• U.S. Survey Chains
• U.S. Survey Links

Area units
• Square Meters
• Acres
• Hectares
• Square Rods
• Roods
• Perches
• Square U.S. Feet
• Square Feet
• Quarter Sections
• Sections
• Square Meters, Hectares, or Kilometers
• Acres, Roods, or Perches

Circular curve parameters
• Radius and Chord Length
• Radius and Arc Length
• Radius and Central Angle

Circular curve direction
• Chord
• Tangent
• Radial

Overriding curve parameters
Sometimes, curves on a plat or plan do not conform to a single set of curve parameters. There may be cases where you will need to enter a curve using different curve parameters from the parameters you specified for the plan. Instead of having to change the curve parameters, you can override the current, set curve parameters in the traverse line entry grid. The following letters can be used to override the current plan curve parameters:

- Chord length—c (or C)
- Arc length—a (or A)
- Delta (central angle)—d (or D)
- Tangent bearing—tb
- Chord bearing—cb
- Radial bearing—rb

For example, to enter a chord bearing when a tangent bearing has been set for the curve, you will enter 54-24-32-1cb or 54-24-32-1-cb (Quadrant Bearing format).

Line categories and feature templates
When entering lines in the parcel traverse grid, you can specify both a line category and a feature template.

Line categories are system defined and are used to represent parcel structure. For example, if a series of boundary lines form a closed loop, a parcel is created. A closed loop of connection lines does not create a parcel. Remaining line categories, such as connection lines and dependent lines, connect to the parcel.

The following line categories are available in the parcel traverse grid:

- **Boundary lines** are the primary lines and define the parcel boundary. Boundary lines can define closed and unclosed parcels. Boundary line accuracy (Accuracy attribute value) is the same as the parcel polygon accuracy (Accuracy attribute value), unless otherwise specified. If no parcel accuracy is specified, a default accuracy level of 3 is used.

- **Dependent lines** are part of the parcel and are dependent on parcel boundary lines. Dependent lines should be a looped sequence of lines that start and end on the same point in the parcel. They can be used to define an easement that belongs to the same parcel. Dependent lines can optionally participate in a fabric adjustment, in which case they are treated in the same way as boundary lines.

- **Precise connection** lines connect a parcel corner point to a control point. Precise connection lines should start at the parcel point and end at the control point and should never start at the control point, that is, be oriented in the reverse direction. The control point is treated as being on the parcel point that
the precise connection line starts from. Precise connection lines are used to connect to control points only. Precise connection lines automatically have an accuracy level that is one level higher than the parcel accuracy. For example, if the parcel accuracy level is 3, precise connection lines will have an accuracy level of 2.

**Caution:** Precise connection lines should not exceed 50 meters (or 164 feet). In a fabric least-squares adjustment, long precise connection lines can effectively constrain the entire adjustment area along the line, making the least-squares adjustment solution unstable. If a precise connection line exceeds 50 meters, it is best to use a standard connection line.

- **Connection lines** connect parcel points or connect a parcel point to a control point. Connection lines should not start at a control point. Connection lines can also connect between points in the same parcel. Connection lines are often used to connect isolated islands of parcels such that a network is formed. A connected parcel network is required by the fabric least-squares adjustment. Connection line accuracy is the same as the parcel accuracy unless otherwise specified.
- **Radial lines** are automatically generated and are lines that radiate out from the endpoint of a curve boundary to its center point. Radial lines are always generated in pairs, one for each end of the curve. Radial line accuracy is the same as the parcel accuracy, unless otherwise specified. For very long radial lines, an accuracy level of 7 (excluded) may be necessary in the fabric least-squares adjustment. This is because adjustments to flat curved boundaries can result in larger shifts in the curve’s center points, causing the radial lines to become outliers.
- **Road frontage lines** are set on a parcel’s road frontage boundary lines. You would change a parcel boundary line to a road frontage line to use the Maintain straight lines option when running the fabric least-squares adjustment. When using the Maintain straight lines option in a fabric least-squares adjustment, any road frontage lines in adjoining parcels within the same plan that have the same bearing are formed into collinear, straight lines. This is a postprocessing option that is run after the fabric adjustment has completed. Road frontage line accuracy is the same as the parcel accuracy unless otherwise specified.

**Note:** Road frontage lines should not be used in unclosed parcels.

- **Origin connection lines** are similar to connection lines but have their line orientation reversed. When entering parcels using the parcel traverse, origin connection lines are entered first, then the parcel boundary lines are entered. Origin connection lines are typically used when there is a connection line required from a point of beginning to a parcel point. Origin connection line accuracy is the same as parcel accuracy unless otherwise specified.
- **Part connection lines** are used to connect the parts and/or rings of a multipart or donut parcel. Part connection line accuracy is the same as parcel accuracy unless otherwise specified.

**Feature templates**

In ArcGIS, feature templates are used to create new features. Feature templates help automate the creation of new features in that attributes are automatically populated when templates are specified. In the fabric, you can use feature templates on parcel lines and polygons. For example, you can define a Subdivision line template that automatically sets the line category to Boundary and Accuracy to 3.

**The curve calculator**

When entering a curve for a traverse line, there may not be enough curve parameters stated on the plan or survey document to complete the curve. You can use the Curve Calculator dialog box to determine the complete set of parameters of a curve from two known parameters.

![Curve Calculator](image)

The Curve Calculator command is found on the COGO toolbar. 

Learn more about the Curve Calculator command.

**Related Topics**

Defining feature templates for fabric sublayers

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**Entering a parcel traverse using bearings and distances**

*This topic applies to ArcEditor and ArcInfo only.*

New parcels are always created in plans. If you are not working with plans, use the `<map>` plan, which is the system default plan. The **New parcel** command can be accessed in the following ways:

- Right-clicking a plan in the **Plan Directory** dialog box.
- Right-clicking a plan node in the **Parcel Explorer** window. If you are working in automatic mode, you can display plan nodes in the Parcel Explorer window by selecting parcels in the map.
- Click the **Create New Parcel In A New Plan** tool on the **Parcel Editor** toolbar.

New parcels are created using the **Parcel Details** window. Boundaries are traversed in under the **Lines** tab, and parcel attributes such as area are entered in under the **Properties** tab.

Typed boundary dimensions, such as bearing and distance, are populated in the traverse grid using the ENTER and LEFT and RIGHT ARROW keys. For more information on entering traverse dimensions in the lines grid, click the **Help** button under the **Lines** tab on the **Parcel Details** window.
The following parcel attributes are available for data entry under the Properties tab in the Parcel Details window:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>The parcel name. Also known as PIN (parcel identification number) and APN (assessor parcel number).</td>
</tr>
<tr>
<td>Type</td>
<td>Used for adding and migrating your own parcel subtypes.</td>
</tr>
<tr>
<td>Unclosed</td>
<td>Specifies whether the parcel is a closed or unclosed polygon. Set to True if the parcel is unclosed.</td>
</tr>
<tr>
<td>Stated Area</td>
<td>The parcel polygon area. It should match the area reported on the survey record. The parcel area is automatically calculated if the parcel misclosure is small. You can overwrite the Stated Area value.</td>
</tr>
<tr>
<td>Legal Start Date</td>
<td>The date on the record of survey document (plan) of the parcel. This attribute is optional and should be populated if you want to maintain legal parcel history in your fabric.</td>
</tr>
<tr>
<td>Legal End Date</td>
<td>The date on the record of survey document (plan) of the parcel that retired this parcel. This attribute is optional and should be populated if you want to maintain legal parcel history in your fabric.</td>
</tr>
<tr>
<td>Accuracy</td>
<td>The accuracy level of the parcel. If the accuracy level is set for the plan, the new parcel automatically inherits its accuracy level from the plan.</td>
</tr>
<tr>
<td>Compiled</td>
<td>Set this value to True if the parcel is compiled from old survey records or inverted dimensions.</td>
</tr>
<tr>
<td>Historical</td>
<td>True if the parcel is historic.</td>
</tr>
<tr>
<td>Rotation</td>
<td>System managed. Parcel rotation is automatically populated.</td>
</tr>
<tr>
<td>Scale</td>
<td>System managed. Parcel scale is automatically populated.</td>
</tr>
<tr>
<td>Misclose Ratio</td>
<td>System managed. The misclose ratio is automatically calculated from the parcel traverse.</td>
</tr>
<tr>
<td>Misclose Distance</td>
<td>System managed. The misclose distance is automatically calculated from the parcel traverse.</td>
</tr>
<tr>
<td>Misclose Bearing</td>
<td>System managed. The misclose distance is automatically calculated from the parcel traverse.</td>
</tr>
</tbody>
</table>

Steps:

To create a new parcel, follow these steps:

1. In an edit session in ArcMap, open the Plan Directory dialog box, right-click a plan, then click Create new parcel.
   To open the Plan Directory dialog box, click the Parcel Editor menu on the Parcel Editor toolbar and click Plan Directory.
   If you are working in manual mode with fabric jobs, open a fabric job, right-click a plan node in the Parcel Explorer window, then click New Parcel.
2. In the Parcel Details window, click the Template button to specify a template for the new parcel if you have defined feature templates for fabric parcels.
3. Under the Properties tab, populate the necessary attribute fields for your new parcel.
4. Click the Lines tab.
5. Click in the Bearing field to type the first leg of your traverse. Press ENTER to move to the Distance field.
6. Type in your distance value and press ENTER to create the first traverse leg.
   If you are entering a curve, type your bearing and press ENTER. Use the RIGHT ARROW key to move to the Radius field. After entering your radius, press ENTER and type an appropriate value in the Chord/Arc Length/Central Angle field. Press ENTER to create the curve.
7. To close the final leg of your traverse to its starting point, type an asterisk (*) next to your distance value (or chord/arc length/central angle for curves). You can also simply enter a 1 in the From field of the final leg of your traverse to close it.
   Once the parcel traverse is closed back to its starting point, misclosure and accuracy information are displayed at the bottom of the Parcel Details dialog box. The Misclose Ratio, Misclose Distance, and Misclose Bearing attributes under the Properties tab are updated with the calculated values.
8. Click the Keep changes to parcel data and Join command on the Parcel Details window to save the parcel or click the Keep changes to parcel data and Join command to save and directly begin joining the parcel to the fabric.

Tip: When working with the traverse grid, pressing ENTER and using the LEFT and RIGHT ARROW keys will automatically maintain and populate the from- and to-points. If the from- and to-points are not automatically populated, you can enter the correct from- or to-point at any time.

Tip: When pressing ENTER to move to the next row in the traverse grid, the Bearing field is populated with the previous row's bearing by default. For curve boundaries, the Bearing field in the next row is populated with the exit tangent of the curve. If your curve direction is set to Radial or Chord, the exit Tangent value will automatically be converted to the radial or chord value.

Tip: When entering curves, you can type an asterisk in the Bearing field to obtain the exit tangent of the previous line. If your curve direction is set to Radial or Chord, the exit Tangent value will automatically be converted to the radial or chord value.

Tip: Press CTRL+ENTER to move in the traverse grid to the end of the row. This saves having to press ENTER multiple times to move to the next row. For example, after you have specified your line category, you can press CTRL+ENTER, then ENTER to move to the next row.

Tip: You can obtain the bearing, distance, and curve parameters of an existing parcel line by pressing CTRL+SHIFT and clicking on the parcel line. If the Bearing field is active, pressing CTRL+SHIFT and clicking on a curve will return the chord bearing of the curve.

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Entering a parcel traverse with a parcel group
Parcels can be traversed in individually or traversed in with an existing parcel or group of parcels. A parcel traverse can only be entered with an existing group of parcels when the parcel group is unjoined. You can select adjacent parcels and unjoin the selected parcels as a group (right-click the selection and click Unjoin). To enter a new parcel into the unjoined parcel group, right-click any parcel in the group and click New in group.

**Note:** When entering in a parcel traverse using an existing parcel group as a starting point, you still need to complete the parcel traverse, even though adjacent boundaries are present in the group. In this way, record information is preserved, and a parcel misclosure can be obtained.

**Caution:** When traversing a parcel with an existing parcel or parcel group, make sure to use the existing points in the group rather than defining new, overlapping points.

### Steps:
To enter a parcel traverse with an existing parcel group, follow these steps:

1. In an edit session in ArcMap or in an open fabric job, select the parcel or parcel group in the map that you want to work with, right-click, then click Unjoin.
2. In the Parcel Explorer window, right-click any of the parcels in the group you just unjoined and click New in group.
3. Click the Lines tab of the Parcel Details window.
4. Click any of the parcel corner points in the parcel group to populate the From point of your first traverse leg.
5. Enter in your remaining traverse legs in the traverse grid. You must traverse the whole parcel, even though adjacent boundaries are present. This is consistent with the parcel fabric data model, which requires two parcel boundaries for every common boundary in the parcel fabric.
6. When connecting a traverse leg to an existing point in the parcel group, make sure to enter the existing point name as the from-point of the traverse leg. This is consistent with the parcel fabric data model, which requires one common point for all adjacent parcel corners.
7. To close your parcel traverse, enter the same value for the To point in your final traverse leg as your from-point from your first traverse leg. You can type an asterisk (*) next to your final distance or curve parameter.
8. Click the Keep changes to parcel data and Join command on the Parcel Details window to save the parcel group or click the Join command to save and directly begin joining the parcel group to the fabric.

**Tip:** You can obtain bearings, distances, and curve parameters from any line in the parcel group by holding down the CTRL and SHIFT keys and clicking on the parcel line. For example, to populate the Bearing field with the bearing of a parcel line, click in the Bearing field, hold down CTRL+SHIFT, then click on the parcel line. Clicking on a curve will return the chord bearing.

### Entering a parcel traverse using internal angles

In some cases, parcel dimensions on a plan or record of survey are shown as angles and distances instead of bearings and distances. In this case, the parcel is entered and created using its internal angles.

A parcel traverse using internal angles requires a Starting back-sight value. The starting backsight is the orientation angle, which is used as a reference for entering the first traverse leg. The starting backsight is based on a north azimuth angle type, and the default backsight is 180 degrees.
For example, if you traversed Lot 1 from the above graphic, you could use 90° as a starting backsight when entering the first traverse leg between points 1 and 2.

The remaining angles are oriented with respect to the previous line entered in the parcel traverse. When the parcel is joined to the parcel fabric, it is rotated and scaled accordingly.

To enter side shots or connection lines in an internal angle parcel traverse, the angle measured to the connection line needs to be referenced to an existing line in the parcel traverse. The to-point of the reference line is required as the ReferenceObject value in the parcel traverse grid. For example, when entering the connection line between points 5 and 6 for Lot 1 in the graphic above, the referencing backsight line can either be the line between 5 and 4 or the line between 5 and 1. The reference object would thus be either 4 or 1.

**Note:** Parcels entered using an internal angle are always created in a new plan.

**Steps:**

1. When creating a new plan for internal angle parcels, click the Record Format tab on the Plan Properties dialog box and set Direction or Angle Type to Internal Angle.
2. In an edit session in ArcMap, open the Plan Directory dialog box, right-click the plan created for internal angle parcels, then click Create new parcel.
3. Type in a starting backsight direction in the Starting back-sight text box under the Lines tab on the Parcel Details window.
4. Enter your first traverse leg. Your first traverse angle is oriented from your starting backsight.
5. Enter your remaining traverse legs. Each traverse leg is oriented with respect to the previous traverse leg.
6. To enter a side shot or connection line, type in the angle and distance of the connection line and type in the reference object of the connection line in the ReferenceObject field. The reference object is the to-point of any line that has the same from-point as the connection line. Angles going counterclockwise are entered as negative values, and angles going clockwise are entered as positive values.

![Diagram of Lot 1 with 90° backsight angle](image)

![Parcel Details window showing internal angles](image)
Creating unclosed parcels

This topic applies to ArcEditor and ArcInfo only.

You can create unclosed parcels using the parcel traverse. An unclosed parcel does not rely on an internal loop that closes on its starting point. Unclosed parcels can be used to model parcel types such as street centerlines. Unclosed parcels behave like normal parcels in the parcel fabric in that they need to be connected to the rest of the parcel fabric network.

Steps:

To create an unclosed parcel, follow these steps:

1. In an edit session in ArcMap or in an open fabric job, traverse in your unclosed parcel just like you would a normal parcel fabric parcel. The traverse lines do not close back onto the starting point.
2. After you have finished entering your traverse lines, click the Properties tab on the Parcel Details window and click the field next to Unclosed.
3. Choose True from the drop-down list.
4. Click the Keep changes to parcel data command on the Parcel Details window to save the parcel or click the Keep changes to parcel data and Join
Importing traverse files

This topic applies to ArcEditor and ArcInfo only.

You can import traverse text files saved from the Traverse tool on the COGO toolbar into the parcel fabric. The Traverse tool on the COGO toolbar lets you create edit sketch geometry from a variety of traverse measurements in the standard editor. COGO traverse files are imported into the traverse lines grid on the Parcel Details window.

COGO traverse files can be loaded one at a time into the parcel fabric, where each parcel traverse exists separately, or a set of traverse files can also be imported such that a parcel group is created.

Learn more about the Traverse file format

Steps:

To import a COGO traverse into the parcel fabric, follow these steps:

1. In an edit session in ArcMap or in an open fabric job, open the Plan Directory dialog box (Parcel Editor > Plan Directory).
2. Right-click the plan into which you want to import your COGO traverse and click Import Traverse.
   
   Tip: You can also right-click a plan node in the Parcel Explorer window and click Import Traverse.

3. In the Load Traverse dialog box, navigate to the location of your COGO traverse files and select the traverse files you want to import.
   To import more than one traverse file, hold the SHIFT key down and select the traverse files you want to import. When more than one traverse file is selected, parcels are imported as a parcel group.
4. Click Add on the Load Traverse dialog box to load your selected COGO traverse files.
   The traverse files are loaded as unjoined parcels and are listed under Unjoined in the Parcel Explorer window.

   Note: If the Parcel Explorer window is not visible, click the Parcel Explorer window command on the Parcel Editor toolbar.

Modifying row highlighting behavior in the traverse grid

This topic applies to ArcEditor and ArcInfo only.

The dimension fields of a line in the traverse/construction grid are highlighted when the line shape differs from its bearing by more than 10 degrees and from its distance by more than 20 percent.

The inconsistent line can be caused by an erroneous dimension in the line itself or by an erroneous dimension of a different line in the traverse. You can modify how and when erroneous lines are highlighted in the traverse grid by editing registry settings.

Turning off yellow highlighting in the traverse/construction grid

To turn off yellow highlighting in the traverse/construction grid, follow these steps:

Steps:

1. Click the windows Start menu and click Run
2. Type regedit in the Run dialog box.
3. In the Registry Editor window, navigate to HKEY_CURRENT_USER \Software\ESRI\ArcMap\Cadastral.
4. Right-click the Cadastral folder, point to New, then click DWORD value.
5. Type ConsistencyReportOnNonCalcPoints as the DWORD name.
6. Double-click the new DWORD value to edit it.
7. In the Edit DWORD Value dialog box, choose the Decimal option.
8. Type \(0\) (false) in the **Value data** text box to turn off yellow highlighting.
9. Click **OK** to add the registry setting.
10. Close the **Registry Editor** window.

**Changing the angle limit that results in dimension highlighting**

When lines are inconsistent with their shape geometry by more than 10 degrees, the line dimensions are highlighted.

To change the 10 degree default, follow these steps:

**Steps:**
1. In the **Registry Editor** window, navigate to `HKEY_CURRENT_USER \Software\ESRI\ArcMap\Cadastral`.
2. Right-click the **Cadastral** folder and click **New > DWORD value**.
3. Type **ConsistencyAngleDifference** as the DWORD name.
4. Double-click the new DWORD value to edit it.
5. In the **Edit DWORD Value** dialog box, choose the **Decimal** option.
6. Type the angle limit in decimal degrees in the **Value data** text box.
7. Click **OK** to add the registry setting.
8. Close the **Registry Editor** window.

**Changing the distance percentage limit that results in dimension highlighting**

When lines are inconsistent with their shape length by more than 20 percent, the line dimensions are highlighted.

To change the 20 percent default, follow these steps:

**Steps:**
1. In the **Registry Editor** window, navigate to `HKEY_CURRENT_USER \Software\ESRI\ArcMap\Cadastral`.
2. Right-click the **Cadastral** folder and click **New > DWORD value**.
3. Type **ConsistencyDistancePercentage** as the DWORD name.
4. Double-click the new DWORD value to edit it.
5. In the **Edit DWORD Value** dialog box, choose the **Decimal** option.
6. Type the percentage in the **Value data** text box.
7. Click **OK** to add the registry setting.
8. Close the **Registry Editor** window.

**About creating parcels using construction lines**

This topic applies to ArcEditor and ArcInfo only.

Parcels can be created using the parcel traverse or built from a network of construction lines.

The parcel traverse works with one parcel at a time, where lines are entered separately for each individual parcel. Parcel construction works with a network of lines where many parcels can be built from closed loops. Once construction lines have been created or pasted, parcels can be built from the line work by clicking the **Build Parcels And Save Into Map** tool on the **Parcel Details** dialog box. Any dangling lines are automatically set to dependent lines unless another valid category has already been set for the line, for example, a connection line.

Parcel construction is useful for copying and pasting line work representing parcel boundaries such as CAD files.

Like with the parcel traverse environment, you can work with parcel construction lines directly in the map or in a local coordinate system.
Creating parcel construction lines

You can use any of the following methods to create parcel construction lines:

- **Digitizing lines**
  You can digitize straight lines in a freehand approach in the parcel construction environment. As each line is added, the dimensions are computed from the line geometry and are populated in the parcel construction line grid.

- **Pasting lines from an external data source**
  You can copy lines from an external source, such as a feature class, and paste the lines into the parcel construction environment. This is an easy way of bringing CAD line work into the parcel construction environment. When copying lines from an external source, you need to ensure that the lines are planarized. Planarized lines are split at their points of intersection (in other words, there are always nodes at points of intersection). Lines that are pasted into the construction environment are automatically planarized for you. You can also planarize your lines before copying and pasting them into the construction environment by using the Planarize tool on the Topology toolbar.

- **Traversing lines**
  You can traverse in construction lines by entering a sequential set of dimensions in the construction line grid. You can traverse in any number of construction lines in the construction line grid; however, you cannot generate misclose information like you can in the parcel traverse grid, as you are not working with an individual parcel. The purpose of the construction line grid is to store a network of construction lines from which parcels can be generated.

- **Spitting lines using the Breakline tool**
  You can add construction points to an existing construction line using the Breakline tool. The Breakline tool is also used to add construction points to the lines of a parcel when the parcel is being split using the Construct from parent command. Construction points are added at specified distances from the starting point of a parcel line or construction line.

- **Creating parallel offset lines**
  You can add new construction lines that are parallel to existing construction lines using the Create Parallel Offset tool. The Create Parallel Offset tool is also used to add construction split lines to a parcel when the parcel is being split using the Construct from parent command. For example, the Create Parallel Offset tool can be used when creating easement lines, which are often parallel to existing parcel boundaries.

- **Creating lines using an internal angle and a distance**
  You can create construction lines that are deflected off an existing construction line at a specified angle and length using the Angle/Length tool. The Angle/Length tool is also used to add construction split lines to a parcel when the parcel is being split using the Construct from parent command. The Angle/Length tool would typically be used when splitting parcels that are created using internal angles instead of bearings.

- **Converting existing parcels to construction lines**
  Existing parcels can be unjoined and converted to construction lines. For example, you would convert an existing subdivision block into its construction lines if you wanted to use new construction lines to split the block into its subdivided parcels and rights-of-way. When a parcel is converted into construction lines, the original parcel is preserved and unchanged.
  To convert an existing parcel to construction lines, right-click the parcel and click **Unjoin** to unjoin it. In the **Parcel Explorer** window, right-click the unjoined parcel and click **Construction**.

- **Adding segmented construction lines**
  The Segmented Line tool located on the Parcel Details dialog box can be used to add construction lines that are already segmented or split with a specified number of segments.

- **Creating construction lines using COGO tools**
  COGO tools are available for adding and computing construction line work. For example, construction lines can be added using tools such as Delta X,Y and distance-distance intersection. Learn more about using COGO tools in the parcel fabric.

Building parcels from construction lines

Parcels can be built from construction lines at any time by clicking the **Build Parcels And Save Into Map** tool located on the Parcel Details dialog box. The build process generates new parcels from each closed loop detected in your construction lines. You can also choose whether to flag parent parcels as historic or to keep them current by clicking the arrow next to the **Build Parcels And Save Into Map** tool.

You can also add your own build methods through ArcObjects, where you can build parcels based on selected lines and/or line types and so on. An example of a custom build method would be to build an overlapping easement parcel from a single construction line drawn across an existing parcel.

If the build process detects construction lines that are not part of a closed loop, for example, dangling lines, the build process will keep the dangling lines as attached dependent lines.

Planarizing construction lines

When building parcels from construction lines, the build process requires that each construction line be a single line between two construction points. Lines that intersect need to have a construction point at their point of intersection. In other words, construction lines need to be planarized. Planarized lines are split at their points of intersection.

When lines are pasted into parcel construction, they are automatically planarized during the paste process. For example, in CAD files, lines are often not planarized, and when these lines are pasted as parcel construction lines, they are automatically planarized for you.
You can also planarize lines in the construction environment that have been traversed, digitized, or created using construction tools.

To planarize construction lines, click the **Planarize Lines** button located on the **Parcel Details** dialog box.

### Digitizing construction lines

*This topic applies to ArcEditor and ArcInfo only.*

You can digitize straight lines in a freehand approach in the parcel construction environment. As each line is added, dimensions computed from the line geometry are populated in the parcel construction line grid.

**Steps:**

1. In an edit session in ArcMap, click the **Parcel Editor** arrow on the **Parcel Editor** toolbar and click **Plan Directory** to open the **Plan Directory** dialog box. If you're working in manual mode using fabric jobs, open the **Plan Directory** dialog box in an open fabric job.
2. On the **Plan Directory** dialog box, right-click the plan in which you want to digitize construction lines and click **Construction**.
The Parcel Details dialog box becomes visible, with the Construction grid active. If you are working with parcels in a local coordinate system, the data frame switches to a local data frame.

**Tip:** If you are not working with plans, right-click the system default plan named `<map>`.

**Tip:** If you are working in manual mode using fabric jobs, you can right-click the plan listed in the Parcel Explorer window, if the plan is part of the open job.

3. To begin digitizing construction lines, right-click using the Construction tool located on the Parcel Details dialog box and click Digitize Mode.

4. Click on the map or local data frame to add your first construction point.

**Tip:** When digitizing lines, if the lines are not visible and only the points are visible, make sure to set line templates in the construction grid.

**Note:** To save your construction lines, click the Keep changes to parcel data command on the Parcel Details dialog box. The construction lines are saved as an unjoined construction and can be reopened from the Parcel Explorer window.

Traversing parcel construction lines

This topic applies to ArcEditor and ArcInfo only.

**Steps:**

1. In an edit session in ArcMap, click the Parcel Editor arrow on the Parcel Editor toolbar and click Plan Directory to open the Plan Directory dialog box. If you are working with parcels in a local coordinate system, the data frame switches to a local data frame.

2. On the Plan Directory dialog box, right-click the plan in which you want to digitize construction lines and click Construction. The Parcel Details dialog box becomes visible, with the Construction grid active.

**Tip:** If you are not working with plans, right-click the system default plan named `<map>`.

**Tip:** If you are working in manual mode using fabric jobs, you can right-click the plan listed in the Parcel Explorer window, if the plan is part of the open job.

3. Click in the map or local data frame to place the starting point of your first traverse leg.

4. Click the Bearing field of the first row in the Construction grid to begin typing your line dimensions.

**Tip:** When working with a large network of lines in the construction environment, it is recommended that you build parcels frequently from your closed loops to check the miscloses of your closed loops. You can then just unbuild the parcels to continue adding lines. In this way, large miscloses can be caught early and are prevented from manifesting themselves somewhere else in the network.

Splitting lines using the Breakline tool

This topic applies to ArcEditor and ArcInfo only.

The Breakline tool is used to add break points to parcel construction lines to split them into smaller segments. The Breakline tool is also used to add break points to parcel lines when using the Construct from parent command.
Steps:

To use the Breakline tool, follow these steps:
1. Right-click the parcel line or parcel construction line to which you want to add break points and click **Breakline**.
   A red line is displayed on the parcel line you right-clicked showing the direction in which the break points will be added. To change the direction of the line, click **Switch** on the **Breakline** dialog box.
2. Under **Break at distance**, enter the distances for each break point.
3. Click the **Proportion** check box to change the length of the line on which you right-clicked. New lines are added that are proportioned to the sum of the break point distances you entered.
   A change in line length might occur when new, more recent parcels are replacing a subdivision with older, less accurate dimensions. The sum of the new, more accurate parcel lengths might not be equal to the length of the older subdivision line.
4. Click **OK** to add the break points.

If you clicked **Proportion**, new lines are added to the construction grid for the new, proportioned segments. The original line on which you right-clicked is preserved and flagged as unbuildable. Unbuildable lines are not used to build new parcels.

Tip: Lines can be planarized using breakline points. For example, you can add a set of breakline points to a construction line using the Breakline tool and planarize (split) the construction line from the newly added breakline points.

Splitting parcels using **Construct from parent**

This topic applies to ArcEditor and ArcInfo only.

You can split an existing parcel in the parcel fabric with construction lines. To add construction lines to a parcel, you can use the following methods:

- Add breakpoints to parcel lines using the **Breakline tool**. Construction lines can then be added between the breakpoints.
- Use the Create Parallel Offset tool to offset existing parcel lines as construction lines between construction points.
Create construction using traverse, digitize, and so on, then use the Planarize lines command on the Parcel Details dialog box to create construction points where lines intersect.

**Steps:**
To split a parcel using construction lines, follow these steps:

1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor toolbar.
2. Select the parcel you want to split, right-click, then click Construct From Parent. If you are working in manual mode using fabric jobs, select the parcel you want to split in an open fabric job. You can also select the parcel in the Parcel Explorer window.
   The parcel is opened in the map or in a local coordinate data frame.
3. If you are adding breakpoints to parcel lines, use the Breakline tool to add breakpoints or construction points.
4. Once the breakpoints are added, click the breakpoints to digitize construction lines between them.
5. If you want to add parallel construction lines as split lines, use the Create Parallel Offset tool.
6. If you are using other methods to add construction lines, such as digitize or traverse, click the Planarize lines command on the Parcel Details dialog box to create construction points where construction lines intersect.
7. Once all the construction split lines are added, click the Build parcels and save into map tool drop-down arrow and click one of the following choices:
   - Build and mark Historic to build the new subdivision parcels and flag the parent parcel as historic.
   - Build and keep all current to build the new subdivision parcels and keep the parent parcel current.
   The new parcels are saved back to the parcel fabric layer or open fabric job.

**Tip:** To view historic parcels, right-click in empty space in the Parcel Explorer window and click View Historic Parcels.

**Tip:** To change a parcel's status from Historic to Active, right-click the parcel and click Historic to uncheck the Historic flag.

**Tip:** When adding construction lines between construction points, check that the inversed dimensions generated from the construction lines in the Construction grid match the recorded dimensions on the associated plan.

**Related Topics**
- About dividing parcels by area in the parcel fabric
- Creating new parcels from multiple existing parcels

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**Creating new parcels from multiple existing parcels**

This topic applies to ArcEditor and ArcInfo only.

You can select and create new parcels from the selection of multiple existing parcels using the Construct from parent command. Selected parcels must be adjacent. An example of creating new parcels from a selection of multiple parcels would be the creation of an easement parcel that would overlay a row of parcels.

**Steps:**
To split multiple parcels using the Construct from parent command, follow these steps:

1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor toolbar and select the adjacent parcels you want to subdivide.
   If you are working in manual mode using fabric jobs, select the parcel you want to split in an open fabric job. You can also select the parcel in the Parcel Explorer window.
2. Right-click the selected parcels and click Construct from parent.
   The parcels are opened in the map or in a local coordinate data frame.
3. Add the construction lines to split the parcels.
   Before building parcels, make sure to flag any lines that you do not want to be used to build parcels as unbuildable. Lines that cross without intersection points need to be planarized and will be used to build new parcels. If a line is flagged as unbuildable, it is not used to build parcels.
4. Right-click the lines that you do not want to be used to build parcels and click Un-buildable.
5. To build parcels, click the Build parcels and save into map tool drop-down arrow and click one of the following choices:
   - Build and mark Historic to build the new subdivision parcels and flag the parent parcel as historic.
   - Build and keep all current to build the new subdivision parcels and keep the parent parcel current.
   The new parcels are saved back to the parcel fabric layer or open fabric job.
Creating construction lines using parallel offset

This topic applies to ArcEditor and ArcInfo only.
The Create Parallel Offset command is useful for adding construction split lines when splitting or creating new parcels using the Construct from parent command.

Steps:
1. Using the Construction tool located on the Parcel Details dialog box, right-click a construction or parcel line and click Create Parallel Offset.
2. On the Parallel dialog box, choose on which side of the construction or parcel line you want to add a new construction line.
3. Enter an offset distance and click OK.

The new construction line is created and its dimensions are computed from the line geometry and populated in the Construction line grid on the Parcel Details dialog box.

Creating construction lines using angle and length

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. In an edit session in ArcMap, click the Parcel Editor arrow on the Parcel Editor toolbar and click Plan Directory to open the Plan Directory dialog box.
2. On the Plan Directory dialog box, right-click the plan in which you want to digitize construction lines and click Construction.
The Parcel Details dialog box becomes visible, with the Construction grid active.
   If you are working with parcels in a local coordinate system, the data frame switches to a local data frame.

   Tip: If you are not working with plans, right-click the system default plan named <map>.

   Tip: If you are working in manual mode using fabric jobs, you can right-click the plan listed in the Parcel Explorer window, if the plan is part of the open job.

3. Using the Construction tool located on the Parcel Details dialog box, click the starting or from-point of the construction line.
4. Right-click a construction or parcel line and click Angle/Distance.
5. Right-click a construction line or a parcel line and click Angle/Length.
6. On the Angle/Distance dialog box, enter an angle and a distance and choose whether to deflect the line clockwise or counterclockwise.

   Tip: The units of the angle are in the units set for the current, working plan.

7. Press ENTER to create the construction line.

Creating segmented construction lines

This topic applies to ArcEditor and ArcInfo only.
The Segmented Line tool is used to digitize construction lines that are already split or segmented with a number of segments that you have specified. The segments will expand to fit the length of the digitized construction line.
Steps: To create a segmented construction line, follow these steps:

1. In an edit session in ArcMap, click the Parcel Editor arrow on the Parcel Editor toolbar and click Plan Directory to open the Plan Directory dialog box. If you're working in manual mode using fabric jobs, open the Plan Directory dialog box in an open fabric job.
2. On the Plan Directory dialog box, right-click the plan in which you want to digitize construction lines and click Construction. The Parcel Details dialog box becomes visible, with the Construction grid active. If you are working with parcels in a local coordinate system, the data frame switches to a local data frame.

Tip: If you are not working with plans, right-click the system default plan named <map>.

Tip: If you are working in manual mode using fabric jobs, you can right-click the plan listed in the Parcel Explorer window, if the plan is part of the open job.

3. Click the Segmented Line tool on the Parcel Details dialog box.
4. Click the starting point or from-point of the construction line.
5. Using the Segmented Line tool, right-click and enter the number of segments to add to the construction line on the Enter the number of segments dialog box.
6. Click OK to segment the line.

Tip: Instead of right-clicking to type the number of segments in a dialog box, type the number of segments with the Segmented Line tool active.

The length of the segments expands proportionately to fit the length of the digitized construction line.

Pasting lines as parcel construction lines

This topic applies to ArcEditor and ArcInfo only.

Steps: To paste lines from an external ArcGIS supported source as parcel construction lines, follow these steps:

1. In an edit session in ArcMap, click the Parcel Editor arrow on the Parcel Editor toolbar and click Plan Directory to open the Plan Directory dialog box. If you are working in manual mode using fabric jobs, open the Plan Directory dialog box in an open fabric job.
2. On the Plan Directory dialog box, right-click the plan in which you want to digitize construction lines and click Construction. The Parcel Details dialog box becomes visible, with the Construction grid active. If you are working with parcels in a local coordinate system, the data frame switches to a local data frame.

Tip: If you are not working with plans, right-click the system default plan named <map>.

Tip: If you are working in manual mode using fabric jobs, you can right-click the plan listed in the Parcel Explorer window, if the plan is part of the open job.

Copy your line work from your external data source:

3. Load your feature class, CAD file, or any other supported vector line source as a layer into ArcMap.
4. Click the Edit tool on the Editor toolbar and select the lines you want to copy.
5. Right-click in the map display and click Copy.
6. Right-click in empty space in the Construction grid on the Parcel Details dialog box and click Paste. The selected lines are pasted into the map or local data frame and the construction line grid is populated with the dimensions computed from the geometry of each pasted line.

Tip: Construction lines that are disconnected are displayed in the construction grid with their from- and to-points highlighted in yellow.
Basis of bearing

This topic applies to ArcEditor and ArcInfo only.

In some cases, when splitting an existing parcel, the new subdivision plan or record of survey has a basis of bearing. A basis of bearing is stated on a plan or record of survey when the origin of north on the document is different from north in your coordinate system. For example, the basis of bearing could be the bearing of a line between two control points or follow a particular boundary line on the plan or record of survey.

When subdividing a parcel in the parcel fabric, you can use the Basis Of Bearing tool to orient or rotate the original parcel to the basis of bearing used on the new subdivision plan.

The Basis Of Bearing tool starts with a reference bearing to which the basis of bearing rotation will be applied. The reference bearing is the bearing of the parcel line on which you right-clicked to activate the tool. The basis of bearing that is entered is used to calculate the rotation or bearing offset that will be applied to the parcel.

The reference line/bearing can be changed at any time by clicking the Change button, which loads a dialog box asking you to specify a new reference line. A new reference line is specified by clicking the from- and to-points of the line.

The basis of bearing rotation is a temporary rotation that is applied to the original parent parcel. The rotation is not stored on the parent parcel. However, the newly subdivided parcels will have the same orientation or rotation that was defined as the basis of bearing for the parent parcel.

Steps:

Note: The Basis Of Bearing tool only works with the Construct from parent command. In other words, you will only use basis of bearing when subdividing parcels with construction line work.

Note: The basis of bearing rotation is not a ground to grid correction. The scales of the original parent parcel and new parcels are represented on the ground in the parcel fabric. The least-squares adjustment will correct parcels to projected grid coordinates based on elevations of the control points used in the adjustment.
To apply a basis of bearing, follow these steps:

1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor toolbar, right-click the parcel you want to subdivide, then click Construct from parent.
   If you are working in manual mode with fabric jobs, right-click the parcel you are subdividing in an open fabric job.
   Before applying the basis of bearing rotation, make sure the parcel is being displayed in parcel measurement view.
2. Click the Parcel Editor menu and click Parcel Measurement View.

   **Note:** In parcel measurement view, parcels are displayed using coordinates derived from their COGO dimensions instead of their fixed, joined locations in the parcel fabric layer. To view the basis of bearing rotation on the parcel, the parcel must be displayed in parcel measurement view. Parcels are automatically displayed in parcel measurement view when opened in a local coordinate frame.

3. On the open parcel, right-click the parcel line that will be used as the reference bearing for the basis of bearing rotation and click Basis of Bearing.
4. On the Basis of bearing dialog box, type the basis of bearing in the Enter the new bearing text box.
5. Click Calculate to display the rotation or bearing offset in the Bearing offset text box.
6. Click Apply to apply the bearing offset or rotation to the open parcel.
   The map is refreshed to display the rotated parcel. You can now add construction lines to split the rotated parcel.

Related Topics
Displaying parcels using dimension vs. shape values

About dividing parcels by area in the parcel fabric

*This topic applies to ArcEditor and ArcInfo only.*

In the parcel fabric, parcels can be divided by area to create new parcels. Using the parcel division tool, you can divide parcels using the following area-based division methods:

- In equal widths
- By proportional area
- Into equal areas

When using the methods in equal widths and into equal areas, you have the option to create a remainder parcel if the areas do not completely divide the parent parcel. The parent parcel is flagged as historic when divided using the parcel division tool.

**In equal widths**

When dividing a parcel into equal widths, you specify a width value and the number of parcels to create. Split lines are equal widths apart, creating parcel areas of equal width. In the Parcel Division dialog box, you need to specify the number of parts (parcels) into which the parcel will be divided, the bearing of the split lines, and the width of each part. Depending on the bearing you enter for the split lines, the parcel will either be split horizontally (west–east) or vertically (north–south).
By proportional area

When dividing a parcel using proportional area, the entire parcel is divided and proportioned into equal areas based on the number of parts you specified. For example, if you specified three parts, the parcel is divided and proportioned into three equal areas, and if you entered four parts, the parcel is divided and proportioned into four equal areas. In the Parcel Division dialog box, you need to specify the number of parts into which the parcel will be divided and specify the bearing of the split lines. Depending on the bearing you enter for the split lines, the parcel will either be split horizontally (west–east) or vertically (north–south).

Into equal areas

When dividing a parcel into equal areas, you specify an area and the number of parcels to create. Newly divided parcels are created with the same area. Unlike proportional area, there can be a remainder parcel when dividing a parent parcel into parcels of equal areas. This is because the number of parcels created with the same area may not equal the entire area of the parent parcel. In the Parcel Division dialog box, you need to specify the number of parts into which the parcel will be divided, the bearing of the split lines, and an area value. Depending on the bearing you enter for the split lines, the parcel will either be split horizontally (west–east) or vertically (north–south).
Create new parcels from multiple existing parcels

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Before working with the Parcel Division dialog box, make sure your editor units are set correctly. The bearing you enter for the parcel split lines will be in the units currently set for the editor.
2. Click the Units tab on the Editing Options dialog box.
3. Click the Direction Type and Direction Units drop-down boxes to set angular units for the editor.
4. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor menu, right-click the parcel you want to divide, then click Parcel Division. If you are working in fabric jobs, open the job, right-click a parcel, then click Parcel Division.
5. If you are working in manual mode using fabric jobs, you will right-click the parcel you are subdividing in an open fabric job.
6. In the Parcel Division dialog box, click the Plan button to select a plan or record of survey from the Plan Directory dialog box for the newly subdivided parcels.
7. Click the drop-down list under Divide this parcel to select how to divide the parcel:
   a. Specify the number of parts or parcels to create in the Number of parts text box. Parcels are created with areas of equal width.
   b. Type a bearing for the split lines that will divide the parcel in the Split-line bearing text box. Depending on the bearing you type, the Starting from the drop-down list will update to display North/South or East/West options for selection.

Tip: If you are not using plans, you can select the default <map> plan from the Plan Directory dialog box.
c. Click the drop-down box next to Starting from the to select the direction from which to start creating parcels.

d. Type a width for the parts or parcels in the Width of each part is text box.

e. If you want to create a remainder parcel, click the Create a remainder parcel check box. To merge the remainder parcel with the adjacent parcel, type maximum area value for the remainder parcel under Merge Remainder if it is less than. Remainder parcels that have an area greater than the value you specified will not be merged.

f. Click the Activate parcel namer tool when I click OK check box to activate the parcel namer tool after the new parcels have been created. The mouse cursor will change to the crosshairs tool that can be used to drag a line over a sequence of parcels to be named.

g. Click OK on the Parcel Division dialog box to subdivide the parcel using the method you have chosen.

- By proportional area
  a. Specify the number of parts or parcels to create in the Number of parts text box. Parcels are proportioned into equal areas to subdivide the entire parcel. There is no remainder parcel.
  b. Type a bearing for the split lines that will divide the parcel in the Split-line bearing text box. Depending on the bearing you type, the Starting from the drop-down list will update to display North/South or East/West options for selection.
  c. Click the drop-down box next to Starting from the to select the direction from which to start creating parcels.
  d. Click the Activate parcel namer tool when I click OK check box to activate the parcel namer tool after the new parcels have been created. The mouse cursor will change to the crosshairs tool that can be used to drag a line over a sequence of parcels to be named.
  e. Click OK on the Parcel Division dialog box to subdivide the parcel using the method you have chosen.

- Into equal areas
  a. Specify the number of parts or parcels to create in the Number of parts text box. Parcels are created with areas that are equal to the area value that is specified.
  b. Type a bearing for the split lines that will divide the parcel in the Split-line bearing text box. Depending on the bearing you type, the Starting from the drop-down list will update to display North/South or East/West options for selection.
  c. Click the drop-down box next to Starting from the to select the direction from which to start creating parcels.
  d. Type an area for the parts or parcels in the Area of each part is text box.
  e. If you want to create a remainder parcel, click the Create a remainder parcel check box. To merge the remainder parcel with the adjacent parcel, type maximum area value for the remainder parcel under Merge Remainder if it is less than. Remainder parcels that have an area greater than the value you specified will not be merged.
  f. Click the Activate parcel namer tool when I click OK check box to activate the parcel namer tool after the new parcels have been created. The mouse cursor will change to the crosshairs tool that can be used to drag a line over a sequence of parcels to be named.
  g. Click OK on the Parcel Division dialog box to subdivide the parcel using the method you have chosen.

Once the parent parcel is subdivided, it is flagged as historic.

Creating remainder parcels

This topic applies to ArcEditor and ArcInfo only.

When replacing existing parcels with new parcels, you can create remainder parcels from parcel areas not covered by the replacing parcels. Remainder parcels can be created when

- New parcels are overlaid on top of existing parcels to represent a parcel annexation.
- Parcels are subdivided into new parcels, and there is an area left over from the subdivision.

The parcel remainder tool can be used to create remainder parcels when doing parcel annexations.
When subdividing parcels by area using the parcel division tool, you also have the option to create remainder parcels. When a remainder parcel is created, the original parcel is always preserved and flagged as historic.

**Tip:** To display historic parcels, right-click in empty space in the Parcel Explorer window and click View Historic Parcels.

### Steps:

1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor menu, select the parcel that overlays the parcel or parcels that will be remainder parcels, right-click, then click Parcel Remainder.
2. In the Parcel Remainder box, click the Plan button to select a plan from the Plan Directory dialog box for the remainder parcel(s).
3. If you have defined parcel templates, click the Template button to specify a feature template for the remainder parcel.
4. Specify a name for the remainder parcel in the text box next to Parcel(s) name.
5. Check the parcel or parcels that will be created as remainder parcels under Choose the parcels to create remainders for.
6. Click OK to create the remainder parcels and close the Parcel Remainder dialog box.

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**Merging parcels in the parcel fabric**

*This topic applies to ArcEditor and ArcInfo only.*

New parcels can be created from merging parcels in the parcel fabric. Adjacent parcels can be merged to create a single, bigger parcel, and disjoint parcels or parcels that are not adjacent can be merged to create multipart parcels.

When using the parcel fabric merge tool, you can choose to copy attribute values from one of the existing parcels being merged or specify a feature template for the new parcel being created.

When merging adjacent parcels, the original lines of the parent parcels are still visible. You can set a definition query to turn off the historic lines, or you can set a historic line feature template on the Merge dialog box. To set a historic line feature template, you will need to have defined line types on your parcel lines that include a historic line type.
To define a feature template for historic line types, go to the Table Of Contents window, display parcel lines by their line type, then choose symbols for your line types.

Once you have displayed your parcel lines by their line type, you can then create feature templates for the symbolized parcel lines.
Steps:

To merge parcels in the fabric, follow these steps:

1. In an edit session in ArcMap, click the **Select Parcel Features** tool on the **Parcel Editor** menu, select the parcels that you want to merge, right-click, then click **Merge**. You can merge two or more adjacent parcels. If selected parcels are not adjacent, multipart parcels are created.

2. On the **Merge** dialog box, type a parcel name in the **Parcel name** text box. If you leave the parcel name blank, a default parcel name of NewParcelxx is used.

3. For the newly merged parcel, choose whether to copy attributes from one of the existing parcels or use a feature template.

4. Click the **Update overlay lines on parent parcels** option to specify a line feature template for the historic lines of the original parcels.

5. Click **OK** to create the new parcel.

Related Topics

Defining feature templates for fabric sublayers

Feature templates and the parcel fabric

Creating natural boundaries in the parcel fabric

This topic applies to ArcEditor and ArcInfo only.

A natural boundary is a parcel boundary that is formed by a natural feature. The most common example of a natural boundary is the bank of a river bed.

In the parcel fabric, natural boundaries are referred to as line strings and can be created using the Line String tool located on the Parcel Details dialog box.
You can also convert a series of existing lines to a single line string in the Lines grid on the Parcel Details dialog box.

**Steps:**

To create a line string, follow these steps:

1. In an edit session in ArcMap, create a new parcel and begin traversing in your parcel lines.
2. To traverse in the natural boundary, click the **Line String Tool** command on the **Parcel Details** dialog box and begin digitizing in your natural boundary.
3. If the line string does not end on an existing parcel point, right-click and click **Finish Digitizing** to finish digitizing the line string. All segments digitized are represented as a single line string in the lines grid.

   **Tip:** To digitize in a series of line strings, click the end point of the previous line string, right-click, then click **Restart Digitizing.**

   **Note:** The line accuracy of a natural boundary is automatically set to **accuracy level** 6, which is the lowest accuracy level. Line strings should have low accuracy levels, as their boundaries are not precise or accurate, and thus the boundary should not have too much influence on the outcome of a fabric least-squares adjustment.

4. To edit a line string, click the **Bearing** field of the line string row in the Lines grid and click the **Line String Tool** command on the **Parcel Details** dialog box.

   Vertices will become visible on the line string parcel boundary. You can click a vertex to drag the vertex and modify the line string shape.

   **Tip:** To convert a sequence of individual parcel boundaries to a single line string, select the lines that represent the line string in the **Lines** grid of the **Parcel Details** dialog box, right-click, then click **Create line string.**

   **Tip:** To split a line string into a series of individual parcel lines, right-click the line string row in the **Lines** grid of the **Parcel Details** dialog box and click **Split line string.**

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**About multipart, donut, and island parcels**

This topic applies to ArcEditor and ArcInfo only.

You can create multipart, donut, and island parcels in the parcel fabric using part connector lines. Multipart and donut polygons can also be migrated to the parcel fabric using the **Load A Topology To A Parcel Fabric** geoprocessing tool or the **Import Fabric Data wizard.**

**Multipart parcels**

Multipart features are composed of more than one physical part that only references one set of attributes. Similarly, multipart parcels are composed of more than one polygon and reference one set of attributes. An example of a multipart parcel is a single parcel that is split by a right-of-way such as a road.
In the parcel fabric, you can create multipart parcels using the following methods:

- Traverse in a part connector line between closed loops in the parcel traverse environment.

- Merge existing, disjoint parcels using the parcel merge tool. When disjoint parcels are merged, a part connection line is automatically created between the parcels.

**Data migration**

The Load A Topology To A Parcel Fabric geoprocessing tool and the Import Fabric Data wizard will migrate disjoint, multipart polygons as multipart parcels if the polygon features are multipart features. Part connection lines are created during the data migration process.

**Donut and island parcels**

Donut parcels are polygons that have an interior hole. Island parcels are polygons that fill the interior hole of a donut parcel. An example of a donut parcel would be a parcel containing a lake. An example of an island parcel would be a parcel surrounded by a right-of-way parcel such as a road.
Donut and island parcels are created in the parcel fabric using part connection lines. In the traverse environment, outer parcel rings are connected to inner parcel rings using part connection lines.

Data migration
The Load A Topology To A Parcel Fabric geoprocessing tool and the Import Fabric Data wizard both recognize and import donut and island parcels. You do not have to create part connection lines in the data being migrated. The part connection lines are created during the migration process. Part connection lines are created between the nearest inner ring and outer ring parcel points.

Related Topics
Creating donut and island parcels in the parcel fabric
Creating multipart parcels in the parcel fabric

Steps:
To create multipart parcels in the fabric, follow these steps:
1. In an edit session in ArcMap, create the first parcel traverse loop of your multipart parcel.
   If you are working in manual mode with fabric jobs, create the first parcel traverse in an open fabric job.
   You can leave the parcel open or save it as unjoined so that it can be reopened for continued work at a later stage.
2. With the first parcel traverse open, click any one of the parcel corner points to add it as the from-point of the part connection line in the next line of the traverse grid under the Lines tab of the Parcel Details dialog box.
3. Type the bearing and distance of the part connection line in the Bearing and Distance fields of the parcel traverse grid.
4. Set the line category to 7 Part Connection.
5. Create the next parcel traverse of the multipart parcel starting at the endpoint or to-point of the part connection line.

6. Once all the parcel traverses of the multipart parcel have been created, click the **Keep changes to parcel data and join** command on the **Parcel Details** dialog box to save and join the multipart parcel to the parcel fabric layer.

7. You can also click the **Keep changes to parcel data** command to save your multipart parcel as unjoined.

**Tip:** To create a multipart parcel by merging existing parcels, select the disjoint parcels you want to merge using the **Select parcel features** tool, right-click, then click **Merge**.

Learn more about merging parcels

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**Note:** Part connection lines are treated the same as boundary lines in the parcel fabric.

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**Creating donut and island parcels in the parcel fabric**

This topic applies to ArcEditor and ArcInfo only.

When creating donut parcels that have interior island parcels instead of holes, the donut parcel is created first, and the hole is filled with the island parcel afterwards.

**Steps:**

To create donut and island parcels, follow these steps:

1. In an edit session in ArcMap, **create the parcel traverse** of the outer ring of the donut or island parcel. If you are working in manual mode with fabric jobs, create the outer ring parcel traverse in an **open fabric job**.

   You can leave the parcel open or save it as unjoined so that it can be reopened for continued work at a later stage.

2. With the outer ring parcel traverse open, click any of the parcel corner points to add it as the From point of the part connection line in the next line of the traverse grid under the **Lines** tab of the **Parcel Details** dialog box.

3. Type the bearing and distance of the part connection line in the **Bearing** and **Distance** fields of the parcel traverse grid.

4. Set the line category to **7 Part Connection**.

5. **Create the inner ring parcel traverse starting at the end point or To point of the part connection line.**

   The inner ring parcel should also finish on the To point of the part connection line.

   **Tip:** To add another inner ring parcel, add another part connection line to any of the outer ring parcel corners and traverse in the next inner ring parcel.

6. Once you are finished entering both the outer and inner rings, click the **Keep changes to parcel data and Join** command on the **Parcel Details** dialog box to save and join your parcel.

   You can also click the **Keep changes to parcel data** command to save your parcel as unjoined.

   The parcel is saved as a donut parcel with an empty hole for the inner ring parcel.

7. To add inner ring or island parcels to fill in the donut holes, create a new parcel and turn on digitize mode by right-clicking using the **Construction** tool and clicking **Digitize mode**. Click the inner ring parcel points to Digitize in the inner ring or island parcel. Save and join.

   When joining the inner ring parcel, the parcel will be placed exactly as digitized. Click the **Create join link using drag box around a fabric point and a join point** tool on the **Join Parcel** dialog box and drag a box around each inner ring parcel point to complete the join.

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About COGO tools in the parcel fabric

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This topic applies to ArcEditor and ArcInfo only.

In the parcel fabric, coordinate geometry (COGO) tools are available for adding and computing parcel traverse lines and construction lines. COGO is the method used to capture and define survey measurements and descriptions that have been recorded on a plan or legal record of survey. Through COGO, survey measurements are captured through the input and manipulation of bearings, distances, and coordinates.

Learn more about COGO in ArcGIS

Parcel fabric COGO tools work specifically for parcels in the fabric and are different from the COGO tools that can be found in the standard editing environment.

COGO tools

The following COGO tools are available in the parcel fabric:

- **Bearing/Distance and Delta X,Y**
  Used for defining parcel traverse lines and construction lines.

- **Tangent Curve**
  Used for creating tangent curves. Using this tool, tangent curves can be created regardless of the curve parameters set for the current, working plan.

- **Bearing-Bearing, Distance-Distance, and Bearing-Distance**
  Used for creating parcel points and construction points at the intersection of two lines.

- **Parallel, Perpendicular, and Deflection**
  Used for creating lines that are parallel, perpendicular, or deflected at an angle to an existing line.

- **Point Reporter**
  Generates a report on a selected point. You can also generate COGO information on the selection of two points and the selection of three points.

This topic applies to ArcEditor and ArcInfo only.

Parcel traverse lines and construction lines in the fabric can be added using Bearing, Distance, and Delta X,Y COGO commands.

Bearing, Distance, and Delta X,Y

This topic applies to ArcEditor and ArcInfo only.

Parcel traverse lines and construction lines in the fabric can be added using Bearing, Distance, and Delta X,Y COGO commands.

Bearing and Distance commands

Instead of typing the bearing and distance dimensions in the construction or traverse line grid on the Parcel Details dialog box, you can use the Bearing, Distance, or Bearing/Distance command on the Construction tool shortcut menu to add lines.

The individual Bearing and Distance COGO commands are useful for forcing the feedback line to either move along the specified bearing or be drawn out to a specified distance.

To use the Bearing, Distance, and Bearing/Distance COGO commands when creating a new parcel or entering construction lines, right-click using the Construction tool and click Bearing, Distance, or Bearing/Distance. Bearing direction units are in the units of the current, working plan.
Bearings and distances entered through COGO commands are automatically populated in the parcel traverse or construction lines grid on the Parcel Details dialog box.

**Delta X,Y command**

You can add a parcel traverse or construction line that is based on a change (delta) in x and a change in y from a previous parcel or construction point. Once you have typed in the delta x and y, the bearing and distance are automatically calculated and populated in the parcel traverse or construction lines grid on the Parcel Details dialog box.

To use the Delta X, Y command when creating a new parcel or entering construction lines, right-click using the **Construction tool** and click **Delta X,Y**. Type the distances for x and y in the two text boxes, respectively, on the Delta X, Y dialog box. The distances are from the last point in the parcel traverse or the last construction point.

**Tangent Curve**

This topic applies to ArcEditor and ArcInfo only.

You can use the Tangent Curve COGO tool to add tangent curves any time you are working with a parcel traverse or a set of construction lines. The Tangent Curve COGO tool is useful in that it allows you to create tangent curves regardless of the curve parameters set for the current working plan.

Learn more about plans in the parcel fabric
Learn how to create a new plan

When using the Tangent Curve tool, the tangent line used is the previous line in the parcel traverse or construction grid. So, if for example, you would like to use an existing parcel or construction line as the tangent line and it is not the last line in the grid, you would need to insert a new row for the tangent curve just below the line.

**Tip:** To insert a row in the parcel traverse or construction grid in the Parcel Details dialog box, right-click the row above which you want to add the tangent curve and click **Insert Row**.

To add a tangent curve using the Tangent Curve COGO tool, click the parcel or construction point that will be the From point of your tangent curve, right-click using the **Construction tool**, then click **Tangent Curve**. The tangent curve is calculated using the previous line in the parcel traverse or construction grid.
intersection tools

This topic applies to ArcEditor and ArcInfo only.

COGO intersection tools are used to create new points from the intersection of dimensions. For example, a bearing-bearing intersection creates a point at the intersection point of two bearings. If the bearings do not intersect, no point can be created.

Another example of a COGO intersection is the bearing-distance intersection, where two possible intersection points are created from the intersection of a distance radiating outward from one point and a bearing from a different point.

In the parcel fabric, you can work with bearing-bearing, distance-distance, and bearing-distance intersection tools for both parcel traverse and construction lines.

**Bearing-bearing intersection**

A new parcel point or construction point can be created from the intersection of two line directions, or a bearing-bearing intersection. The point created from the bearing-bearing intersection creates a new line in the parcel traverse or construction grid. The end point or from point of the new line is the point created from the bearing-bearing intersection. The starting point of the line is the end point or to point of the previous line in the parcel traverse or construction grid.

The bearings of the intersection lines can be manually entered or obtained by clicking existing lines or curves (chord will be used).

To use the Bearing-Bearing intersection tool when creating a parcel traverse line or construction line, follow these steps:

1. Using the **Construction Tool** , click the parcel point or construction point that will be the starting point of the line created by the bearing-bearing intersection.
2. Click the **Create a point at the intersection of the two lines** tool on the **Parcel Details** dialog box.
3. In the **Bearing bearing Intersect** dialog box, type the bearing of the first intersection line. By default, this line will be from the end point of the previous line in the traverse or construction grid.
4. Click the clear button under the second **From Point ID:** label and click a point that will be the from point of the second intersection line.
5. Type a bearing for the second intersection line. By default, a bearing will automatically be populated such that the second intersection line intersects with the first intersection line.
6. Click **OK** to create the intersection point and the new line in the parcel traverse or construction grid.

**Distance-distance intersection**

A new parcel point or construction point can be created from the intersection of two line distances. The distance-distance intersection has no reference to bearings. The intersection requires two distances, which radiate out from two different points.
The distance-distance intersection results in the creation of two possible intersection points. The point chosen and created from the distance-distance intersection creates a new line in the parcel traverse or construction grid. The end point or From point of the new line is the point created from the distance-distance intersection. The starting point of the line is the end point or To point of the previous line in the parcel traverse or construction grid.

The distances of the intersection lines can be manually entered or obtained by clicking existing lines or curves (chord will be used).

To use the Distance-Distance intersection tool when creating a parcel traverse line or construction line, follow these steps:

1. Using the Construction Tool, click the parcel point or construction point that will be the starting point of the line created by the distance-distance intersection.
2. Click the Create a point at the intersection of two circle distances tool on the Parcel Details dialog box.
3. In the Distance Distance Intersect dialog box, type the distance of the first intersection line. By default, this line will be from the end point of the previous line in the traverse or construction grid.
4. Click the clear button under the second From Point ID: label and click a point that will be the from point of the second intersection line.
5. Type a distance for the second intersection line. By default, an intersection point is automatically chosen and highlighted in green.
6. Click the Switch button to change the intersection point and choose the other point.
7. Click OK to create the intersection point and the new line in the parcel traverse or construction grid.

Bearing-distance intersection

A new parcel point or construction point can be created from the intersection of a bearing from one point and a distance from a second point. The bearing-distance intersection results in the creation of two possible intersection points.

The point chosen and created from the bearing-distance intersection creates a new line in the parcel traverse or construction grid. The end point or From point of the new line is the point created from the bearing-distance intersection. The starting point of the line is the end point or To point of the previous line in the parcel traverse or construction grid.
The bearing and distance of the intersection lines can be manually entered or obtained by clicking existing lines or curves (chord will be used).

To use the bearing-distance intersection tool when creating a parcel traverse line or construction line, follow these steps:

1. Using the Construction Tool, click the parcel point or construction point that will be the starting point of the line created by the bearing-distance intersection.
2. Click the Create a point at the intersection of an angle and distance tool on the Parcel Details dialog box.
3. In the Bearing Distance Intersect dialog box, type the bearing of the first intersection line. By default, this line will be from the end point of the previous line in the traverse or construction grid.
4. Click the clear button under the second From Point ID: label and click a point that will be the from point of the second intersection line.
5. Type a distance for the second intersection line. By default, an intersection point is automatically chosen and highlighted in green.
6. Click the Switch button to change the intersection point and choose the other point.
7. Click OK to create the intersection point and the new line in the parcel traverse or construction grid.

This topic applies to ArcEditor and ArcInfo only.

In the parcel fabric, parcel traverse and construction lines can be added using the Parallel to Line, Perpendicular to Line, and Deflection off Line COGO tools.

Parallel, Perpendicular, and Deflection

This topic applies to ArcEditor and ArcInfo only.

In the parcel fabric, parcel traverse and construction lines can be added using the Parallel to Line, Perpendicular to Line, and Deflection off Line COGO tools.

Parallel to Line

Parcel traverse and construction lines can be added such that they are parallel to an existing line. When a line is added using the Parallel to Line tool, the bearing of the line in the traverse or construction grid will be the same bearing as the line on which you right-clicked.

To add a parallel traverse line or construction line, right-click the line to which the new line will be parallel and click Parallel to Line. The line feedback cursor is constrained parallel to the line on which you right-clicked.
To specify a distance for your parallel line, right-click and click **Distance**. Type a distance in the text box on the **Distance** dialog box.

**Perpendicular to Line**

Parcel traverse and construction lines can be added such that they are perpendicular to an existing line. When a line is added using the Perpendicular to Line tool, the bearing of the line in the traverse or construction grid will be a bearing that is perpendicular to the line on which you right-clicked.

To add a perpendicular traverse line or construction line, right-click the line to which the new line will be perpendicular and click **Perpendicular to Line**. The line feedback cursor is constrained perpendicular to the line on which you right-clicked.

To specify a distance for your perpendicular line, right-click and click **Distance**. Type a distance in the text box on the **Distance** dialog box.

**Deflection off Line**

Parcel traverse and construction lines can be added such that they deflect at an angle off an existing line. Positive angles deflect lines counterclockwise off an existing line, and negative angles deflect lines clockwise off an existing line. The units of the deflection angle will be in the units set for Direction and Angle of the current, working plan.

When a line is added using the Deflection off Line tool, the bearing of the line in the traverse or construction grid will either be the addition or subtraction of the bearing of the line on which you right-clicked and the angle you specified. Negative angles are subtracted.

To add a traverse line or construction line that is deflected off an existing line, right-click the line off which the new line will be deflected and click **Deflection off Line**. Type an angle in the text box on the **Deflection** dialog box and click **OK**. The line feedback cursor is constrained at the angle you specified to the line on which you right-clicked.

To specify a distance for your deflected line, right-click and click **Distance**. Type a distance in the text box on the **Distance** dialog box.
Point reporting

This topic applies to ArcEditor and ArcInfo only.

The point report tool displays information on the selections of one point, two points, and three points. To open the Point Report dialog box, click the Point Reporting On 1, 2 Or 3 Points tool on the Parcel Editor menu.

One point

When one point is selected, the following information is displayed on the Point Report dialog box:

- Point ID and database ID of the point that was clicked.
- Point coordinates
- Point scale. This is the ground to grid scale for the point. The value represents the difference between the point height on the ground and the point height in the projected grid.
- Point convergence. This is the angle between true north and grid north at the point.

To generate a report for one point, open the Point Report dialog box, click the point for which you want to generate a report, then click the Report button.

Two points

When two points are selected, the point report tool generates information on the position of the points relative to each other. The following data is listed on the Point Report dialog box:

- From-point ID and database ID. This is the ID of the first point that was clicked.
- To-point ID and database ID. This is the ID of the second point that was clicked.
- From-point coordinates.
- To-point coordinates.
- Bearing and distance between the two points. The bearing and distance are calculated using the point coordinates.

To generate a report for two points, click the middle button on the Point Report dialog box. Click the two points for which you want to generate a report and click Report.

Three points

When three points are selected, the point report tool generates information about the offset of the third selected point relative to the line created by the first two selected points. The following data is listed on the Point Report dialog box:

- From-ID and database ID. This is the ID of the first point that was clicked.
- To-point ID and database ID. This is the ID of the second point that was clicked.
- At-point ID and database ID. This is the ID of the third, offset point that was clicked.
- From-point coordinates.
- To-point coordinates.
- At-point coordinates. These are the coordinates of the third, selected offset point.
- Perpendicular offset, which is the distance and direction of the perpendicular line that goes from the third point to the line defined by the first two points.
- Internal angle, which is the angle formed by the line going from the first point to the second point and the line between the second point and the third point.
- External angle, which is the opposite angle to the internal angle.
To generate a report for three points, click the third button on the **Point Report** dialog box. Click the three points for which you want to generate a report and click **Report**.

**Tip:** Angles and directions displayed on the Point Report dialog box are displayed in the units currently set for Editor. To change Editor units, click the **Editor** arrow on the **Editor** toolbar and click **Options**. On the **Editing Options** dialog box, click the **Units** tab.

### Naming parcels using the parcel namer tool

*This topic applies to ArcEditor and ArcInfo only.*

You can use the parcel namer tool located on the Parcel Editor toolbar to batch assign sequential names, parcel identification numbers (PINs), or assessor's parcel numbers (APNs) to a set of adjacent parcels in the parcel fabric. If a set of adjacent parcels has names that are sequential, the parcel namer tool can be used to automatically populate the parcel name attributes of the selected adjacent parcels.

**Steps:**

1. In an edit session in ArcMap, click the **Name Parcels Sequentially Using A Line** tool on the **Parcel Editor** toolbar and drag a line across the adjacent parcels to which you want to batch assign sequential names. Click the first parcel and drag a line to the last adjacent parcel in the set. Then double-click to finish dragging the line.

If you are working in manual mode using fabric jobs, click the **Name Parcels Sequentially Using A Line** tool in an open fabric job.

**Tip:** You can add another line segment and change the direction of the line to name adjacent parcels that do not follow a straight line. Instead of double-clicking to finish dragging the line, click once to add another line segment.
2. On the **Parcel sequence naming** dialog box, type a numeric value in the **Starting parcel number** text box. The first parcel in the adjacent sequence is assigned this value.

3. Type a numeric value in the **Increment** text box.

4. Type an alphanumeric prefix and suffix, respectively, in the **Prefix** and **Suffix** text boxes. Prefixes and suffixes are optional.

5. Click **OK** to assign the parcel names.

For example, if you typed a starting parcel number of **001**, an increment of **2**, and a prefix of **A54**, selected adjacent parcels are named **A54001**, **A54003**, **A54005**, and so on.

**About joining parcels to the parcel fabric**

This topic applies to ArcEditor and ArcInfo only.

When new parcels are created in the parcel fabric, the parcels are created as floating parcels in the map extent. A newly created parcel is not yet connected to the parcel fabric layer, even if existing fabric points were used as from or to points in the creation of the parcel. Newly created parcels need to be joined to the parcel fabric to be connected to the parcel fabric. Since parcels can be created as floating geometries or floating features, this allows the data entry of parcels without the knowledge of coordinates, points of beginning, or spatial references. All that is required to enter a parcel in the parcel fabric are the recorded dimensions from the plan or record of survey.

**Tip:** Parcels can be entered in the data frame of the map display or in a separate, local coordinate system data frame. You can choose how to enter your parcels in the Parcel Editor Options dialog box under Parcel view behavior. The Parcel Editor Options dialog box can be accessed from the Parcel Editor menu on the Parcel Editor toolbar.

Parcel joining is an interactive process where the parcel points of a floating parcel or group of parcels are matched with their corresponding points in the parcel fabric.
Establishing join links

Join links are established between the join parcel’s points and the corresponding points in the parcel fabric. Failure to establish a join link between a join parcel point and its matching fabric point will result in duplicate points for the same location. Overlapping points compromise the topological connectivity of the parcel fabric and may result in a less than optimal solution in a fabric least-squares adjustment.

Learn more about maintaining the topological structure of the parcel fabric.

Join links can be manually created or created by dragging a box around the two points you want to join. To manually create a join link, the **Join A Parcel Or Group Of Parcels** tool is used to snap to the joining parcel’s point and snap to the corresponding point in the fabric.

Join links can also be automatically created by dragging a box around the two points you want to join. The **Create A Join Link Using A Dragbox** tool is used to drag a box around the points to be joined.

Join residuals

As each parcel point is matched with its corresponding fabric point, a set of join residuals, a scale, and a rotation are recomputed and displayed in the Join Parcel dialog box.
Join residuals are computed from a transformation between the joining parcel's points and the corresponding points in the parcel fabric. If only two points are joined, a Helmert transformation is used. If more than two points are joined, a least-squares transformation is used. Each time another point is joined, join residuals, scale, and rotation are recalculated.

Join residuals are an indication of how well the unjoined parcel fits with the surrounding parcel fabric. Large join residuals may result from a situation where the parcel being joined is more accurate than the surrounding parcel fabric. Large residuals may occur when the surrounding parcel fabric has been migrated from digitized data and the parcel being joined has been entered from the survey record. Large join residuals could also indicate an error in the dimensions of the parcel being joined.

Auto-joining

After at least two join links have been established, the Auto Join button on the Join Parcel dialog box can be clicked to detect remaining links.

Auto-join uses the transformation parameters from the existing established join links and applies them to all other points in the parcel group to detect other possible join lines. If there is a large difference in accuracy between the parcels being joined and the surrounding fabric, you may need to establish a few more join lines for auto-join to correctly detect remaining join links.

Auto-join will also detect line point join links. A line point join link occurs when a parcel point is joined to a parcel line.

The auto-join process uses the Auto-join settings tolerance located under the Tolerance tab on the Parcel Editor Options dialog box when detecting line points. You can edit this tolerance to suit the quality of your data. For example, a small tolerance of about 0.3 feet can be used if data quality is good.

---

**Note:** Specifying an auto-join settings tolerance that is too large might result in incorrectly joined line points and parcel points. If no match is found between a joining parcel's point and a point in the parcel fabric, the point will simply be transformed using the transformation parameters from the existing join lines.

---

Appending parcels in parcel fabric XML format

Parcels can be appended and joined to the fabric layer from parcel fabric XML files.

You can also save selected parcels to parcel fabric XML files by clicking the Parcel Editor menu and clicking Save as XML. In an open fabric job, the Save as XML command will save all parcels in the job to a parcel fabric XML file. Saving parcels to XML files allows exporting parcels from and importing parcels to the parcel fabric.
The structure of a parcel fabric XML file essentially reflects the structure of the parcel fabric data model.

Parcel fabric XML files are also in the same file format as the fabric job XML file.

Related Topics

Join methods

This topic applies to ArcEditor and ArcInfo only.

There are two join methods to choose from on the Join Parcel dialog box when joining parcels to the fabric layer:

- **Fabric points held fixed, line points moved to lines**: Using this method, parcels being joined are fitted to the surrounding fabric. This is the most commonly used method.
- **Joining points held fixed at map position, line points moved to lines**: Using this method, the coordinate location of the floating parcels is held fixed and the surrounding fabric is fitted to the parcels being joined.

**Fabric points held fixed**

Using the Fabric points held fixed method, join parcels are fitted into the surrounding parcel fabric, based on the established join lines. The join parcels are
cartographically fitted to the surrounding fabric such that there are no slivers or overlaps. Any line points are automatically moved to their parcel lines. When appending and joining parcels from parcel fabric XML files, the join process uses the parcel point coordinates in the XML file to place the parcel in the map extent. If parcels are appended from a different coordinate system or spatial reference, the placed joined parcels may not be visible in the map extent. The Bring Joining Parcel To Map Extent tool located on the Join Parcel dialog box can be clicked to place the parcels in the visible map extent.

**Joining and accuracy**

Because join parcels are fitted cartographically to the surrounding fabric, the join parcels may be distorted if the parcels being joined are of a higher accuracy and data quality than the surrounding fabric. When joining more accurate parcels to less accurate surrounding parcels, it is important to specify the appropriate accuracy levels on the joining parcels and the surrounding parcels. When a parcel is joined, it is initially fitted to the surrounding parcels for cartographic and visual purposes. However, if the joining parcel’s accuracy is set to a higher level than the accuracy level of the surrounding parcels, a fabric least-squares adjustment will result in the surrounding parcels adjusting around the more accurate parcel and the more accurate parcel maintaining its data integrity. Parcels with a higher accuracy level have a higher weight in a fabric least-squares adjustment and will adjust less than those parcels with a lower accuracy level and lower weight.

**Joining points held fixed**

Using the Joining points held fixed method, the join parcels are held at a fixed position and the surrounding parcel fabric is fitted to the join parcels.

This method is useful for appending parcel data with coordinates. The point coordinates in the parcel fabric XML file are used to place the parcels in the map extent. Using the Joining points held fixed method, accurate coordinates appended from parcel fabric XML files can be preserved during the joining process. Using this method, you can still drag joining parcels in the map extent. The coordinates in the new location will be used and held fixed in the joining process.

- If you have dragged or moved the joining parcels, you can click the Reset X And Y Coordinates To The Original Position tool on the Join Parcel dialog box to reset the joining parcels to their original coordinates.

- The Move A Point In Joining Parcel tool can be used to move vertices on the joining parcels and snap them to existing points and lines in the map extent.

- Click the Use coordinate averaging check box to calculate an average (mean) between the join parcel coordinates and corresponding fabric coordinates when the fabric is fitted to the join parcels.

**Scale and rotation**

The Scale And Rotate Joining Parcel tool can be used to scale and rotate the joining parcel. Using this tool, rotation and scale values can be typed in on the Join Parcel dialog box.
You can also scale and rotate joining parcels using the mouse. The scale and rotation values on the Join Parcel dialog box will update as you scale and rotate the parcels.

When using the mouse to scale and rotate joining parcels, you can snap joining parcel vertices to existing points and lines on the map.

**Tip:** You can also use the Scale Joining Parcel tool to only scale the joining parcels and the Rotate Joining Parcel tool to only rotate the joining parcels.

### About maintaining topological structure in the parcel fabric

*This topic applies to ArcEditor and ArcInfo only.*

There are several tools available for correcting topological errors and data corruptions in the parcel fabric. Topological errors can arise from the migration of poor-quality parcel data and incorrect parcel joining. Data corruptions can arise from incorrect data entry, incorrect parcel joining, and so on.

#### Checking the parcel fabric for errors

You can use the Check the fabric command on a parcel fabric to detect topological errors and data corruptions. Errors are detected in parcels, lines, points, line points, and control points.
The Check the fabric command is run on a parcel fabric in the Catalog window. To run the command, right-click a parcel fabric in the Catalog window and click Check the fabric.

**Maintaining topological connectivity**

**Merging points**

There should always be one common point for all coincident parcel corners, curve center points, and endpoints of connection lines. Common points maintain the internal topological connectivity of the parcel fabric.

The Merge Points tool located on the Parcel Editor toolbar can be used to merge a group of points that lie within a specified tolerance of each other into a single point. When merging points, the average or mean of all the points is used to compute the location of the single point.

![Merge Points](image)

**Adding line points**

Line points are parcel corner points that lie on adjacent parcel boundaries without splitting the boundaries. Sometimes line points are not detected during the joining process or during data migration. You can use the Add a Line Point tool located on the Parcel Editor toolbar to assign line points to parcel corner points.

**Note:** You can only assign line points to parcel corner points that do not split an adjacent boundary line.

**Tip:** To remove line points, use the Delete a line point tool located on the Parcel Editor toolbar.

**Checking the topological integrity of the parcel fabric**

This topic applies to ArcEditor and ArcInfo only.

The Check the fabric command is available for validating the topological integrity of your parcel fabric. The command identifies data corruptions such as parcel traverses with lines that are out of sequence.

The Check the fabric command is run on a parcel fabric in the Catalog window. To run the command, right-click a parcel fabric in the Catalog window and click Check the fabric.
Checking the fabric is useful for validating parcel data that has been migrated to the fabric from standard feature classes or CAD files. When migrating data into the fabric, inconsistencies and errors in the source data can result in corruptions in the fabric. The Check the fabric command identifies data corruptions in the fabric and reports the errors in a list format that can be saved for future use.

Errors found in parcels, lines, and points are listed with the ObjectID of the corrupt feature. The ObjectID can then be used to locate the corresponding feature in the parcel fabric. The corrupt feature can be either edited and corrected or unjoined and deleted.

**Parcel fabric validation errors**

The Check the fabric command will identify and report the following data corruption errors:

**Parcel errors**

- **"Line sequence error"**
  The parcel contains lines that are out of sequence.
  In this case, the parcel's traverse lines are out of sequence, for example, 1-2-4-3. Line sequence errors are caused either by incorrect data entry of the parcel traverse or by dangling, overshot/undershot, or tiny line segments in migrated data. For example, in the parcel line feature class shown below, an undershot line is resulting in a failure by the importer to create a fabric parcel:

- **"Line sequences do not start at 1"**
  The sequence IDs of the lines within this parcel do not start at 1. Parcel traverse lines are stored in the Lines table, and the sequence of the traverse lines should always start at 1.

**Causes**

- Road centerline parcels with multiple paths
  Each path should be a separate parcel and not form one single parcel.
- Connection line as the first line of the parcel
  The line category should be changed to Origin Connection rather than Connection.
- Incorrect from- and to-point IDs in the traverse grid
  Sometimes this is caused by incorrect data entry when entering a parcel in a parcel group.

Often, the corrupt parcel is not rendered in the fabric. To open and examine the parcel, the parcel must be selected in the parcel layer's attribute table and opened by right-clicking the parcel, which is listed in the Parcel Explorer window.

- **"Parcel has dangling boundary links"**
  This error can result from a parcel traverse that does not close back onto its starting point.
Causes

- Dangling or overshot lines in migrated data, which has resulted in incorrectly assigned from- and to-points
- Overlapping lines in migrated data, which has resulted in a duplicate parcel line in the parcel fabric

- "Parcel has disconnected links"
  A disconnected link is a line that is not connected to or part of a parcel boundary but is stored as a parcel traverse line for that parcel boundary. This line could be connected to another parcel boundary in the fabric but is related to the wrong parcel.
  Possible causes
  - Incorrect data entry or migration of poor-quality parcel data
  - Data corruption resulting from manually editing parcel fabric system tables

- "Parcel has missing points"
  This parcel's boundary lines are referencing point IDs that do not exist.
  Possible causes
  - Data corruption resulting from manually editing parcel fabric system tables
  - Migration of poor-quality parcel data

- "Parcel contains lines with errors"
  There are errors on some of the traverse lines of this parcel. A list of line errors should appear with the parcel error. Examples of line errors are invalid line categories and invalid line radii. See the "Line errors" section for a more detailed explanation of each type of line error.

- "Parcel contains line points with errors"
  There are errors on some of this parcel's points that are line points on other parcels. A list of line point errors should appear with the parcel error. Examples of line point errors are invalid referenced point IDs—for example, the line point refers to a point on the parcel that does not exist—and invalid referenced lines. See the "Line point errors" section for a more detailed explanation of each type of line point error.

- "Parcel contains points with errors"
  There are errors on some of this parcel's points. A list of point errors should appear with this parcel error. Examples of point errors are invalid coordinates and invalid curve center points. See the "Point errors" section for a more detailed explanation of each type of line point error.

### Line errors

- "Line has invalid ID"
  The ObjectID of this line is not valid.

- "Line has invalid sequence"
  The sequence value for this line (in the Sequence attribute field in the parcel lines table) is not a valid number.

- "Line has invalid category"
  The category value for this line (in the Category attribute field) is not a recognized value. The following line categories are recognized:
  - 0—Boundary line
  - 1—Dependent line
  - 2—Precise connection line
  - 3—Connection line
  - 4—Radial line
  - 5—Road frontage line
  - 6—Origin connection line
  - 7—Part connection line

- "Line has invalid from point"
  The parcel line is referencing an invalid from-point ID. The referenced point ID most likely does not exist in the points table.

- "Line has invalid to point"
  The parcel line is referencing an invalid to-point ID. The referenced point ID most likely does not exist in the points table.

- "Line has invalid center point"
  Parcel lines do not form a closed loop.
The center point for this curved line is invalid. The referenced point ID most likely does not exist in the points table.

- **"Line has invalid radius"**
  The value stored in the Radius attribute field for the curved line is invalid. The radius value is most likely missing.

- **"Line does not have a valid shape"**
  The line shape geometry is invalid. The line shape could be corrupt or missing.

- **"Line has same from and to points"**
  This line is referencing the same from- and to-point IDs. The same from- and to-point IDs can be seen in both the parcel traverse dialog box and in the FromPointID and ToPointID attribute fields in the Lines table.
  **Causes**
  - Incorrect data entry of the parcel traverse
  - Overlapping lines of different lengths in data that has been migrated to the parcel fabric

In the graphic below, there are two overlapping lines for the same parcel boundary that partially overlap each other:

Run a topology to find overlapping lines in your source lines before building a fabric source for migration into the parcel fabric.

- **"Curve is missing a radial line"**
  Each curved line in a fabric parcel has two stored radial lines in the lines table. This error is generated when a curve has one or both radial lines missing.

Causes
- Incorrectly stored and entered multiring or donut parcels
- Poor-quality data that has been migrated to the parcel fabric

**Point errors**

- **"Invalid coordinate"**
  One or all of the x, y, z coordinate values of the parcel point are invalid. A coordinate might be missing or might contain an invalid number or character.

- **"The center point attribute is set incorrectly"**
  If a point is the center point of a curve, it is flagged with a value of 1 in the CenterPoint attribute field in the Points table. This error occurs when a point is not the center point of a curve and has a CenterPoint attribute value of 1.

- **"Point is missing"**
  A point is being referenced that most likely does not exist in the Points table. For example, this error will occur if a line references a from- or to-point that does not exist in the Points table.

- **"Point does not have a valid shape"**
  The point shape geometry is invalid. The point shape could be corrupt or missing.

**Line point errors**

- **"Linepoint does not refer to a valid point"**
  A parcel point becomes a line point when it lies on an adjacent parcel boundary but does not split the boundary. In the LinePoints table, LinePointID references a point ID in the Points table. This error will occur when the LinePointID attribute value is not a valid point ID. The point ID most likely is missing.
• "Linepoint does not have a valid from point"
The point ID referenced in the FromPointID field is not a valid point ID. The point ID is most likely missing.

• "Linepoint does not have a valid to point"
The point ID referenced in the ToPointID field is not a valid point ID. The point ID is most likely missing.

• "Linepoint does not have a valid line"
This error occurs when a line does not exist between the from- and to-point IDs (FromPointID, ToPointID) referenced in the LinePoints table.

Control point errors
• "Control point has invalid coordinates"
One or all of the x,y,z coordinate values of the control point are invalid. A coordinate might be missing or might contain an invalid number or character.

• "Control point back reference is invalid"
A control point references the fabric point to which it is associated via the PointID field in the Control table. The fabric point stores a back reference to the control point via the Name field in the Points table. This error indicates that the ID references in the Points or Control table are either incorrect or missing.

Steps:
To merge a group of close points, follow these steps:
1. In an edit session in ArcMap, click the Merges Unconnected Points Inside A Given Rectangle tool on the Parcel Editor window and drag a box around the points you want to merge.
   If you are working in manual mode using fabric jobs, click the tool in an open fabric job.
2. On the Mean Points dialog box, type a tolerance in the Mean point tolerance text box and click OK.

Adding line points

Steps:
1. In an edit session in ArcMap, click the Add A Line Point tool on the Parcel Editor toolbar.
2. Click the start point (or from-point) of the parcel line on which you want to add a line point.
3. Click the end point (or to-point) of the parcel line on which you want to add a line point.
4. Click the parcel point that should be a line point.
5. Click **Apply** on the **Add a Line Point** dialog box to create and assign the line point.

6. Click **Close** to close the dialog box.

**Note:** If the line point is offset from the parcel line on which it should lie, the offset amount is displayed in the **Offset** text box. Once the line point is added, the line point is moved onto its parcel line and the point is no longer offset from the line. There is no longer a gap.

**Tip:** You cannot add a line point to a parcel point that already splits the boundary of the adjacent parcel line (this could occur in migrated parcel data).

**Tip:** To view line points, turn on the line points sublayer in the **Table Of Contents** window in ArcMap.

**Tip:** Use the **Delete A Line Point** tool located on the **Parcel Editor** toolbar to remove line points.

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**Measurements, coordinates, and accuracy in the parcel fabric**

This topic applies to ArcEditor and ArcInfo only.

**Parcel measurements**

Parcel boundaries in the parcel fabric are defined by bearing and distance dimensions typically derived from raw survey measurements. Often, these bearing and distance dimensions do not accurately close the parcel polygon. That is, if you compute around the parcel boundary using the dimensions, you will not return to the exact coordinates of the starting point. The difference between the starting and closing coordinates of the parcel is referred to as the parcel misclosure and is a measure of the accuracy of the parcel dimensions. The smaller the misclosure, the more accurate the parcel dimensions. Larger misclosures indicate blunders in the original survey measurements or data entry. Smaller, acceptable misclosures usually occur due to the following:

- Scale discrepancies between overlapping surveys
- Differences in accuracies between overlapping surveys done in different time periods
- Human error and inconsistency
- Measurement error

Acceptable tolerances for parcel misclosure are typically specified by government agencies, the survey profession, or other agencies governing the conduct of surveys in a jurisdiction.

Parcel misclosure provides a first-level quality check when entering parcels into the parcel fabric. Erroneous measurements and data entry errors can be caught before the parcel is joined. Joining parcels into the parcel fabric provides a second-level quality check through a display of transformation residuals, which are derived from transforming the parcel from its local coordinate system to the coordinate system of the parcel fabric.

A least-squares adjustment of all joined parcels provides the final and most comprehensive level quality check.

**Learn more about the least-squares adjustment process.**

In the parcel fabric, parcels are entered using a traverse. A parcel traverse is a sequence of dimensioned lines that start and end at the same point and define new points after each line sequence. When entering a parcel traverse in the parcel fabric editor, the traverse misclosure is always displayed.
Measurement accuracy

Parcel dimensions are derived from raw survey measurements observed in the field. Raw survey measurements always have an associated accuracy, which is a reflection of the quality of the measurement. The closer the measurement is to its true value (the more correct it is), the more accurate the measurement.

Because parcel dimensions are derived from raw survey measurements, parcel dimensions can have an associated accuracy as well.

In the parcel fabric, accuracies are assigned to parcels by date of survey. This is because in general, survey accuracy has improved with survey technology and survey practice advancements. Accuracies are grouped by categories, and each category corresponds to a date of survey.

The accuracy category assigned to a parcel line in the parcel fabric is significant for the least-squares adjustment. Accuracy categories provide a weighting system in the parcel network. For example, a high-accuracy category is considered a high weight in the least-squares adjustment. Boundary lines with high accuracies (weights) adjust less than boundary lines with low accuracies.

Parcel point coordinates

The physical location of a parcel corner is defined by a parcel point in the parcel fabric. The parcel point has x,y,z coordinates, which model the current "best fit" representation of that point. Parcel point coordinates are initially generated during the parcel joining process or during the data migration process when migrating existing parcel datasets into the parcel fabric.

When joining a parcel to the parcel fabric, coordinates of the unjoined parcel in local coordinate space are transformed to the spatial reference of the parcel fabric. When the parcel fabric is adjusted using least squares, the parcel dimensions are used together with the control points to improve the accuracy of these initial coordinates. As more accurate parcel data is added to the parcel fabric, more accurate coordinates result from the adjustment.

Only an adjustment of the parcel fabric can alter the coordinates of a parcel point. Coordinates are derived quantities that are held as transient attributes of the point rather than a definition of the point.

About accuracy in the parcel fabric

This topic applies to ArcEditor and ArcInfo only.

Each parcel dimension and thus each parcel in the parcel fabric can have an associated accuracy. This is because parcel dimensions are derived from raw survey measurements, which always have associated accuracies. Measurement accuracy is a way for surveyors to measure the quality, or "correctness," of their measurements.

By default, accuracy in the parcel fabric is defined by survey date. This is because, in general, surveying equipment was less precise in the past than it is today. You can assign accuracy at the parcel line level, the parcel polygon level, and the plan level.

Accuracy and the fabric least-squares adjustment

Accuracy in the parcel fabric is significant in a fabric least-squares adjustment. Parcels with a high accuracy category will thus have a higher weight in the adjustment and will adjust less than those parcels with lower accuracies and thus lower weights. Low-accuracy parcels will adjust around the more accurate parcels.

Parcel fabric accuracy categories

The parcel fabric supports seven accuracy categories or levels, with accuracy category 1 being the highest and accuracy category 7 being the lowest. Any parcel line assigned with accuracy category 7 is excluded from the fabric least-squares adjustment. This means the parcel line will have no influence on the outcome of the least-squares adjustment, but it will adjust along with the rest of the parcel fabric. By default, the parcel fabric assigns standard deviation and date ranges to accuracy categories as follows:

<table>
<thead>
<tr>
<th>Accuracy level</th>
<th>Std. deviation bearing (secs)</th>
<th>Std. deviation distance (m/ft)</th>
<th>PPM (m) (parts per million)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>0.001/0.00328</td>
<td>5</td>
<td>Highest</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>0.01/0.0328</td>
<td>25</td>
<td>After 1980</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>0.02/0.0656</td>
<td>50</td>
<td>1908–1980</td>
</tr>
<tr>
<td>4</td>
<td>120</td>
<td>0.05/0.164</td>
<td>125</td>
<td>1881–1907</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>0.2/0.656</td>
<td>125</td>
<td>Before 1881</td>
</tr>
<tr>
<td>6</td>
<td>3,600</td>
<td>1/3.28</td>
<td>1,000</td>
<td>1800</td>
</tr>
<tr>
<td>7</td>
<td>6,000</td>
<td>10/32.8</td>
<td>5,000</td>
<td>Lowest—excluded from adjustment</td>
</tr>
</tbody>
</table>

Table of accuracy categories in the parcel fabric

In the table above, the standard deviations for distance are shown in both meters and feet. You can change the standard deviation and PPM values by editing the Accuracy table in the parcel fabric.

To view and edit the parcel fabric Accuracy table, use the Make Parcel Fabric Table View geoprocessing tool in ArcMap to create a table view of the fabric Accuracy table you want to edit. Once the table view is created, click List to start an edit session and open the table.
This topic applies to ArcEditor and ArcInfo only.

### Standard deviations and PPM

Deviation is a measure of the spread of values when measuring the same target. So if a surveyor were to measure the same target point many times with the same instrument, he/she would want the spread or range of values to be as close to each other as possible (in other words, the standard deviation as small as possible).

The standard deviation for the most accurate measurements in the parcel fabric is 5 seconds for bearings and 0.001 meters for distances. Parts per million in surveying is a measure of change or uncertainty in measurements. The value given is out of a million. In the parcel fabric, the PPM value is an indication of accuracy. For accuracy level 1 in the table above, 5 PPM means an accuracy of 5 millimeters over a kilometer (1 kilometer = 1,000,000 millimeters).

### Assigning accuracy categories

Accuracy categories can be assigned at the parcel line level, the parcel polygon level, and the plan level. When assigning an accuracy at the plan level, all new parcels created in the plan will inherit that accuracy level. Plan accuracy is set on the Plan Properties dialog box under the Attributes tab. You can override the plan accuracy by specifying a different accuracy for an individual polygon. Parcel accuracy is set under the Properties tab on the Parcel Details dialog box. When assigning accuracy at the parcel level, all related parcel lines will inherit their accuracy from their parcel. You can override the parcel accuracy by specifying a different accuracy for an individual parcel line in the traverse grid under the Lines tab of the Parcel Details dialog box.

If no accuracy has been specified, the following default accuracies will be used:
- Boundary lines, connection lines, dependent lines, radial lines, road lines, and origin connection lines are assigned a default accuracy level of 3.
- Precise connection lines are assigned a default accuracy level of 2. (By default, precise connection accuracy is always one level higher than the parcel accuracy.)
- Digitized lines and lines with dimensions computed from the line geometry (inverted lines) are assigned a default accuracy level of 6.
- Compiled parcel lines are assigned a default accuracy level of 5. Compiled parcels are those parcels that have been assembled from previous plans and do not represent a survey carried out on the plan date. The Compiled field on the parcel is set to True.

### Related Topics

- About the fabric least-squares adjustment
- Viewing and editing the parcel fabric Accuracy table

### Viewing and editing the parcel fabric Accuracy table

This topic applies to ArcEditor and ArcInfo only.

**Steps:**

1. To view and edit the parcel fabric Accuracy table, follow these steps:
   - In an edit session in ArcMap, click the Catalog Window button on the Standard toolbar to open the Catalog window.
   - In the Catalog window, navigate to Toolbox > System Toolboxes > Parcel Fabric tools.tbx > Layer and Table Views. Double-click the Make Parcel Fabric Table View tool to open it.
   - On the Make Parcel Fabric Table View dialog box, load the target parcel fabric and choose Accuracy from the Select Parcel Fabric Table list.
   - Type a name for the table view in the Output Table View text box and click OK to run the tool.
   - After the tool has finished processing, click the List By Source button on the Table Of Contents window.
   - The table view is listed under Layers.
   - Right-click the table view and click Open to open and edit the table view of the Accuracy table.

**Tip:** The parcel fabric recognizes seven accuracy categories. You can edit the accuracy categories to define your own accuracy categories, but you can only define seven accuracy categories.

### About control points in the parcel fabric

This topic applies to ArcEditor and ArcInfo only.

Control points define and publish accurate, surveyed x,y,z coordinates for physical features on the surface of the earth. A control point network is added to the parcel fabric so that parcels can be adjusted to the control point network in a fabric least-squares adjustment. The result is parcels that are accurately georeferenced on the surface of the earth. While parcel dimensions accurately define parcel boundaries in relation to each other, control points, when used in a least-squares adjustment, result in accurately defined spatial locations for parcel corner points.

**Note:** In a fabric least-squares adjustment, the horizontal and vertical coordinate system (the datum) of the control points is transferred to the parcel fabric.

**Note:** Control point coordinate values are held fixed in a fabric least-squares adjustment.

Parcels in the fabric are defined by a series of dimensioned lines and corner points. Parcel corner points are the from- and to-points of the parcel lines. In many cases, records of survey or plans display parcel dimensions but do not include coordinate information for the parcel corners. The parcel fabric provides an environment that allows you to add parcels without knowing anything about the coordinates while also letting you add, at a later date, control points.

### Adding control points to the parcel fabric
Control points are added to the fabric as stand-alone control points that are not connected to the parcel fabric, or they can be added and linked to fabric points. Control points can only participate in a fabric least-squares adjustment if they are linked to an existing fabric point. Any point in the fabric can be linked to a control point. This is done when a control point location can be correctly identified with a fabric point location.

Control points are located on parcel corner points or at the endpoints of connection lines. When control points are added and linked to an existing fabric point, the point might not necessarily match the location of the control point. This is because the control point location is more accurate than that of the fabric point location. Even though the control point may not sit exactly on top of the fabric point, it is still linked to the fabric point.

Often, control points do not lie on parcel corner points; for example, they are located on street centerlines. In this case, connection lines can be added from parcel points to the control point locations. You can also use an unclosed parcel to model street centerlines and have the control located on the corner points of the unclosed parcel.
When creating connection lines that connect to a control point, the dimensions of connection can be implied or calculated from the record of survey or plan.

Control points can be manually added, where the coordinates are typed in, or control points can be imported into the parcel fabric. When adding control points manually and individually, the link between a fabric point and a control point can be immediately established. When importing a set of control points, a tolerance or search radius can be specified where the control point is linked to the first fabric point found within the search radius. If no fabric point is found in the search radius, a control point is imported as a stand-alone control point and can be manually linked to a fabric point at any time. Manually linking control points to fabric points is useful when control points are added first and parcels are added later, for example, adding parcels to a new, empty parcel fabric.

**Linking control points to fabric points**

Control points can be linked and relinked to fabric points when the Control dialog box is open. The Control dialog box can be opened by clicking the Maintain Control Points tool on the Parcel Editor toolbar. Control points are linked to fabric points by clicking to snap on the control point, then clicking to snap on the fabric point. The Network Point ID attribute on the Control dialog box is immediately updated with the fabric point ID.

Sometimes, the point ID to which a control point is linked can change. This can happen when a fabric point is merged with another point; for example, the endpoint of a newly added connection line is the same location as another point in the fabric and needs to be merged with that fabric point into a single
Active control points

There are two types of control points in the parcel fabric: active and inactive control points. Active control points are linked to a fabric point and are used in the fabric least-squares adjustment. Inactive control points are either stand-alone control points that are not linked to any fabric point or have been deactivated from participating in a fabric least-squares adjustment. In some cases, not all of the control points need to be active in an adjustment, and deactivating control points is a way to detect and remove potential blunders in the data that may cause an adjustment to fail. The fabric least-squares adjustment requires a minimum of two control points; this is called a minimally constrained adjustment. Doing a minimally constrained adjustment helps to detect blunders in the dimensions because the influence of the control point coordinates is minimized. For large adjustment areas, a network of well-distributed control points is recommended.

Checking the fit of control points

When there are more than two active control points in the map display, you can run a check fit of the control points. The check fit function checks how well the parcel network fits with the control network. Check fit is also useful for evaluating control points for use in a fabric least-squares adjustment. Control points that appear to be outliers can be deactivated from participating in the adjustment.

The check fit process computes transformation parameters between the linked fabric point coordinates and the coordinates of the control points. The transformation used is a Helmert transformation. The computed parameters (rotation, shift in x, shift in y, and scale) are then applied to the linked fabric point coordinates to compute temporary new values for the fabric point coordinates. The differences between the newly computed fabric point values and the original control point values are reported as residuals for each active control point. The residuals (dx, dy values) show how fabric point coordinates, when transformed to their control point network, fit with that network. Residuals are reported next to each control point on the Control dialog box.

Any control points showing large residuals should be investigated before proceeding with a least-squares adjustment. If you know that the parcel fabric has fairly good measurement precision and is devoid of blunders, any erroneous or incorrectly identified control points will show large residuals when running a check fit. If you know your control point coordinates are sound, large residuals will most likely indicate a blunder surrounding the associated fabric point coordinate. If the source of the higher residual is not immediately apparent, you can choose to remove the control point from the least-squares adjustment. If there is a blunder in the parcel data surrounding the associated fabric point, the blunder will be exposed in the least-squares adjustment.

If a check fit is run after a least-squares adjustment, residuals for active control points will be zero because all the linked fabric points have been transformed into the control point coordinate system during the adjustment.

Note: It is always good practice to run a check fit on your control points before running a fabric least-squares adjustment. The check fit residuals indicate how well the parcel network will fit with its control network. Parcel lines are going to have to adjust at least by the amount of the check fit residuals in the least-squares adjustment. Therefore, check fit residuals can be used as a guideline for setting adjustment tolerances on the Adjust Coordinates dialog box. If check fit residuals are large and inconsistent with each other, it makes no sense to run a least-squares adjustment. Parcel lines are going to have to adjust at least by that amount, and the result will be an unstable adjustment. The reasons for the large and inconsistent residuals should be identified first, and the problems should be rectified. In most cases, very large check fit residuals are caused by control points that are linked to the wrong fabric point.

Related Topics

About the fabric least-squares adjustment

Inserting control points into the parcel fabric

This topic applies to ArcEditor and ArcInfo only.
Steps:
To insert a control point into the parcel fabric, follow these steps:

1. In an edit session in ArcMap, zoom to the area where you want to insert control points and click the **Maintain Control Points** tool located on the **Parcel Editor** toolbar.
   - If you are working in manual mode using fabric jobs, click the **Maintain Control Points** tool in an open fabric job.
2. Make sure the fabric **Points** sublayer is turned on in the **Table Of Contents** window.
3. On the **Control** dialog box, click the **New** button and click to snap on the fabric point to which the control point will be linked.
   - The **Network Point ID** attribute field on the **Control** dialog box is automatically populated with the linked fabric point ID. The **Control Point Name** attribute field is populated with an autogenerated control point name. The **Easting** and **Northing** attribute fields are populated with the easting and northing values of the fabric point. If the fabric point has no height, the **Height** attribute field remains empty.
4. Optionally, click in the field next to **Control Point Name**, delete the autogenerated name, then type a new name for the control point.
5. If the **Easting** and **Northing** values do not match the coordinates of the new control point, click in the fields to edit the current values to match the coordinates of the control point.
6. Optionally, populate the remaining attribute fields.
7. Click the **Update** button to add the control point to the list of control points and to the map display.

**Tip:** To insert a new control point without linking it to an existing fabric point, populate the attribute fields on the **Control** dialog box without clicking a fabric point.

**Tip:** To edit an existing control point, choose the control point in the control point list and click the **Edit** button.

**Tip:** To deactivate a control point, uncheck the check box next to the control point you want to deactivate.

**Tip:** To activate a control point, check the check box next to the control point you want to activate.

**Tip:** If you add a new attribute to the parcel fabric **Control** table, the attribute field will be available for editing on the **Control** dialog box.

Linking control points to fabric points

This topic applies to ArcEditor and ArcInfo only.

Steps:
To link a control point to a fabric point, follow these steps:

1. In an edit session in ArcMap, click the **Match A Control Point To A Point** tool located on the **Parcel Editor** toolbar.
   - If you are working in manual mode using fabric jobs, click the tool in an open fabric job.
2. On the **Control** dialog box, choose the control point you want to link and click the **Pan To** button to pan the map display to the control point location.
3. Click to snap on the control point, then click to snap on the parcel point to which you want to link the control point.
   - The **Network Point ID** attribute field on the **Control** dialog box is populated with the fabric point ID.

**Tip:** To change the fabric point ID to which a control point is linked, choose the control point on the **Control** dialog box, then click the **Edit** button and type in another fabric point ID in the **Network Point ID** attribute field. Click the **Update** button to update and save the control point.

Understanding the least-squares adjustment

This topic applies to ArcEditor and ArcInfo only.

A single observation (bearing and distance) from an existing survey point can be used to compute the coordinates for a new survey point. However, relying on a single observation is risky, since there is no way to tell whether the measurement is correct. A second measurement from the same or another existing survey point will confirm, or check, the coordinates defined by the first measurement. Generally, the more measurements fixing the coordinates of a survey point, the more reliable the coordinates. These additional measurements are called redundant measurements.

**Weighted average**

All measurements contain some degree of error. Therefore, each measurement will compute slightly different coordinates for the same survey point. For practical reasons, there should be one coordinate location for a survey point. A single, best estimate coordinate can be derived by computing a weighted average of the additional or redundant measurements, with each weight defined by the measurement accuracy.
Although the weighted average approach works for a single point, it is not sufficient to compute the coordinates for multiple points in a network such as the parcel fabric. A more advanced method is needed to account for the numerous possible measurement paths between the points. The techniques and algorithms in a least-squares adjustment provide the most rigorous and widely accepted solution for processing a network of measurements and points.

A least-squares adjustment is a mathematical procedure based on the theory of probability that derives the statistically most likely coordinate location of points defined by multiple measurements in a network. In mathematical terms, a least-squares adjustment defines a best-fit solution for weighted measurements by finding a minimum for the sum of the squares of the measurement residuals. A measurement residual is the amount needed to correct a measurement for it to fit into the best-fit solution found by the least-squares adjustment.

Using a least-squares adjustment to adjust a parcel fabric

In the parcel fabric, the least-squares adjustment uses all the measurement data together with control points to estimate the most probable coordinate for every point in the network. This description of the least-squares adjustment can be more easily understood by considering one traverse path between two control points in the fabric network. Fabric points P1 and P5 should be coincident with their corresponding control points CP1 and CP2. The least-squares adjustment adjusts the misclose error between P1 and CP1 as well as P5 and CP2 through the remaining points P2, P3, and P4 such that P1 and P5 become coincident with their control points. The coordinates of P2, P3, and P4 are adjusted into the best-fit solution and the lines are recalculated from the adjusted points. In the parcel fabric, accuracy on parcel lines acts as a weighting system in the least-squares adjustment. Lines with higher weights will adjust less than lines with lower weights. The higher the accuracy, the higher the weight on a parcel line. In the graphic below, the line between P2 and P3 has a high accuracy and thus a high weight. In the least-squares adjustment, line P2–P3 received proportionally less of an adjustment than the other lines in the traverse path.

The residual differences between the original lines and the lines computed from the adjusted coordinates reveal how well the parcel lines fit among themselves and with the control points. A large residual suggests a problem with the parcel line itself or nearby parcel lines, since the original value required a significant change to fit into the best-fit solution.

Related Topics

About the fabric least-squares adjustment
This topic applies to ArcEditor and ArcInfo only.

A fabric least-squares adjustment is run on a selection of parcels in automatic mode or on all the parcels in an open fabric job in manual mode. The least-squares adjustment engine in the parcel fabric uses dimensions on parcel lines together with control points to determine the statistically most likely coordinate location for every parcel point in the network. Parcel boundary dimensions accurately define the shape of a parcel, and a least-squares adjustment with control points accurately defines the spatial location of a parcel.

Learn more about the least-squares adjustment

A minimum of two active control points are required to run a fabric least-squares adjustment. Control points can be imported into the parcel fabric or manually inserted in an edit session.

An overview of the parcel fabric least-squares adjustment

In the first step of the fabric least-squares adjustment, transformation parameters between the original coordinates of the control points and the corresponding coordinates of their underlying parcel points are determined. If the transformation residuals are within acceptable limits (the differences between the two coordinate systems), the transformation parameters are applied to all parcel fabric coordinates to transform them into the coordinates of the control system. The recorded bearing and distance of every parcel line is compared with the same bearing and distance of the line shapes computed in the transformed coordinate system (the coordinate system of the control points). This is done by calculating the difference between the bearing and distance computed from the transformed coordinates and the original bearing and distance. Any parcel line with a bearing and distance difference that exceeds the tolerances you specify in the Adjust Coordinates dialog box is reported in the least-squares adjustment report. After the coordinates of the parcel fabric have been transformed into the coordinates of the control system, the adjustment engine averages (computes a mean) the coordinates and determines the most optimal, best fit solution for all points in the network. The adjustment is a weighted least-squares adjustment, where parcels with a higher accuracy level (higher weight) adjust less than those parcels with lower accuracy level (lower weight).

Learn more about accuracy in the parcel fabric

Note: The least-squares adjustment process determines a more accurate location and a more accurate representation of the line geometry for each parcel line. The original parcel line dimensions (attributes) are not altered. The geometric and spatial representation—the parcel line shape—of the dimensions is updated from the newly adjusted coordinates.

Redundancy

A least-squares adjustment produces the most reliable results when there are redundant measurements in a network. Redundancy implies that there are repeated observations for a single measurement. Repeated observations validate the measurement network. A parcel fabric is a redundant measurement network.

In the graphic below, a single parcel has four lines and four points. Corner point 2 is defined by two lines (measurements).

With the redundant eight lines defining the same point 2, it's now easier to identify a line that defines a coordinate for point 2 that is significantly different from the coordinates defined by the other lines. Thus, the more lines defining the same point coordinate, the more reliable the detection of outliers or inconsistent lines. The least-squares adjustment uses redundancy to identify those lines that do not fit with the best fit solution. Redundancy in the parcel fabric is created through common points and connectivity.

Adjustment tolerances

Before running a fabric least-squares adjustment, you need to specify adjustment tolerances, which are necessary for evaluating data in your parcel fabric. Tolerances should be based on how much you expect recomputed parcel line shapes to differ from the original recorded bearings and distances once the parcel network is adjusted to the more accurate control network. Running a check fit on your control network will give you a good idea of how large your adjustment tolerances should be. The check fit residuals will indicate the least amount a parcel line has to adjust to transform to the control network.

The following adjustment tolerances are specified before running a least-squares adjustment:
How the least-squares adjustment handles basis of bearing

In the parcel fabric, dimensions are stored on parcel lines, and these dimensions are never altered by the fabric least-squares adjustment. Parcel line dimensions can only be manually edited.

In the parcel fabric, bearings for the lines in each parcel are assumed to be on an azimuth for that parcel. Furthermore, each parcel may have to be separately rotated and scaled to fit with the datum and projection used in the parcel fabric. If internal angles are used for the traverse entry of a parcel, the angles are stored and bearings are computed for the lines based on an assumed azimuth. Bearings are required because the adjustment uses bearing equations, not angle equations, for the parcel lines.

When a parcel is joined to the fabric, the original dimensions are used to first calculate coordinates for the parcel corners on a local coordinate system. The first dimensions can only be manually edited.

Adjustment postprocessing: Plan structure constraints

After the least-squares adjustment is completed, a few postprocessing procedures can be applied to enforce geometric constraints. These include enforcing line points and straight lines.

During adjustment or parcel joining, line points may shift off their adjacent parcel lines. When a line point is within the tolerance specified, it will be shifted back onto its parcel line. If it is outside the tolerance, a warning message is written to the adjustment report. This option will remove any slivers or gaps resulting from line points in the parcel fabric. Data inaccuracies are often the cause of line points shifting off their adjacent parcel lines.

Enforcing straight lines retains the original subdivision structure. Often, a series of adjacent lots in a plan requires that front and/or back lot lines have the same bearing, meaning that the individual lot lines are intended to be collinear. Enforcing straight lines detects these plan structures and, if the boundary points are within the specified tolerance, will make these lines collinear.

- **Line points tolerance**: Any line points found within the specified tolerance will be forced back onto their adjacent parcel lines.
- **Straight lines tolerance**: Enforces the original subdivision structure. If the points are within the specified tolerances, collinearity will be enforced.

**Including dependent lines**

Dependent lines are often used to represent parcel line types that are dependent on parcel boundary lines such as easement lines. In most cases, dependent lines should follow, and be dependent upon, the boundary lines of a parcel. If the Treat dependent lines as standard boundary lines option on the Adjust Coordinates dialog box is unchecked, dependent line dimensions will not participate in and influence the adjustment process. After the adjustment is completed, any dependent lines will receive the same adjustments that were applied to the parcels. If the option is checked, dependent line dimensions will participate in and influence the outcome of the adjustment.

**How the least-squares adjustment handles basis of bearing**

In the parcel fabric, dimensions are stored on parcel lines, and these dimensions are never altered by the fabric least-squares adjustment. Parcel line dimensions can only be manually edited.

In the parcel fabric, bearings for the lines in each parcel are assumed to be on an azimuth for that parcel. Furthermore, each parcel may have to be separately rotated and scaled to fit with the datum and projection used in the parcel fabric. If internal angles are used for the traverse entry of a parcel, the angles are stored and bearings are computed for the lines based on an assumed azimuth. Bearings are required because the adjustment uses bearing equations, not angle equations, for the parcel lines.

When a parcel is joined to the fabric, the original dimensions are used to first calculate coordinates for the parcel corners on a local coordinate system. The first
point in the parcel is given coordinates of 0.0 east and 0.0 north and the dimensions are used to compute all subsequent points. A Bowditch adjustment is used to distribute the misclose before computing the local coordinates.

During the joining process, unjoined parcel corner points are matched with their corresponding points in the fabric. Transformation parameters are calculated between the coordinates of the parcel and the coordinate system of the fabric. A Helmert transformation (rotation, scale, shift in x, and shift in y) is used. If more than two points are used in the joining, a least-squares procedure is used to determine the parameters. As points are joined, they are transformed into the network of the fabric and the differences or transformation residuals are displayed as dx (change in x) and dy (change in y) on the join dialog box. These residuals are a good indication of how well the parcels being joined are fitting into the surrounding parcel fabric.

After a parcel is joined, the rotation and scale factor (from the transformation) is stored with the parcel and is used by the least-squares adjustment in setting up the bearing equations. In the least-squares adjustment, parcel bearings are treated like a geodetic "direction set." The assumption is that the angles between each parcel line are correct, but the whole group of lines could be rotated slightly (basis of bearing). So the least-squares adjustment solves for corrections for x, y for every point and for a rotation correction or "orientation element" for each parcel.

The adjustment reports a rotation, scale factor, dx (change in x), and dy (change in y) for each parcel adjusted. Within a subdivision plan, the rotation and scale factor should be very similar for each parcel, and the dx and dy give an indication of change of shape for the parcel. If the adjustment is rerun, the rotation and scale for each parcel will be recalculated.

Learn more about basis of bearing

Related Topics
About accuracy in the parcel fabric
About control points in the parcel fabric
About the parcel fabric feature adjustment
Tutorial: Running a fabric least-squares adjustment
Understanding the least-squares adjustment

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About using connection lines to improve parcel fabric connectivity

This topic applies to ArcEditor and ArcInfo only.

The parcel fabric needs to be well connected for a fabric least-squares adjustment to run successfully. A well-connected fabric improves network redundancy, which leads to more reliable results from the fabric least-squares adjustment.

You can use the Create Connection tool located on the Parcel Editor toolbar to add connection lines in the parcel fabric.

For a fabric least-squares adjustment to run successfully, the parcel fabric network needs to be well connected. The Create Connection tool can be used to quickly add connection lines between blocks of parcels without having to open and edit the parcels themselves. For example, a fabric least-squares adjustment does not run if an island of parcels is not well connected to the surrounding parcel fabric.

Connectivity is also established from common center points of curves.

Line points
In some cases, parcel blocks are connected through line points. Since line points sit or float on top of adjacent parcel lines, connectivity is insufficient, and the
fabric least-squares adjustment will fail. In the graphic below, adjacent parcels share no common points. Parcel points are line points that sit on the adjacent parcel boundaries and do not split the boundaries. Because no common points are being shared, these parcels are effectively floating next to each other and are not connected. For a fabric least-squares adjustment to run on these parcels, connection lines may need to be added between parcel corners. Connection lines can sit on top of parcel boundary lines.

Adding connection lines to improve connectivity in the parcel fabric

This topic applies to ArcEditor and ArcInfo only.

When adding connection lines between parcel points, connection lines are added to the traverse of each parcel you want to connect.

Steps:
To add connection lines to parcels in the fabric, follow these steps:

1. In an edit session in ArcMap, click the Create Connection tool on the Parcel Editor toolbar.
   If you are working in manual mode using fabric jobs, click the Create Connection tool in an open fabric job.
2. Click to snap on the two points between which you want to add a connection line.
   The Point 1 and Point 2 text boxes on the Create Connection Line dialog box are populated with the point IDs of the points you clicked.
3. On the Create Connection Line dialog box, check the check boxes of the parcels listed under Parcels to Connect for which you want to create connection lines.
   Any parcels that share the points you clicked are displayed under Parcels to Connect. For example, you may want to add a connection line to only one of the adjacent parcels that shares the point you clicked.
   The rotation of the parcels is displayed under Rotation on the Create Connection Line dialog box.

   Note: A parcel has a rotation if it needs to be rotated to fit into the surrounding parcel fabric. Large rotations might indicate data inaccuracies that could cause a fabric least-squares adjustment to fail. When adding a connection line to a parcel that has a rotation, be aware that the difference between the specified dimensions of the connection line and the rotated dimensions could cause a fabric least-squares adjustment to fail.

4. If necessary, type the correct bearing and distance of the connection line in the Bearing and Distance text boxes.
   The bearing and distance of the connection line are initially generated from the connection line geometry. Connection line dimensions should be obtained from the plan or record of survey. If the parcel fabric contains accurate data, the differences between the generated and typed values should not be significant.
5. Click Apply to create the connection line.
This topic applies to ArcEditor and ArcInfo only.

A fabric least-squares adjustment should be run repeatedly until the maximum and average coordinate shifts become 0.0 or do not change.

Steps:

1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor toolbar and drag a box to select the parcels you want to adjust.
   If you are working in manual mode using fabric jobs, select the parcels you want to adjust and click Parcel Editor > Modify to open the selected parcels in a fabric job. All parcels in the open fabric job are adjusted.

2. Click the Parcel Editor arrow and click Adjust.

3. On the Adjust Coordinates dialog box, type the tolerances you want to use in the Bearings, Distances, Line Points, and Close Points text boxes or accept the defaults.

4. Choose which constraint you want to enforce under Plan Structure Constraints and type the tolerance you want to use. You can choose to enforce both constraints.

5. Click the Treat dependent lines as standard boundary lines check box if you want dependent lines to participate in and influence the outcome of the adjustment.

Running a fabric least-squares adjustment

To run a fabric least-squares adjustment, follow these steps:

1. In an edit session in ArcMap, click the Select Parcel Features tool on the Parcel Editor toolbar and drag a box to select the parcels you want to adjust.
   If you are working in manual mode using fabric jobs, select the parcels you want to adjust and click Parcel Editor > Modify to open the selected parcels in a fabric job. All parcels in the open fabric job are adjusted.

2. Click the Parcel Editor arrow and click Adjust.

3. On the Adjust Coordinates dialog box, type the tolerances you want to use in the Bearings, Distances, Line Points, and Close Points text boxes or accept the defaults.

4. Choose which constraint you want to enforce under Plan Structure Constraints and type the tolerance you want to use. You can choose to enforce both constraints.

5. Click the Treat dependent lines as standard boundary lines check box if you want dependent lines to participate in and influence the outcome of the adjustment.

Tip: Adjustment postprocessing or plan structure constraints should be enforced only after adjustment convergence is reached. Line points tolerance and Straight line tolerance under Plan Structure Constraints on the Adjust Coordinates dialog box should remain unchecked until the adjustment has converged. Once the adjustment has converged, run the adjustment one more time with the Straight line tolerance and/or the Line points tolerance options checked.

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adjustment. If you leave this option unchecked, dependent lines will not influence the outcome of the adjustment but will adjust along with the parcel upon which the parcel is dependent.

6. Click the **Report type** arrow to choose the adjustment report type. In an extended report, every parcel line and its adjustment are listed.
7. Click the **browse** button to browse to a location to save a log file of the adjustment, or accept the default location.
8. Click **Run** to run the adjustment and display the adjustment report on the **Least Squares Adjustment Summary** dialog box.
9. On the **Least Squares Adjustment Summary** dialog box, click the **Results File** button to save the adjustment report as a text file.
10. If the adjustment is successful and the adjustment statistics are acceptable, click the **Accept** button on the **Least Squares Adjustment Summary** dialog box to accept the adjustment iteration and close the dialog box. To reject the adjustment, click the **Cancel** button.
11. If you do not want to rerun another iteration of the adjustment, click **OK** on the **Adjust Coordinates** dialog box to complete the adjustment.

**Note:** Any parcel lines that need to be adjusted by greater than three times the distance or bearing tolerance will cause the adjustment to fail.

### Project Option Settings summary

Under the **Project Option Settings summary**, information about adjustment input parameters is listed. These parameters include the coordinate system of the data and tolerances used for bearings and distances. If you checked the **Treat dependent lines as standard boundary lines** option on the **Adjust Coordinates** dialog box, **Dependent data** is set to **Yes**. If there are historical parcels and lines participating in the adjustment, **Historical Data** is set to **Yes**. By default, the
boundary of the adjustment is not held fixed. Parcels adjacent to adjusted parcels will receive the same adjustments as the adjusted parcels so that the
adjusted parcels can be seamlessly integrated back into the parcel fabric.

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**Dive-in:** If running the adjustment using ArcObjects, you can hold the adjustment boundary fixed by setting the FixBoundary property of PerformAdjustment Method on the I_CadastralAdjustment Interface to True.

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**Adjustment Statistical Summary**

Under Adjustment Statistical Summary, statistical information about the adjustment is listed such as the number of control points used, the number of parcels
being adjusted, coordinate residuals, and network redundancy.

You can also get a quick overview of the number of lines that are adjusting outside the specified tolerances as well as any close points and line points that have
been found. The Parcel Lines, Close Points, and Line Points reports displayed farther down on the Least Squares Adjustment Summary dialog box will list further
details about data that exceeds tolerances.

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**Number of unknowns and redundancy**

The value listed for the number of unknowns under Adjustment Statistical Summary is a measure of the actual work that is going to have to be done by the
least-squares adjustment. For each point in the fabric, there are two unknowns, a correction to the x-coordinate and a correction to the y-coordinate. In
addition to the corrections to fabric point coordinates, there is also a parcel rotation correction, which is also an unknown.

The bearings and distances of parcel lines are the "knowns" in the adjustment. An equation is generated for each bearing and each distance. If there is a line
point sitting on a parcel line, two bearings are generated for that line, which is why the number of bearings is greater than the number of distances. In
the example below, the number of bearings is 1,832, the number of distances is 1,482, and the number of unknowns is 1,177 for this particular adjustment.

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Redundancy equals the number of bearings plus the number of distances minus the number of unknowns. For example, in the example above, redundancy
equals 1,832 + 1,482 - 1,177, which is 2,137. When the redundancy is greater than the number of unknowns, the least-squares adjustment can determine
the best solution as well as flag those lines that are statistically suspect. If the redundancy is the same or less than the number of unknowns, the least-
squares adjustment cannot perform well and cannot determine the best solution. In the above example, the parcel network is well conditioned, with
redundancy being almost twice the number of unknowns.

Learn more about redundancy

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**Coordinate residuals**

Coordinate shift statistics are also displayed under Adjustment Statistical Summary. The point that received the maximum coordinate shift is listed with the
average coordinate shift for all points.

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A fabric least-squares adjustment should be run repeatedly until the maximum and average coordinate shifts become 0.0 or do not change.

Each time an adjustment is rerun, an adjustment iteration has been performed. You are iterating an adjustment if you click Run on the Adjust Coordinates
dialog box or Accept on the Least Squares Adjustment Summary dialog box, then click Run again on the Adjust Coordinates dialog box to run another
adjustment iteration. Once OK is clicked on the Adjust Coordinates dialog box, the adjustment is completed with no more iterations. Once the maximum and
average coordinate shifts become 0.0 or do not change, the adjustment has converged to an optimal solution.

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**Close Points report**

The Close Points report lists those points that lie closer to each other than the specified tolerance and do not have dimensions between them. Close points are a
good indication of points that mostly likely should be merged into single, common points.

---

**Line Points report**

The Line Points report lists those line points that are offset from their lines at a greater distance than the specified tolerance. Line points that are significantly
offset from their adjacent parcel lines indicate data inaccuracies or incorrect parcel joining.

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**Parcel Lines report**

The Parcel Lines report lists all those lines that have a bearing or distance that adjusted outside the specified tolerances. The adjustment finds a best fit for all
parcels in the network and computes new coordinates for the parcel points. Parcel line shapes are recomputed using the adjusted parcel points. In the
Parcel Lines report below, (c-o) stands for computed minus observed. The computed minus observed value is the difference between the distance or bearing of
the recomputed line shape and the original distance or bearing attribute on the line (observed). In other words, the Parcel Lines report is reporting how much
difference there is between the adjusted line shape and the original recorded bearing and distance of the line attributes.

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```
| Parcel Lines Report - Difference between Computed and Observed (c-o) |
|-------------------------|-------------------------|
| Line Name | Bearing | Distance | c-o | o-c |
| 123/Map 6070 | 505.497 | 505.497 | 0.000 | 0.000 |
| 123/Map 6070 | 621.532 | 621.532 | 0.000 | 0.000 |
| 123/Map 6070 | 494.907 | 494.907 | 0.000 | 0.000 |
| 123/Map 6070 | 508.927 | 508.927 | 0.000 | 0.000 |
| 123/Map 6070 | 737.810 | 737.810 | 0.000 | 0.000 |
| 123/Map 6070 | 475.417 | 475.417 | 0.000 | 0.000 |
| 123/Map 6070 | 468.467 | 468.467 | 0.000 | 0.000 |
| 123/Map 6070 | 490.492 | 490.492 | 0.000 | 0.000 |
| 123/Map 6070 | 464.961 | 464.961 | 0.000 | 0.000 |
```

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If running the adjustment using ArcObjects, you can hold the adjustment boundary fixed by setting the FixBoundary property of PerformAdjustment Method on the I_CadastralAdjustment Interface to True.
Only those lines that are adjusting more than the tolerances specified for Bearings and Distances on the Adjust Coordinates dialog box are listed under the Parcel Lines report. To see the adjustments for every line in the network, select the Extended report type on the Adjust Coordinates dialog box.

**Note:** Lines that have a bearing or a distance that adjusts more than three times the specified tolerances will cause the adjustment to fail. These lines will be marked with a ## in the Parcel Lines report.

Plan structure constraints

If you checked either the Line points tolerance or Straight lines tolerance option under Plan Structure Constraints on the Adjust Coordinates dialog box, the least-squares adjustment summary will display a report listing the points moved. Plan structure constraints are postprocessing options and are performed after the adjustment has completed.

**Line points forced to their line**

A list of line points that have been moved to their adjacent parcel lines is displayed under Linepoints forced to their line. The distance the line point was moved is also included. If line points were found that were offset from their lines at a greater distance than the specified tolerance, these line points are listed as well.

**Straight lines report**

When enforcing straight lines, the adjustment postprocessing examines series of points, which are on adjacent parcels that are part of the same plan and which are connected by lines with the same bearing. A vector for the series of points is computed, and the distance between each point in the series and the vector is measured. If the distance is less than the tolerance specified for straight lines, the point is moved onto the vector line and collinearity is enforced.

**Suspect points and lines**

After the adjustment, the standard deviation for all the points and lines in the network is calculated. Those points and lines with standard deviations that are greater than three times the standard deviation of the entire adjusted network are reported in the Suspect points and lines report.

**Related Topics**

[![Tutorial: Running a fabric least-squares adjustment](http://example.com)](http://example.com)

Best practices for running a fabric least-squares adjustment

This topic applies to ArcEditor and ArcInfo only.

When running an adjustment, it is good practice to examine the adjustment report to ensure that there are no blunders and that the control coordinates are correct. Examining the close point and line point errors will help to reveal data inaccuracies and connectivity problems in the fabric network. Close point errors indicate that there are some points that most likely should be merged into single points. Line point errors may indicate data inaccuracies as the line points have become offset from their lines at a distance greater than the specified tolerance. Close point and line point errors should be repaired before any further adjustments are carried out.

Another useful way to assess fabric quality or the validity of control points is to perform the adjustment with a few control points left inactive. If the corresponding fabric points of the inactive control points adjust to the locations of the inactive control points within the expected tolerances, the adjustment is performing well. Large discrepancies at the inactive control points is cause for concern: either the control coordinates are inaccurate, some parcel dimensions are suspect, or there is insufficient connectivity in the network geometry. If some parcel lines are the culprit, they will usually appear in the adjustment report. Work should not proceed until the cause of the problem is uncovered and remedied. Often fabric data or control problems reveal themselves as unexpectedly large errors in most adjustment reports.

Once problems are resolved, the adjustment should converge and give useful information about the real quality of the fabric dimensions. Least-squares adjustment convergence occurs when coordinate shifts become zero or do not change after each successive adjustment iteration (running and accepting the adjustment repeatedly).
A satisfactory adjustment not only yields parcel geometry commensurate with the real precision of the survey dimensions but also the most probable coordinates for the parcel corners. By invoking least-squares adjustments at an early stage and running them often, you can be alerted to any problematic data as soon as it enters the fabric.

**Redundancy**

A redundant parcel network allows the least-squares adjustment to determine the best solution as well as flag those lines that may be statistically suspect. On the Least Squares Adjustment Summary dialog box under Adjustment Statistical Summary, the value for Redundancy should be greater than the value for Number of Unknowns.

<table>
<thead>
<tr>
<th>Adjustment Statistical Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Control Points</td>
</tr>
<tr>
<td>Number of Parcels</td>
</tr>
<tr>
<td>Number of Points</td>
</tr>
<tr>
<td>Number of Attributes</td>
</tr>
<tr>
<td>Number of Distances</td>
</tr>
<tr>
<td>Number of Unknowns</td>
</tr>
<tr>
<td>Redundancy</td>
</tr>
<tr>
<td>Bearings Exceeding Tolerance</td>
</tr>
<tr>
<td>Distances Exceeding Tolerance</td>
</tr>
<tr>
<td>Close Points Found</td>
</tr>
<tr>
<td>Line Points Exceeded</td>
</tr>
</tbody>
</table>

**Area of adjustment**

A fabric least-squares adjustment is run on a group of parcels selected in the map or on the parcels in a fabric job. When running a least-squares adjustment, the best results are obtained when the adjustment area is a well-balanced geometric shape with redundant measurements and evenly distributed control. Long, narrow areas without adequate control and areas with minimal redundancy (connectivity) can give poor results. These problems can be solved with more strategically located control and tighter parcel networks with higher degrees of connectivity. As more survey data and control are added to a poorly conditioned parcel fabric, readjustment will improve the accuracy and stability of the parcel fabric over time.

**Entering new parcels into the parcel fabric**

In general, when entering new parcels into the parcel fabric, it is recommended that you perform a least-squares adjustment after 20 or 30 parcels have been completed. Miscloures in parcels cause the shape of the fabric to be determined by the order in which the parcels are assembled. This is evidenced by the fact that as more parcels are joined to the fabric, the residuals during the joining phase begin to grow larger. By running an adjustment, these errors are distributed and new parcels will fit more closely with the adjusted fabric. Moreover, running adjustments fairly frequently during the parcel assembly process reduces the number of iterations needed for the adjustment to converge to an optimal solution.

**Running least-squares adjustments when starting out with poor quality or unreliable data**

It is not recommended that you run a least-squares adjustment on data with dimensions that do not match the plan or record of survey. If dimensions do not match the record of survey or plan, it is impossible to tell how inaccurate or accurate the dimensions really are. A least-squares adjustment could be run to preliminarily examine the network and identify those parcels with lines that do not fit in a best fit solution of the network. The results of this least-squares adjustment should not be applied (that is, the Accept button on the Least Squares Adjustment Summary dialog box should not be clicked).

When starting out with poor quality or unreliable data, it is best to first enter new parcel data into the parcel fabric before running and applying your first least-squares adjustment. If you have one or two large, new subdivisions entered with dimensions that match the plan, a least-squares adjustment can be run on these subdivisions and surrounding data. In this way, you can apply an appropriate accuracy level (an accuracy level that makes sense) to your newly entered subdivisions and apply a low accuracy level, for example, accuracy level 6, to parcels surrounding the subdivisions. The least-squares adjustment then has reliable survey dimensions with corresponding accuracies to work with and has a benchmark of good data versus the surrounding unreliable data. The reliable subdivision data will have a greater influence on the outcome of the adjustment results than the unreliable data, and more probable, realistic coordinates will be generated.

Because the adjustment now has a benchmark of reliable survey data to work with, it is now able to better identify which parcel lines in your migrated data are accurate, that is, which parcel lines fit well into the solution and which do not. If you supply no benchmark of good data to your least-squares adjustment, the results of the adjustment will be unreliable.

Thus the best approach is to adjust your parcel fabric in sections as new parcel data is entered. Over time, with the newly entered parcel data, the results of your adjustments will become more reliable and accurate and your network will stabilize.

**Restricting adjustment update privileges**

This topic applies to ArcEditor and ArcInfo only.

In many situations, organizations use data entry staff to enter subdivision plans and deeds into the parcel fabric. Organizations usually also have a small set of qualified staff who are enabled to approve each plan and the least-squares adjustment of each plan. You can prevent staff from applying least-squares adjustment results by adding a registry key that will make the Accept button on the Least Squares Adjustment Summary dialog box unavailable. Staff can still run the least-squares adjustment and view the adjustment report, but they will not be able to apply the adjustment results.

You need to add a registry key to your registry to use this functionality. Here is the process to follow to set this up on each ArcGIS seat:

**Steps:**

1. Click the windows Start menu and click Run.
2. Type regedit in the Run dialog box.
3. Navigate to HKEY_CURRENT_USER\Software\ESRI\Desktop10.0\ArcMap\Cadastral\.
4. Right-click the Cadastral folder, point to New, then click DWORD value.
5. Type LeastSquaresAdjustmentRestricted as the DWORD name.
6. Double-click the DWORD to edit it.

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7. In the Edit DWORD value dialog box, choose the Decimal option.

8. To make the Accept button on the Least Squares Adjustment Summary dialog box unavailable, type 1 in the Value Data text box.

9. To enable the Accept button, type 0.

10. Click OK.

11. Close the Registry Editor window.

About the parcel fabric feature adjustment

This topic applies to ArcEditor and ArcInfo only.

It is common for feature classes to be related to parcel boundaries. For example, road centerline and sewer feature classes must maintain a spatial distance from the boundary of a land parcel, zoning districts must follow the boundaries of land parcels, and building footprints must lie inside the boundaries of land parcels. It is thus typical for feature classes to be edited using parcel boundaries as a background reference. For example, road centerlines are constructed at a specified distance from the road frontage boundary of a parcel.

The parcel fabric acts as a background reference for related feature classes. When the parcel fabric is adjusted through a least-squares adjustment, parcel corner point coordinates may change and update with new values, resulting in discrepancies between the fabric parcels and overlaying feature classes. It is important for feature classes based on the parcel fabric to be adjusted similarly, thereby maintaining their relative position.

Parcel fabric feature adjustment is used to realign standard feature classes to adjusted fabric parcel boundaries. If fabric parcels are adjusted in a least-squares adjustment, the parcel corner coordinates may change over time. Depending on the size of the coordinate changes, discrepancies may result between parcel boundaries and the overlaying feature class layers. Any feature class that is associated with the parcel fabric can be adjusted by the parcel fabric feature adjustment.

When a set of parcels is adjusted in a fabric least-squares adjustment, vectors are generated between the old and new coordinates of the parcels. The parcel fabric feature adjustment uses these vectors to adjust and realign features in associated feature classes.

The adjustment level

Each time a least-squares adjustment is run on a set of parcels, the vectors generated from the least-squares adjustment are stamped with a date and time. This time stamp corresponds to an adjustment level. When a feature class is first associated with the parcel fabric, its adjusted date, or adjustment level, is set to Not Yet Adjusted. Once features in a feature class are adjusted in a feature adjustment, the adjustment level of the feature class is set to the date and time of the latest least-squares adjustment run on the underlying parcels.

For example, if a set of parcels is adjusted in a least-squares adjustment and there are overlaying features that are adjusted in a feature adjustment for realignment, the adjustment level of the feature class is set to the adjustment level that corresponds to the date and time of the least-squares adjustment. If another least-squares adjustment is run on a different set of parcels and different features in the same feature class are adjusted in a feature adjustment, the adjustment level of the feature class is updated to the date and time of the more recent least-squares adjustment run on the underlying parcels.

Note: Only those features that overlay adjusted parcels are adjusted by the feature adjustment.

When first associating a feature class to the parcel fabric, you can set its adjustment level to either your own specified date or an existing adjustment level in the system. In this case, you are telling the feature class that it is already adjusted and current with the date or adjustment level that you specify. The feature class will receive all adjustments happening in the system after your specified date or adjustment level.

Note: Associated feature classes and datasets can have different adjustment levels. You can only set the adjustment level once; after that, the adjustment level is managed by the system.

Adjustment buffer

When features are adjusted in a feature adjustment, an adjustment buffer of 50 meters, or 164.04 feet, is applied to surrounding features outside the adjustment area. A buffer is applied to surrounding features for seamless integration of adjusted features. Smaller and smaller adjustments are applied to surrounding features such that the adjustment vector becomes zero at 50 meters.
Running a parcel fabric feature adjustment

This topic applies to ArcEditor and ArcInfo only.

A parcel fabric feature adjustment is run in ArcMap. Feature classes are associated with a parcel fabric in both ArcMap and the Catalog window. In ArcMap, features are associated with the current target fabric by clicking the Add button on the Feature Adjustment dialog box. In the Catalog window, features are associated with a parcel fabric by clicking the Add button on the Associations tab on the Parcel Fabric Properties dialog box.

Learn more about associating feature classes with a parcel fabric

Notes:
A parcel feature adjustment is only used to realign features that have become misaligned with parcel boundaries after they have been adjusted with least squares. A feature adjustment cannot be used to align features that were originally misaligned with parcel boundaries.

Steps:
To run a parcel fabric feature adjustment, follow these steps:

1. In an edit session in ArcMap, click the Parcel Editor arrow on the Parcel Editor toolbar and click the Feature Adjustment command. If you are working in manual mode using fabric jobs, the fabric job in which you are working needs to be closed. Features are adjusted outside fabric jobs.

2. On the Feature Adjustment dialog box, choose the feature classes that will participate in the feature adjustment.

   Note: The adjusted date of an associated feature class is set when the feature class is first associated with a parcel fabric. If a feature class is already listed as an associated feature class on the Feature Adjustment dialog box, the Set Date button is unavailable.

3. Click the Adjust button to run the feature adjustment.

   The adjustment is applied to the chosen feature classes, and the Feature Adjustment dialog box is closed.

4. Reopen the Feature Adjustment dialog box (Parcel Editor > Feature Adjustment).

   The adjusted date of the adjusted feature classes is set to the date of the most recent fabric least-squares adjustment that was run on the underlying parcels.

Versioning considerations for the parcel fabric feature adjustment

This topic applies to ArcEditor and ArcInfo only.

The parcel fabric supports editing and feature adjustment on a versioned ArcSDE geodatabase. Parcel fabric editing is supported on one version level below the default version. If you are working in manual mode using fabric jobs, multiple, overlapping fabric jobs can exist on both the default version and the child version of the database.

Running fabric least-squares adjustments on versioned geodatabase

Fabric parcels are always locked when edited on a versioned ArcSDE geodatabase and cannot be simultaneously edited in the same version or another version. Parcels can, however, be simultaneously adjusted by least squares on the same version or another version.
When overlapping fabric least-squares adjustments are run on the same set of parcels on different versions, the parcel point coordinates will receive adjustments from the last version to post to the default version. Coordinates in the overlapping area will not receive adjustments from both least-squares adjustments run on the area. Similarly, on the same version, coordinates in the overlapping area will receive adjustments from the most recent adjustment run on the area.

When reconciling versions with a parcel fabric, reconciliation will always occur in favor of the child version when dealing with changes to the parcel fabric. For example, a least-squares adjustment is run on version A. Version A is reconciled without conflicts and is posted to the default version. An overlapping least-squares adjustment is run on version B. When version B is reconciled, adjustment conflicts are automatically resolved in favor of version B (last version to post to default). All other conflicts, such as attribute edits, are resolved manually through interactive conflict resolution.

**Note:** Conflicts are never detected on parcel geometry edits because parcel geometry is always locked across versions. However, parcel conflicts can be detected on the editable attributes of a parcel and any attributes that you have added to the parcels table.

**Note:** Conflicts detected in a parcel fabric are defined by row, not by attribute.

Adjustment vectors and overlapping least-squares adjustments

Adjustment vectors are generated between the old and new coordinates of parcel points that have been adjusted with least squares. If versions are posted to default that have fabric least-squares adjustments, overlapping sets of vectors are posted for those parcel points.
In areas with overlapping least-squares adjustments, the adjustments from the most recent version to post to default persist. Similarly, only those adjustment vectors from the most recent version to post to default are maintained. When there are overlapping least-squares adjustments on the same version, adjustment vectors from the most recent least-squares adjustment are preserved.

For example, a least-squares adjustment is run on a set of parcels on version 1. A feature adjustment is then run on associated features on the version. On version 2, a least-squares adjustment is run on a set of parcels that partially overlap an adjustment area in version 1. A feature adjustment is run on associated features on version 2. Version 1 reconciles and posts to the default version. Version 2 reconciles where conflicting coordinate adjustments in the overlapping area are resolved in favor of the child version, which is version 2. Conflicting adjustment vectors are also resolved in favor of the child version, which is version 2. Since associated features in the overlapping area on the default version have already been adjusted with adjustment vectors posted from version 1, a correction vector needs to be generated to move associated features to the adjusted location resulting from vectors posted from version 2.

**Associating feature classes on a versioned ArcSDE geodatabase**

For a feature class to participate in the parcel fabric feature adjustment, the feature class needs to be associated to the parcel fabric. In ArcSDE, feature classes can only be associated on the default version. Existing child versions need to be reconciled to pick up any new feature classes that have been associated with the parcel fabric.

**Related Topics**

*Editing the parcel fabric and versioning*
An overview of COGO

This topic applies to ArcEditor and ArcInfo only.

When surveyors or civil engineers need to record the location of human-made features, such as land parcels, road centerlines, utility easements containing transmission lines, and oil and gas leases, they typically provide the results on a survey plan that describes the location of features relative to each other. Below is an example survey plan that diagrammatically shows a road centerline and the edge of the land properties adjoining the road. The road centerline and parcel boundaries comprise a number of straight and curved lines.

Each line has measurements that describe it. A straight line has a direction and distance, while a curved line has a radius, angle, arc length, direction, and so on. These measurements are coordinate geometry descriptions. You can use these COGO descriptions to accurately re-create the features the surveyor captured. The survey plan also includes references to existing locations that help you to tie these new features into your GIS database. The reference could be the coordinates for a point or a measurement to a well-known location such as a control point, a road intersection, or an existing parcel corner.

Building blocks for COGO

These are the basic building blocks for COGO:

- Points—Survey plans can describe point features such as control points, section corners, and monuments. You can use a simple point feature class to represent these features.
- Lines—Use a simple line feature class to represent these features. You can optionally add COGO fields to your line feature class, and measurements you enter are recorded on the features. There are three types of lines found on survey plans:
  - Straight lines—Straight lines are the predominant type of lines on a survey plan, they are used to represent all types of features.
  - Curved lines—A typical use for curved lines is to smoothly change direction on a road centerline. Parcel boundaries are usually parallel to the road centerline, so boundaries adjacent to a curved centerline are also curved. Curves are used in a number of other situations: in cul-de-sac parcels to provide a large turning circle for vehicles and on parcels at an intersection to provide greater visibility.
  - Spirals—Spirals are not as common as the other types of lines. Spirals typically provide a transition to and from circular curves. Spirals are used in roadway and railroad design, where a high-speed vehicle or train must be eased into or out of a circular path from or to a straight tangent. Creating and modifying spirals is only supported through programming. For more information, see the geometry section of the ArcGIS software documentation kit help.
- Polygons—Polygon features are used to represent the parcel areas formed by your COGO line features. You usually don’t directly create polygons with the ArcMap COGO functionality; more typically you derive polygons from your lines. For example, you can use the Construct Polygons command on the Topology toolbar to create polygons from selected lines.
- Traverses—Much of the data that is entered using COGO descriptions is entered from traverses. A traverse is simply an ordered collection of COGO descriptions that are used to create either a line or a polygon. Each individual line is referred to as a course. Traverses are not stored in the GIS; however, you can save a traverse to a text file and recall it later.

Creating features from COGO descriptions

The commands and dialog boxes in the ArcMap editing environment for creating features from COGO descriptions are integrated into the editing experience. The common commands and dialog boxes you will use include these:

- Traverse window—Create a set of features from a traverse description.
- 2-Point Line window—Quickly create a feature from a single COGO description.
- Offset Line window—Create a set of features from a strip description, a type of survey plan used for realigning road centerlines.
- Cul-de-sac command—Create a cul-de-sac from a selected road centerline.

These are just some of the commands and dialog boxes available for creating features in ArcGIS. Refer to Common COGO workflows to understand how you can use these and other commands to build and maintain your land parcels.

Correcting for differences between the survey plan and GIS data

When you are using the COGO descriptions from a survey plan, you are using measurements the surveyor took on the ground and possibly adjusted to some coordinate system. However, a GIS stores coordinates relative to a projection’s coordinate grid. You can use ground to grid correction to adjust the geometry of the features you create.

Reporting COGO descriptions

Before you begin adding features from COGO descriptions, you might need to investigate and understand how the new features will fit compared to the existing features. You can use the COGO Report dialog box to measure directions and distances between points you click on the map as well as query the COGO descriptions for line features in your database. You can also use the COGO Area command to calculate the legal area of selected line features, useful when deciding which approach to use in modifying features.

Storing COGO attributes on line features

In ArcMap, you can store the COGO values that you enter when creating features as an attribute of the line feature. One reason to do this is to keep a record of the original COGO description of the line features. This is useful if you need to research the original value when you are modifying the line feature in the future.
Not every command and tool in ArcMap updates the COGO attributes of a line feature. The Traverse window, 2-Point Line window, Cul-de-sac command, and Proportion command are examples of those that do update. For a complete list, see About COGO descriptions. To get this behavior, you need a line feature class with the appropriate COGO attributes. You can use the Create COGO Fields command in ArcCatalog to do this.

How is COGO different from other ESRI COGO capabilities?
The COGO functionality provided when editing in ArcMap with the COGO toolbar allows you to create and maintain your land parcels and other surveyed features in a geodatabase. There is other ESRI functionality that provides similar capabilities, such as parcel editing and the COGO extension to ArcInfo Workstation.

Parcel editing (parcel fabric and Parcel Editor toolbar)
Parcel editing allows you to capture and maintain survey information collected from field notes, data collectors, and record information submitted by surveyors to public authorities. You can use this survey information to incrementally improve the accuracy of GIS feature geometry in the geodatabase.

Parcel editing provides a parcel fabric dataset, job tracking, and workflow functionality for maintaining a land records database.

How does this differ from COGO?
- Maintaining your features over time—When you create line and polygon features with COGO functionality in ArcGIS, you cannot go back and change the measurements and readjust the features. For example, if you use the Traverse window to create a parcel boundary and realize later you made an error, you must delete the parcel boundaries and create them again. Using parcel fabrics, the parcel record information is stored in the parcel fabric so you can reapply the measurements and adjust the fabric.
- Adjustment of the parcels—With COGO, as new parcels are added, you need to decide how those new parcels integrate into the existing parcel layers. You might need to delete some lines or modify or re-create others. Parcel editing uses a least squares adjustment that defines a best fit for your new parcels. As you add new parcels, they are seamlessly integrated into the parcel fabric. Old record information is not deleted; it is kept as a historical record and can continue to contribute to the coordinate accuracy of the fabric.
- Tracking history of parcels—The geodatabase allows you to archive data so you can model your parcel data over time. This works for the parcels created with COGO. Parcel editing provides additional functionality to geodatabase archiving where you can store incremental changes to the parcels in a parcel fabric.

COGO extension for ArcInfo Workstation
The COGO extension for ArcInfo Workstation provides functionality for capturing and maintaining land records data in a coverage. How does this differ from COGO in ArcGIS?
- Availability of functionality—COGO is available with an ArcEditor or ArcInfo license. The COGO extension for ArcInfo Workstation requires an additional extension license.
- Similar functionality—COGO in ArcGIS provides similar functionality to the COGO extension for ArcInfo Workstation. Refer to Common COGO workflows to understand what capabilities are available.
- No COGO point feature class—COGO in ArcGIS does not have an explicit COGO point feature class.
- Support for spiral curves—Creating and modifying spirals is only supported through programming. For more information, see the geometry section of the ArcGIS software documentation kit help.
- Stationing—This is not supported in ArcGIS.

Related Topics
About COGO descriptions
Common COGO workflows

Common COGO workflows

This topic applies to ArcEditor and ArcInfo only.

When you use COGO methods to create parcel boundaries from a survey plan, you get highly accurate features. However, you may find some challenges when you integrate these new features into your existing feature layer. There can be any number of reasons why this is the case: your existing data may have been captured with different accuracy, the control points you used to tie your new survey plan into your dataset may not be as accurate as you need, and so on. The workflow steps outlined below will help you maintain your database as accurately as possible. The ArcMap editing environment contains a rich set of construction and COGO functionality, and the workflow described below represents just some of the possibilities.

What is your COGO data model?
Before you start creating parcels, you need to decide what your data model will be: Do you want to store point features? Do you need lines to represent your boundaries? Do you want to maintain COGO attributes on those lines? This is particularly true if you previously used COGO in ArcInfo Workstation. You might want to consider whether you’ll model your features the same way. The geodatabase allows you more flexibility than coverages.

The parcel data model at the ESRI Support Center is a good starting point to understand what is possible. You can download the parcel data model and case studies on how it has been used. The parcel data model has been used in many projects and provides ideas on which feature classes to include, the kinds of geodatabase behavior you can model, topology rules that are important, and so on. For more information on data models, see http://support.esri.com/data models.

There are also several books available from ESRI Press that describe how to use ArcGIS to model parcels: GIS and Land Records: The ArcGIS Parcel Data Model by Nancy von Meyer and Designing Geodatabases: Case Studies in GIS Data Modeling by David Arcut and Michael Zeiler. For more information on these books and how to purchase them, visit http://store.esri.com.

If you are new to the geodatabase, you can also refer to the Designing a geodatabase section in the help.

Investigating how parcels will fit
Before you begin adding parcels, you need to explore how the new parcels will fit with the existing parcels. For example, you might want to check that the widths of any rights-of-way are correct and that the areas of parcels match their attributed areas. Use the COGO Report dialog box and interactively click on the map to find the distances and directions between points and the COGO descriptions of existing features. You can also use the COGO Area command to compare the perimeter and area of the feature geometries to the attributed area of the COGO descriptions.

Correcting for differences between the ground and grid
When you read the COGO descriptions from a survey plan or some other legal document, the directions and distances are measured on the surface of the earth. These are referred to as ground measurements. To correctly enter these directions and distances into the spatial coordinate system of your GIS—the grid—you need to apply a ground to grid correction. The [Ground to Grid Correction dialog box](#) allows you to interactively change the correction between the two.

If you choose not to use ground to grid correction when you create your features, you can select the features later and use the [Rotate tool](#) to move the features into place.

**Adding parcels from a survey plan**

The approaches described here can be applied to survey plans that have one parcel or many parcels.

**Creating the external boundaries of the parcels**

First, you need to create the external boundaries of the parcels. You can use the Traverse window to enter this into a line layer. It is important that you add this external boundary as accurately as possible, so start your traverse at an existing ground control point or boundary that you believe to be accurate.

When using the Traverse window, you have the option to adjust the features you create to account for differences between the calculated endpoint and the actual endpoint. You should only adjust the features if the difference between the two endpoints is within an acceptable closure distance. Remember that when you adjust the features, you introduce small differences in the feature geometry from the COGO description. This could cause problems later when you connect the internal boundaries to these features.

**Creating the road right-of-way boundaries and back lot lines**

Continue to use the Traverse window to enter boundaries as described above. When you have a straight boundary that runs across many parcels, you can either create one line feature for every parcel or you can create a single line feature that extends across all the features and use the [Proportion command](#) later to split the line into parts.

**Alternate approach to creating the road right-of-way boundaries**

You can use the Traverse window to enter the road centerlines into a separate line feature class.
You will build the road right-of-way boundaries from the road centerlines you just created. Use the Cul-de-sac command to create the parcel boundaries around a cul-de-sac. Then use the Copy Parallel command to create parallel lines to the road centerlines. You can clean up the intersections between these lines with the Line Intersection, Extend, Trim, and Fillet tools. Finally, use the Proportion command to split the parcel boundaries at each intersection.

Creating internal parcel boundaries

Now, you need to add the internal boundaries of the parcels. If you split each road and back lot boundary, you can digitize each boundary. An alternative is to use the 2-Point Line window to enter a start point and the direction and distance of the boundary. This will ensure the COGO description you enter is stored with the new line features. Set your snapping environment before using either technique to ensure your boundaries snap.
Ensuring coincidence of your parcel boundaries

To create parcel polygons from the boundary line features, you need the ends of the lines to be coincident with other lines. You can use a geodatabase topology to define topology rules that help you find and fix where your lines aren't coincident. Some topology rules that are useful include Lines Must Not Have Dangles, Lines Must Not Intersect, and Lines Must Be Covered By Boundary Of Polygons.

Creating parcel polygons

There are several ways to create parcel polygons from the parcel boundaries you built. The most common interactive way is to use the Construct Polygons command on the Topology toolbar. Other approaches include using the Feature To Polygon geoprocessing tool.

An important point is that to create a polygon in ArcGIS, you don’t need your boundary line features to be split at every intersection. This gives you a lot of flexibility in your data model. You can choose any of the following:

- Maintain separate line features for every parcel boundary. You might do this if you want a COGO description for your boundary.
- Maintain line features for the cartographic entities you want to represent. For example, you can have lines for subdivision boundaries, rights-of-way, easements, and so on. You don’t need to split these lines where they intersect, but you do need to ensure they snap to each other.
- If you only want parcel polygons and aren’t interested in the lines, you can use a construction line feature class and temporarily create your boundary lines. Then, create your parcel polygons from those lines and subsequently delete the lines when you are done.

Importing parcel boundaries from CAD

If you are fortunate enough to receive a digital copy of the survey plan from a surveyor, you might be able to use that data to save you the work of entering the parcels. While it’s obvious the surveyor has faithfully and accurately recorded the boundaries of the parcels, the computer-aided design (CAD) drawing may not be accurate enough for your purposes. You are mostly concerned about whether the parcel lines snap to each other and whether you can easily separate out the layers you need from the rest of the drawing.

If you have confidence in the accuracy of the CAD drawing and are sure of which layers the boundary lines are in, you can set up a geoprocessing model or script to automatically load the new lines into a feature class, create polygons, and so on. If you need to visually inspect the CAD file, you can use the steps described below.

Adding the CAD file to ArcMap

You need to first add the relevant CAD file to ArcMap. You want to add the polylines and annotation from the CAD file as CAD feature classes, allowing you to identify, select, and copy the geometry. Use the Identify window to determine which layers/levels or other CAD attributes distinguish your parcel boundaries. Once you determine this, set either the drawing layers or a definition query in the layer properties of the CAD layers to only draw the features you are interested in.

It is possible the CAD file is in a different coordinate system or not projected at all. Use the Georeferencing toolbar to translate, scale, and rotate your CAD file to the appropriate location.

Is the CAD data accurate enough for your purposes?

You need to make a decision on whether the CAD data is accurate enough for you to copy the geometry and use it for your GIS features. With the COGO Report dialog box, you can get the coordinates of an existing feature and the COGO description of a line feature. Use this window to check whether lines snap to each other and directions and distances are consistent with what you expect.

It’s okay if the CAD lines aren’t split at each parcel boundary intersection. You can fix them at a later stage.

Copying the CAD lines into your boundary feature class

If your CAD file is correctly positioned, you can select the parcel boundaries, copy them, and paste the CAD lines into your parcel boundary layer.

If you did not georeference your CAD file, you can use the Copy Features tool on the Advanced Editing toolbar to copy the boundaries you need to a new location. Then, use the Edit tool together with the Rotate tool (and possibly the Scale tool) to move the parcel boundaries to their correct location.

Intersecting parcel boundaries

This is an optional step since you don’t need your boundary lines to be split at every intersection to create polygons. There are various commands and tools at your disposal:

- Proportion command on the COGO toolbar
- Line Intersection tool on the Advanced Editing toolbar
- Split Into COGO Lines command on the COGO toolbar
Creating parcel polygons

Use the same approaches described in the last section to create polygons from your new parcel boundaries.

Modifying existing parcels

If you receive a survey plan or other legal description that describes modifications to existing parcels, you have several options: you can either modify the existing parcel boundaries and polygons, or you can delete the existing boundaries and polygons and reenter the parcels as if they were new. The key to determining which approach to take is based on how accurate the existing parcels are and whether you have the COGO descriptions for just the new boundaries or the entire parcel.

You can start by using the COGO Report dialog box to check the directions, distances, areas, and so on, for the existing features. If you maintain COGO descriptions on your boundary features, you can select the boundaries for your particular parcel and use the COGO Area command to check the closure between the geometry and the COGO description. You can also create the parcel boundary with the Traverse window and visually inspect the difference between the edit sketch and existing boundaries. From these techniques, you can determine if the existing boundaries are within some predefined tolerance, and you can move the existing parcel boundaries. Otherwise, you probably need to re-create the entire parcel from the COGO description.

Moving parcel boundaries and polygons at the same time

The main problem when changing parcel boundaries is the parcel polygons that are coincident that must also be moved. The way to move these coincident features in the ArcMap editing environment is to use the Topology Edit tool on the Topology toolbar. This allows you to select nodes and edges that are shared between features and modify their geometry. The Topology Edit tool requires a topology to tell it which feature classes share their geometry. You can either use a geodatabase topology, if you have created one, or you can create a temporary map topology that indicates your parcel boundaries and parcel polygons should be coincident.

An alternative approach to use if you have a number of boundaries to change is to convert your parcel polygons to points, modify the boundaries, and re-create the parcel polygons from the lines and points. Follow the steps below to do this:

1. Select the parcel polygons whose boundaries need to change.
2. Use the Feature To Point geoprocessing tool to create points that will temporarily store your polygon attributes. This creates a new point feature class.
3. Delete the parcel polygons.
4. Modify the parcel boundary lines using the approaches described above. Employing a geodatabase topology can help you avoid creating overlapping, dangling lines, and so on.
5. Select the parcel boundary lines and use the Feature To Polygon geoprocessing tool to create polygons from the lines and points. This creates a new polygon feature class.
6. Select the newly created parcels, then copy and paste them into your parcel polygon feature class. The attribute fields should match, so the attributes you copied onto the points will be preserved.
7. Make sure you clean up the temporary feature classes that were created by geoprocessing.

Related Topics

About COGO descriptions
An overview of COGO

About COGO descriptions

This topic applies to ArcEditor and ArcInfo only.

The geometry of a straight line can be described using a direction and a distance. Similarly, you can describe the geometry of a circular arc with parameters such as arc length, chord distance, radius, central angle, and tangent length.

COGO lines

A COGO line is a feature that is either completely straight or completely circular. If the feature has any vertices between the endpoints, every vertex must fall within the x,y tolerance of a line or curve created between the endpoints. Only these types of line features have valid COGO descriptions.

COGO lines can be created a number of ways. For example, you can create them when you use the following:

- Traverse window
- Offset Line window
Construct 2-Point Line window
Cul-de-sac command
Split Into COGO Lines command

Required COGO fields
The table below lists and describes the required table fields to maintain COGO attributes.

<table>
<thead>
<tr>
<th>Field name</th>
<th>Description</th>
<th>Field alias</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction (or Angle)</td>
<td>If the feature is straight, this is the direction of the line. If the feature is a circular arc, this is the direction of the chord line. The field is named either Angle (to be compatible with ARC/INFO coverages) or Direction (if you use the Create COGO Fields command).</td>
<td>COGO Direction</td>
<td>Text=12 Length=12</td>
</tr>
<tr>
<td>Distance</td>
<td>If the feature is straight, this is the distance between the endpoints. If the feature is a circular arc, this is the distance along the chord line.</td>
<td>COGO Distance</td>
<td>Text=10 Length=10</td>
</tr>
<tr>
<td>Delta</td>
<td>The central angle formed between the endpoints of the curve and the center point. When editing in ArcMap, this is typically referred to as the Angle.</td>
<td>COGO Delta</td>
<td>Text=10 Length=10</td>
</tr>
<tr>
<td>Radius</td>
<td>The length from the center point to the curve.</td>
<td>COGO Radius</td>
<td>Text=10 Length=10</td>
</tr>
<tr>
<td>Tangent</td>
<td>The distance between the endpoint and the point of tangency. The point of tangency is determined by intersecting a perpendicular line from each of the endpoints of the curve.</td>
<td>COGO Tangent</td>
<td>Text=10 Length=10</td>
</tr>
<tr>
<td>ArcLength</td>
<td>The length along the curve. When editing in ArcMap, this is typically referred to as Arc.</td>
<td>COGO ArcLength</td>
<td>Text=10 Length=10</td>
</tr>
<tr>
<td>Side</td>
<td>The side on which the center point of the circular arc is located.</td>
<td>COGO Side</td>
<td>Text=1</td>
</tr>
</tbody>
</table>

Outputting COGO descriptions
Specific COGO commands in ArcGIS can store the COGO descriptions you enter as attributes on COGO line features. The values added include the direction and length for straight features and curve characteristics such as chord distance, chord direction, arc length, radius, tangent length, and side. The current direction type and angular units for the ArcMap editing environment are used when populating these attributes. The map's current coordinate system linear units are used when populating distance attributes.

The COGO commands in ArcGIS should be used to update line features to maintain COGO attributes. For example, to split a line, use the Proportion tool on the COGO toolbar so the COGO attributes will be automatically updated. Using the Split command or tool will not update COGO attributes.

The following commands write COGO descriptions to the COGO attributes of a line feature class:
- **Merge**—Merges two or more selected features into a single feature. If you select lines that are entirely straight or curved and they have COGO fields, you can update the COGO descriptions.
- **Traverse window**—Creates a feature from a series of COGO descriptions that form an open or closed traverse.
- **2-Point Line window**—Creates a COGO line feature from a COGO description.
- **Cul-de-sac**—Creates a symmetrical or asymmetrical cul-de-sac from a street centerline.
- **Proportion**—Splits the selected line into a number of segments.
- **COGO Report**—Lists the COGO descriptions for lines and features in the map.
- **Split Into COGO Lines**—Splits the selected lines at every vertex and updates the COGO fields.
- **Update COGO Attributes**—Calculates COGO descriptions for selected lines from the feature geometry.

Related Topics
Adding COGO fields to a feature class
An overview of COGO
Common COGO workflows

Adding COGO fields to a feature class

This topic applies to ArcEditor and ArcInfo only.

To add and maintain COGO descriptions in a feature class, you need to have certain fields in its attribute table. You can easily add COGO fields to your feature class using the Create COGO Fields command in ArcCatalog.

**Steps:**
1. In ArcCatalog, click the Customize menu and click **Customize Mode**.
2. Click the **Commands** tab.
3. Type **COGO Fields** in the **Show** box. The available geodatabase tools appear on the right side of the panel.
4. Drag the **Create COGO Fields** button onto any of the ArcCatalog toolbars.
5. In the Catalog tree in ArcCatalog, select the line feature class to which you want to add COGO fields.
6. Click the **Create COGO Fields** button. A message appears showing that the fields have been added.

Related Topics
About COGO descriptions

About applying a ground to grid correction
This topic applies to ArcEditor and ArcInfo only.

When you read the COGO descriptions for boundaries on a survey plan or other legal document, the directions and distances are measured on the surface of the earth. These are referred to as ground measurements. However, the directions and distances in your GIS data are based on the spatial data's coordinate system, or the grid measurements.

Ground and grid measurements are often different. You may set constants (the ground to grid correction) for directions and distances so that the software can correctly convert between the ground and grid measurements.

Why correct directions?
A surveyor may measure angles on the ground relative to any of several definitions of north: true north, magnetic north, grid north, or a locally defined north. However, directions in your spatial data are always relative to the coordinate system's grid north. Ground and grid directions must be rotated to convert one into the other.

The direction offset is an angle that is added to ground directions to rotate them to grid directions or that is subtracted from grid directions to rotate them into ground directions.

Why correct distances?
A surveyor measures distances on the ground relative to the local ground elevation. However, grid distances in your spatial data are always measured relative to the coordinate system's ellipsoid (to simplify matters, sea level).

For example, a 1,000-foot line surveyed at a high elevation must be scaled down to fit the earth's ellipsoid at sea level. So its grid distance is somewhat less than 1,000 feet:

\[
\text{Ellipsoid (sea level)}
\]

The distance factor is a scale factor that is used to multiply ground distances to convert them to grid distances or to divide grid distances to convert them into ground distances.

Where is the correction specified?
The correction constants (Direction Offset for directions and Distance Factor for distances) are part of the ArcMap editing environment. You can set them on either the Units tab of the Editing Options dialog box or with the Ground to Grid Correction dialog box opened from the COGO toolbar.

When is the correction applied?
The ground to grid correction affects all direction and distance inputs that you make in the ArcMap editing environment, whether you are entering the bearing for a course in the Traverse window or constraining a vertex to a specific direction with the sketch construction tools. Your inputs are assumed to be in ground measurements; they are corrected to grid measurements and used to construct the feature geometry. Any command that writes the COGO descriptions you enter to COGO attribute fields will always write the uncorrected ground measurements.

Determining the correction
If you don't set a direction or distance correction, the geometry of newly constructed features will be rotated or scaled improperly relative to the coordinate system grid. There are several ways you can find the ground to grid corrections for a particular survey plan or legal document:

- Examine the survey plan or legal document for the corrections, which may be called the basis of bearing or convergence angle for directions and scale factor for distances. Look for statements such as "Bearings shown hereon are based on an assumed bearing of..."
- Consult government publications on state plane coordinate systems that describe the basis of bearing and scale factors at locations throughout the specific coordinate system.
- Use the Ground to Grid Correction dialog box launched from the COGO toolbar to calculate the corrections from existing features that also appear on your plan or document.
- Use the COGO Report command on the COGO toolbar to calculate averaged correction values from existing features.

You should set the correction, or at least check the current correction, before you start entering features from a new survey plan or legal document. However, you might not want to change the corrections in the middle of entering features from that same plan since you could introduce slight differences in the geometries you create.

Converting from ground to grid
When you use directions and distances to construct feature geometry, ArcMap assumes you are entering the values in ground-based measurements and uses the corrections to convert them to grid-based measurements before it constructs the geometry.

The direction offset is an angle that is added to the ground direction measurement to rotate it to match the grid direction. Positive angles rotate counterclockwise and negative angles rotate clockwise. This may seem backward (negative values typically rotate counterclockwise); however, it makes sense when you consider the direction you entered is converted to a polar direction before the direction offset is applied. In the polar system, you measure from the x-axis, and positive angles increase in a counterclockwise direction.

Here's an example. Suppose you set Direction Offset to -5°. If you enter a ground direction of N40°E, the resulting line feature will have a grid direction of N45°E, even though N40°E is written to the COGO Direction field. The steps below show how ArcMap applies the direction offset in this example:

1. Convert N40°E to a polar direction: N40°E = 50°.
   \[
   \begin{align*}
   \text{Angles in Bearing} & \quad \text{Angles in Polar Degrees} \\
   90° & \quad 0° \\
   45° & \quad 50° \\
   40° & \quad 55° \\
   90° & \quad 85° \\
   0° & \quad 135° \\
   
   \end{align*}
   \]
   2. Add the direction offset: 50° + (-5°) = 45°.
3. Convert the polar direction back to quadrant bearing: 45° = N45°E.

The distance factor is used to multiply the ground distance to scale it to match the grid distance. For example, if Distance Factor is set to 0.95 and you enter a ground distance of 100 feet, the resulting line feature will have a grid distance of 95 feet (the shape length), even though 100 is written to the COGO Distance field.

Converting from grid to ground

When you measure a direction and distance in the map, you are working in grid measurements. If there is a ground to grid correction set, the direction, offset, and distance factors are applied to the grid measurements in reverse order to calculate the ground measurements. That is, the direction offset is subtracted from the grid direction, and the grid distance is divided by the distance factor.

The following editing commands apply the correction in reverse:
- The construction tools’ constraints on direction and length
- The edit sketch segment direction and length reported in the ArcMap status bar
- The COGO Report command
- The Split Into COGO Lines command
- The Update COGO Attributes command

Using the Ground to Grid Correction dialog box

The Ground to Grid Correction dialog box allows you to enter the ground to grid correction in three ways, including typing in values and interactively changing the correction.

Typing the correction you read from a plan

The Ground to Grid Correction dialog box lets you type in the corrections, the same way as the Units tab of the Editing Options dialog box. Use this approach if the corrections are stated on your plan or you have used the COGO Report dialog box to calculate an average correction across the area in which you are working.

Entering the ground line and clicking the map for the grid line

If you have an existing line in your dataset that you know the ground direction and distance for, you can use this approach to set the corrections. An example of how you can use this option is below. In the graphic below, the feature on the left describes a line on a survey plan; on the right is a feature representing the same boundary. You can use the Enter the ground line and click on the map for the grid line option. First, type the direction and distance, then click the ends of the line feature to set the correction.

Clicking the map for the ground and grid lines

If you have points in your dataset that represent both the ground and grid lines, you can use this approach to set the corrections. An example of how you can use this option is below. The graphic on the left describes a traverse between two control points. On the right, the two control points have been added as point features into the dataset. Next, you can create an edit sketch without a ground to grid correction set that starts at the northern control point and ends near the southern control point. The difference between the control points and the edit sketch represents the ground to grid correction. Finally, you can use the Click the map for the ground and grid lines option. Click the two control points first, then click the ends of the edit sketch to set the correction.

If you only want to set the direction offset, use the Enter the ground line and click on the map for the grid line option and type a distance of 0.

Related Topics

Applying a ground to grid correction
Applying a ground to grid correction

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click **Ground To Grid Correction** on the **COGO** toolbar.
2. Check the **Use Ground to Grid Correction** box.
3. Enter the values for the direction offset and distance factor. Either type values from the survey plan in the boxes or click the options to use interactive correction. You cannot enter a scale factor of 0, as this would result in erroneous ground distances.
4. You also can set the correction interactively:
   - To type a ground line and click the map for the grid line, click that option, then click the Interactive Correction Change button. Enter a ground distance and direction and click **OK**. Click twice on the map for the grid line.
   - To click the map for both the ground and grid lines, click that option, then click the Interactive Correction Change button. Click twice on the map for the ground line and twice for the grid line.
5. Click **Close**.

Related Topics

About applying a ground to grid correction

About COGO and feature templates

This topic applies to ArcEditor and ArcInfo only.

Feature templates define all the information required to create a new feature: the layer where a feature will be stored, the attributes each new feature will be created with, and the default tool used to create a feature. When your layers have COGO fields, feature templates have special behavior to ensure the integrity of features you create.

The Template Properties dialog box hides COGO fields, preventing you from inadvertently setting the default attribute values for those fields. This way, the correct COGO values can be populated when you create a new feature.

The list of construction tools is filtered to show only the Line tool when working with line templates for layers with COGO attributes, layers participating in geometric networks, or turn feature classes in network datasets. This is because the other construction tools create closed ring shapes that are invalid geometries in those layer types.

Although the Line tool is available, you will most likely use Traverse, 2-Point Line, Offset Line, and the other tools on the COGO toolbar to create new COGO features.

When COGO fields are present, ArcMap automatically creates two-point lines. Regardless of the number of segments you sketch, each segment becomes a separate feature when you finish the sketch. This ensures each feature is a COGO line that is either completely straight or completely circular.

Related Topics

About feature templates

About creating a line with the Traverse window

This topic applies to ArcEditor and ArcInfo only.

One common COGO editing task is to create a line or polygon edge using a set of survey measurements collected in the field. The data may be in the form of directions and distances, angles and distances, curves, or tangent curves measured from a known point. These are collectively known as a traverse.

Traverse lets you create edit sketch geometry from a variety of traverse measurements. Once you've started a traverse, you can add segments or curves to the edit sketch using Direction–Distance, Angle–Distance, Curve, and Tangent Curve methods. The Traverse command adds each segment as a line in the Traverse course table and to the edit sketch. You can select each course segment by clicking it in the table—the corresponding segment will flash on the map.

Populating COGO attributes

You can create features using the Traverse window to populate COGO attributes in a feature class and save each course in the traverse as a COGO two-point line feature.

The features must be either straight lines or circular arcs. They typically have two vertices, but more are allowed as long as each feature is consistently straight or consistently curved. In addition, the line feature class must have the following COGO attributes as text fields: Direction, Distance, Delta, Radius, Tangent, ArcLength, and Side.

By default, features are created as two-point lines when the feature class contains COGO attributes. Traverse creates individual line features for each course and automatically assigns the appropriate COGO attribute values.

Direction-Distance course

You need to have an edit sketch with at least one vertex. You can also use the Interactive Start Point tool to set a start point for the course. You enter a direction and a distance. A new straight segment is added to the edit sketch. The direction is based on the current direction type and direction units for the editing environment. The distance can be in any of the supported distance units.
Angle-Distance course

You must have at least one segment in the edit sketch, either from a previous course or already existing in the edit sketch. You enter an angle and a distance. A new straight segment is added to the edit sketch. The angle is based on the current direction units. The distance can be in any of the supported distance units.

The angle—also called the backsight angle—is a clockwise angle between the last segment and the intended line. To add a line tangent to the last segment, you need to use an angle of 180 degrees.

Curve course

You need to have an edit sketch with at least one vertex. You can also use the Interactive Start Point tool to set a start point for the course. You enter two curve parameters, a curve direction, and whether the curve is to the left or right. A new circular arc segment is added to the edit sketch. A curve can be created by entering two of the following parameters:

- Chord—Also referred to as the chord distance, the straight line distance between the endpoints of the curve.
- Angle—The angle formed between the endpoints of the curve and the center point.
- Arc—Length along the curve. The arc length needs to be greater than the chord distance.
- Radius—Length from the center point to the curve.

You cannot add the tangent distance (the distance between the endpoints of the curve and their intersection point) as a parameter for the curve. If you have a tangent distance, use the Curve Calculator dialog box to determine one of the other curve parameters.

The curve direction can be one of three types:

- Chord direction—Direction from the start point of the curve to the endpoint of the curve.
- Tangent direction—Direction to the tangent point of the curve. This creates a curve where the center point of the curve is at 90 degrees from the tangent direction, on the same side as the turn direction.
- Radial direction—Direction toward the center point of the curve.

The curve direction is based on the current direction type and direction units. The angle is based on the current direction units. The distances can be in any of the supported distance units.

Tangent curve course

You must have at least one segment in the edit sketch, either from a previous course or already existing in the edit sketch. You enter two curve parameters and whether the curve is to the left or right. A new circular arc segment is added to the edit sketch. The curve is created from the last point in the edit sketch with the center point of the curve 90 degrees from the edit sketch, on the same side as the turn direction.

Related Topics

...using a Curve course
...using a Direction-Distance course
...using a Tangent Curve course
...using an Angle-Distance course

Being productive while entering values in the Traverse window

The Traverse window allows you to be extremely productive when you are entering values. You can use the number pad together with the arrow keys to enter all values. Press + and / to tab forward and backward through the controls. For any combo box, use the arrow keys to change the current value. You can enter an angle using the following notation: dd.mmss. For example, 34°12'54" can be entered as 34.1254. You can enter quadrant bearing directions using the notation dd.mmss-[1234] where the second-last character is a - (hyphen) and the last digit indicates the quadrant (1=NE 2=SE 3=SW 4=NW). For example, S64°41'29"W can be entered as 64.4129-3.

When using the mouse to enter values, there are also some ways to increase productivity. You can insert a duplicate of a segment by right-clicking it in the table and clicking Insert. You can reorder a segment by selecting it in the table and clicking the up and down arrows. You can remove a segment by selecting it in the table and clicking Remove.
Related Topics

About creating a line with the Traverse window

Starting a traverse from a known coordinate

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Click Traverse on the COGO toolbar.
2. Click Edit to the right of the Start box.
3. Type x- and y-values for the starting coordinate or click the Interactive Start Point Selection tool to set a start point by clicking on the map.
   
   Tip: If you have already started an edit sketch when you click the Traverse window, the start point will be the last vertex of the edit sketch.
4. Click OK.

The start point of the traverse is set in the Start text box. The next vertex of the edit sketch will be placed on the measurements you specify from this location. The first course in your traverse table cannot be based on an angle distance or tangent curve because these techniques are calculated from the direction of the previous course.

Related Topics

...using a Curve course
...using a Direction-Distance course
...using a Tangent Curve course
...using an Angle-Distance course
About creating a line with the Traverse window

Adding a segment to a traverse using a direction-distance course

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Click the Course Type drop-down arrow and click Direction–Distance.
2. Type a direction.
   The Traverse window uses degrees measured counterclockwise from east by default. You can change the angular measuring system and units on the Units tab of the Editing Options dialog box.
3. Type a distance.
   The Traverse window uses the data frame's coordinate system units of measurement by default. You can use an abbreviation to enter different distance units.
4. Click Add.

Related Topics

...using a Curve course
...using a Tangent Curve course
...using an Angle-Distance course
About creating a line with the Traverse window
Starting a traverse from a known coordinate

Adding a segment to a traverse using an angle-distance course

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Click the Course Type drop-down arrow and click Angle–Distance.
2. Type an angle.
   The Traverse window uses degrees measured counterclockwise from east by default. You can change the angular measuring system and units on the Units tab of the Editing Options dialog box.
3. Type a distance.
   The Traverse window uses the data frame's coordinate system units of measurement by default. You can use an abbreviation to enter different distance units.
4. Click Add.

Related Topics

...using a Curve course
Adding a segment to a traverse using a curve course

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Click the Course Type drop-down arrow and click Curve.
2. Click the drop-down arrows and choose two parameters to use in determining the curve.
3. Type the appropriate values for the parameters. Distance values will use map units.
4. Type a chord direction for the curve.
5. Click the drop-down arrow to choose whether the curve will be to the right or left.
6. Click Add.

Related Topics
...using a Direction-Distance course
...using a Tangent Curve course
...using an Angle-Distance course
About creating a line with the Traverse window
Starting a traverse from a known coordinate

Modifying a segment in a traverse

This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Choose the segment in the course list.
2. Click the Properties button . You can also double-click the segment in the course list or right-click it and click Properties.
3. In the course properties, adjust the values as required.
4. Click OK.

Note: If you modify the edit sketch in any way on the map, the courses within the Traverse window are cleared. You can undo the modification to the edit sketch, then right-click the course list and click Load Traverse From Sketch to retrieve them.

Loading a traverse
This topic applies to ArcEditor and ArcInfo only.

Steps:
1. Right-click the Traverse window and click Load Traverse.
2. Navigate to the traverse text file.
3. Click the traverse you want to open.
4. Click Open to load the traverse information from the text file.

Tip: You can also load a traverse from the edit sketch by right-clicking in the Traverse window and clicking Load Traverse From Sketch. Each segment in the edit sketch becomes a course in the traverse. The course type can be either Direction-Distance or Curve. The values for each course are inverted from the geometry of the sketch. You cannot load a sketch from a multipart feature.

Related Topics
Saving a traverse
Traverse file format

Saving a traverse

This topic applies to ArcEditor and ArcInfo only.
A traverse can be saved in a text file for reuse later. Typically, the traverse file is created by saving a traverse that has been entered into the Traverse window. It can also be created externally in a text editor.

Steps:
1. Right-click the Traverse window and click Save Traverse.
2. Navigate to the place where you want to save the traverse.
3. Type a name for the traverse.
4. Click Save to save the traverse information to the text file.

Related Topics
Loading a traverse

Obtaining a closure report

This topic applies to ArcEditor and ArcInfo only.
The closure report lists the following: number of courses; total length of the traverse; the specified and calculated endpoints; the difference of misclosure in both x,y and direction-distance values; and relative error that is a ratio of the misclose distance over the total length.

Steps:
1. In the Traverse window, click Edit to the right of the End box.
2. Type the x,y coordinates for the ending point or click the Interactive End Point Selection tool to set an endpoint by clicking on the map. Checking the Close Loop box sets the beginning and ending points the same.
3. Click OK.

Related Topics
About adjusting a traverse

About adjusting a traverse

Often when generating a traverse, the coordinates of an ending destination are known. ArcMap provides a method to specify this endpoint and determines the difference between the traverse endpoint and the desired endpoint. This difference is known as the misclosure. ArcMap also provides three different techniques for adjusting the traverse to eliminate misclosure. Each of these adjusting techniques varies in the amount of adjustment of the direction and distance of the individual courses of the traverse. These techniques include:

- Compass correction
- Transit correction
- Crandall correction

The compass correction technique specifies that the misclosure, or difference in x and y between the resulting endpoint and the desired endpoint, are equally distributed among the individual two-point arcs and curves that make up the traverse. This is done by adjusting the location and distance of each arc proportional to the difference in closure. The compass correction technique is the technique most often used to resolve errors in misclosure. It assumes that the errors are related to both errors in the direction measurements as well as the distance measurements. Thus, the corrections are reflected in each distance and direction...
value. This technique is also known as the Bowditch rule.

Much like the compass correction technique, the transit correction method specifies that the misclosure is equally distributed among the individual two-point arcs and curves that make up the traverse. However, this technique favors the direction measurements over the distance measurements. In determining the location change required of each arc, the proportion assigned to each arc is proportional to the total x or y values of all the arcs. This results in changes that will affect both the direction and the distance of each arc but will alter the distance to a greater extent.

The Crandall correction technique is used when the direction values are assumed to be precise and accurate, and any misclosure is due solely to errors in distance measurements. This adjustment will preserve all the direction measurements and will alter only the distance measurements to eliminate the closure error. Since directions are fixed, the Crandall adjustment can result in unexpected results, such as flipped directions, very long distance adjustments, or no adjustment at all. Use an alternative method in these cases.

With this array of correction techniques, you will be able to not only correct the errors in the traverse but also place greater or lesser value on specific characteristics of the traverse data.

Related Topics
Adjusting a traverse
Obtaining a closure report

---

Adjusting a traverse

_This topic applies to ArcEditor and ArcInfo only._

**Steps:**
1. In the Traverse window, ensure that an endpoint is set.
2. Click Adjust.
3. Choose an adjustment method.
4. To save the adjusted values in a text file, click Save.
5. Click Accept. The traverse is adjusted based on the adjustment method chosen and feature created.

Related Topics
About adjusting a traverse

---

Traverse file format

_This topic applies to ArcEditor and ArcInfo only._

A traverse file is generated automatically when you save a traverse. It can also be created manually for loading into the Traverse window.

The following is a sample traverse file:

```
DT QB
DU DMS
SP 454868.9 298986.09
EP 454868.9 298986.09
DD D90-0-0E 105
AD 45-0-0 100
TC C 45 D 100-0-0 L
NC C 45 D 100-0-0 C N45-0-0E R
```

The traverse file consists of several header lines describing the direction type and units as well as the start and end coordinates. The subsequent lines describe each course in the traverse.

Any direction in a course must be in the appropriate direction type and direction units. There must not be spaces in the direction. Angles must be in the appropriate direction units format. All distances are specified as numerals and will be assumed to be in the distance units of the coordinate system into which the traverse is loaded.

<table>
<thead>
<tr>
<th>Part Meaning</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
<td>Direction type (required). The direction type is used to specify directions in the direction–distance and curve courses. These are the valid choices:</td>
</tr>
<tr>
<td></td>
<td>• QB—Quadrant bearing</td>
</tr>
<tr>
<td></td>
<td>• NA—North azimuth</td>
</tr>
<tr>
<td></td>
<td>• SA—South azimuth</td>
</tr>
<tr>
<td></td>
<td>• P—Polar</td>
</tr>
<tr>
<td>DU</td>
<td>Direction units (required). The direction units are used to specify directions and angles in the direction–distance, tangent curve, and curve courses. The following are valid choices:</td>
</tr>
<tr>
<td></td>
<td>• DD—Decimal degrees</td>
</tr>
<tr>
<td></td>
<td>• DMS—Degrees/Minutes/Seconds</td>
</tr>
<tr>
<td></td>
<td>• R—Radians</td>
</tr>
<tr>
<td></td>
<td>• G—Gradians or gons</td>
</tr>
<tr>
<td>SP</td>
<td>Start point (required). The start coordinates for the traverse, specified as x,y. For example:</td>
</tr>
</tbody>
</table>
SP 454868.9 298986.09

EP  End point (optional). The end coordinates for the traverse, specified as x,y. For example:

EP 454868.9 298986.09

DD  Direction–distance course. A straight course specified by a direction and a distance. For example:

DD N90-0-0E 105

AD  Angle–distance course. A straight course specified by an angle relative to the previous course and a distance. This must not be the first course in the traverse. For example:

AD 45-0-0 100

TC  Tangent curve course. A curved course that is tangent to the previous course. After the TC, the next two pairs of tokens specify how to construct the curve. Use any of the following choices followed by the value:

- D—Central angle of the curve
- A—Distance along the arc of the curve
- C—Distance across the chord
- R—Radius of the curve

The final token describes which way the curve turns, to the left or the right:

- L—Left
- R—Right

In the following example, a tangent curve with a chord length of 45 units and central angle of 100 degrees curving to the left is defined:

TC C 45 D 100-0-0 L

This must not be the first course in the traverse.

NC  Nontangent curve. After the NC, the next two pairs of tokens specify how to construct the curve. Use any of the following choices followed by the value:

- D—Central angle of the curve
- A—Distance along the arc of the curve
- C—Distance across the chord
- R—Radius of the curve

The next pair of tokens describes the direction of the curve. Use any of the following choices followed by the value:

- C—Chord direction
- R—Radial direction toward the center point
- T—Tangent direction

The final token describes which way the curve turns, to the left or the right:

- L—Left
- R—Right

In the following example, a nontangent curve with a chord length of 45 units, a central angle of 100 degrees, and a chord direction of N4SE curving to the right is defined:

NC C 45 D 100-0-0 C N45-0-0E R
About creating a line with the 2-Point Line window

This topic applies to ArcEditor and ArcInfo only.

A common editing task you encounter when creating lines from COGO measurements is to add COGO lines between existing features you have already created with a traverse. In the example below, the parcel boundaries along the road and across the back of the parcels have been created. Now you need to add the lines between the parcels. While you could use the Traverse window to accomplish this, the 2-Point Line window allows you to enter these boundaries more quickly.

Lines with COGO attributes are automatically created as two-point COGO lines.

The 2-Point Line window lets you create line features using a wide variety of construction methods. You can add straight lines or curved features using Direction–Distance, Angle–Distance, Curve, and Tangent Curve methods.

Populating COGO attributes

If the output layer has COGO fields, the COGO values you type into the 2-Point Line window are written to the appropriate attributes.

Setting the reference

You can set the start point of the new feature by entering the x and y coordinates, clicking on the map, or using the coordinates of the start or end point of a selected line feature.

If you want to create a segment using the Angle–Distance or Tangent Curve constructions, you need to set a reference direction to which the segment will be relative. You can either enter a direction or use the direction of the selected line feature. If you want to click the map to set the reference direction, use the Direction and distance of a line option of the COGO Report window and copy and paste the direction into the Direction edit box.

The reference direction is a foresight, the direction toward the start point. If you are using a selected line, the reference direction is toward the end of the line you choose.

Snapping to existing features

When you are adding line features, you can choose to snap the endpoint to existing features. This allows you to take small differences between the ground direction and distance and features in your dataset into account. In the graphic below, a line feature is being added at a direction of N0E and a distance of 115 feet. When this feature is added, it will snap to the first snap point based on the current snapping environment. The geometry of the feature could be slightly different from the Direction and Distance attributes that are written.

This option uses the general snapping environment to locate a snap point within the snap tolerance of the end of the constructed line feature. When editing, you have a choice of snapping environments: the Snapping toolbar and classic snapping, which resembles the ArcGIS 9.3 snapping environment. The Snapping toolbar uses a snapping tolerance in pixels, while classic snapping allows you to set a tolerance in pixels or map units. To ensure you snap the end of your line to features within a reasonable distance, you could consider using classic snapping and specifying the snap tolerance in map units instead of pixels.

Direction–Distance construction

You enter a start point, direction, and a distance. The direction is based on the current Direction Type and Direction Units for the editing environment. The distance can be in any of the supported distance units.

Angle–Distance construction

You enter a start point, reference direction, angle, and a distance. The reference direction is based on the current Direction Type and Direction Units for the editing environment. The angle is based on the current Direction Units. The distance can be in any of the supported distance units.
The angle—also called the backsight angle—is a clockwise angle between the inverse of the reference direction and the intended line. For example, if you specify a reference direction of S45°E and an angle of 135°, the following occurs:

- Inverse the reference direction: S45°E + 180° = N45°W
- Add 135°: N45°W + 135° = N90°E

To add a line tangent to the reference direction, you need to use an angle of 180°.

Curve construction

You enter a start point, two curve parameters, a curve direction, and whether the curve is to the left or right. A new feature is created in the target layer. A curve can be created by entering two of the following parameters:

- Chord—Also referred to as the chord distance, the straight line distance between the endpoints of the curve.
- Angle—The angle formed between the end points of the curve and the center point.
- Arc—Length along the curve. The arc length needs to be greater than the chord distance.
- Radius—Length from the center point to the curve.

You cannot add the tangent distance (the distance between the endpoints of the curve and their intersection point) as a parameter for the curve. If you have a tangent distance, use the Curve Calculator dialog box to determine one of the other curve parameters.

The curve direction can be one of three types:

- Chord direction—Direction from the start point of the curve to the end point of the curve.
- Tangent direction—Direction to the tangent point of the curve. This creates a curve where the center point of the curve is at 90 degrees from the tangent direction, on the same side as the turn direction.
- Radial direction—Direction toward the center point of the curve.

The curve direction is based on the current Direction Type and Direction Units for the editing environment. The angle is based on the current Direction Units. The distances can be in any of the supported distance units.

Tangent Curve construction

You enter a start point, reference direction, two curve parameters, and whether the curve is to the left or right. A new feature is created in the target layer. The curve is created from the start point with the center point of the curve 90 degrees from the reference direction, on the same side as the turn direction.

Related Topics

- Being productive while entering values in the 2-Point Line window
- Creating a line with the 2-Point Line window

Being productive while entering values in the 2-Point Line window

The 2-Point Line window allows you to be extremely productive when you are entering values. You can use the numeric keypad together with the arrow keys to enter all values. Press the ADD (+) and DIVIDE (/) keys to tab forward and backward through the controls. For any combo box, use the arrow keys to change the current value. You can enter an angle using the following notation: dd.mmss. For example, 34°12'54" can be entered as 34.1254. You can enter quadrant bearing directions using the notation dd.mmss-1234 where the second-to-last character is a HYPHEN (-) and the last digit indicates the quadrant (1=NE, 2=SE, 3=SW, 4=NW). For example, 56°41'29"W can be entered as 64.4129-3.

If you have multiple line features to add, you can hold down CTRL while you click to add more features with the same parameters.

Related Topics

- About creating a line with the 2-Point Line window
- Creating a line with the 2-Point Line window

Creating a line with the 2-Point Line window

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click Construct 2-Point Line on the COGO toolbar.
The **2-Point Line** window opens.

2. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the **Template** button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.

3. Click the **Construction** drop-down arrow and choose an appropriate construction method based on the information you have about the line.

4. You can set the reference by entering a known coordinate, clicking the map, or using a selected line.
   - Click **Enter coordinates** and type x- and y-values for the starting coordinate.
   - Click **Enter coordinates**, click the **Interactive Start Point Selection** tool, then click the map.
   - Click **Use selected line** and choose which end of the line feature you want as the start point.

5. Type the parameters required by the construction method. If you want to construct a line feature using angle-distance or tangent curve constructions, you must also set a direction.
   - The 2-Point Line window uses the data frame’s coordinate system units of measurement by default. You can use an abbreviation to enter different distance units.

6. **Click Create.**

**Related Topics**

**About creating a line with the 2-Point Line window**

This topic applies to **ArcEditor** and **ArcInfo** only.

Occasionally land boundaries are described in a strip description survey plan. A strip description describes boundaries on either side of a specified centerline. This is used to describe easements or rights-of-way in land records.

The example below shows how a right-of-way is described relative to the centerline. The centerline has an arbitrary start point, 0=500.000. The stationing notation is used here; this is a shorthand method used to describe lengths. The stations are specified in even increments, typically units of 100 or 1,000, which appear on the left of the plus sign. To describe a point to the left of the centerline, you would say "0+519.775 16.240 LEFT," which means 19.775 along the line (remembering the arbitrary start point is 500m) and 16.240 to the left of the centerline.

The **Offset Line** window lets you create an edit sketch from selected lines. After you enter a start distance, which you read from your survey plan, you can add offset points by setting a distance along the selected line, an offset distance, and the side on which you want the offset point to be. Each offset point is added to the end of the edit sketch.

Offset Line works with one or more selected lines. Arrows are drawn to show the direction of the selection. You can select multiple lines as long as they form a single continuous line (regardless of the direction of the lines).

In the example below, the graphic on the left shows the strip description, and the right shows it added to an edit sketch in ArcMap. The road centerline has been traversed and is selected, so the right side of the road right-of-way can be added.

To enter the edit sketch, you need to initially set the start distance for the centerline to 383.228. Then you can enter the offset points by specifying a distance along the line, an offset distance, and a side (left or right).

<table>
<thead>
<tr>
<th>Offset points</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>383.228 6.858 R</td>
</tr>
</tbody>
</table>
Creating a line with the Offset Line window

This topic applies to ArcEditor and ArcInfo only.

The Offset Line window allows you to add COGO lines on either side of a specified centerline. Specify parameters, such as the start distance along the line, side, and length, to create the new line.

Steps:
1. Click the Edit tool on the Editor toolbar.
2. Click the line feature or features for which you want to create an offset line.
3. Click Offset Line on the COGO toolbar. The Offset Line window opens.
4. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the Template button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
5. The direction of the selected line is indicated by arrows. If you want to reverse it, check Reverse the selection direction.
6. Set the Start Distance value to be the initial value for the selected line.
7. Type values for the distance along the line and the offset from the line. The value for distance along the line is added relative to the start distance. You can press the TAB key to move to the next option box.
8. Click the Side to offset drop-down arrow and click Left of line or Right of line.
9. Click the Add button or press the ENTER key. A new offset point is added to the edit sketch. As you add points, they are shown in the list at the bottom of the dialog box and on the map in an edit sketch. To reorder the items in the list, select them and click the up or down arrows. To delete points, select them and click the Delete button. You can also right-click the list to save and load offset points from a text file, remove points, and navigate the sketch.
10. You can add another line to the selection or change the selected line while you are entering points. The points will be offset from the currently selected lines.
11. Click Finish to finish the sketch and create the new feature.

Note: The Offset Line window does not populate COGO values. However, you can use the Update COGO Attributes command to achieve this.

Related Topics
About creating a line with the Traverse window

Saving an offset points file

This topic applies to ArcEditor and ArcInfo only.

An offset point file is generated when you save offset points. It can also be created manually for loading into the Offset Line window.

The following is a sample offset point file:

```
2 383.228 12 R
3 464.184 12 R
4 476.366 26.371 R
```

The offset point file consists of a single header line that describes the start distance for the offset line. Each subsequent line describes three parameters: distance from the start, offset distance, and the side on which the point is created.

Note: Loading from a sketch, rather than a file, is primarily intended to be used to recover from accidentally moving a vertex or other item in an edit sketch. To use this command, undo any modifications you made to the sketch, right-click the list on the Offset Points window, then click Load Offset Points From Sketch.

Steps:
1. Right-click the list on the Offset Points window and click Save Offset Points.
2. Navigate to the place where you want to save the points.
3. Type a name for the file.
4. Click **Save**.
5. To reload the points, right-click the list, click **Load Offset Points**, then browse to the text file.

### Splitting features into COGO lines

*This topic applies to ArcEditor and ArcInfo only.*

A COGO line is a feature that is either completely straight or completely circular. COGO lines are created when you use a number of the commands when editing. Sometimes you will want to convert lines with many segments into COGO lines. You can use the Split Into COGO Lines command to do this.

Each selected line feature is split at every vertex, creating a new feature for each segment. If you choose a feature template that refers to the same layer as the selected features, the existing features are split. If you choose one, new features are created using the properties of the feature template and COGO fields are populated.

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar.
2. Select the lines you want to split into COGO lines. These lines could be in a noneditable feature class, for example, a CAD dataset.
3. Click **Split Into COGO Lines** on the **COGO** toolbar.
4. Choose the target in which the new feature will be created.
   - If you have feature templates for the layers in your map, click the **Template** button and click the template to use to create the new feature. You can also double-click the preview of the template to choose a different template.
   - If you do not have feature templates, click the layer in which to create the feature.
5. Click **OK**.

### Updating COGO attributes

*This topic applies to ArcEditor and ArcInfo only.*

Update COGO Attributes calculates the coordinate geometry values for selected line features by inverting the geometry of the features. The values calculated include the direction and length for straight features, and curve characteristics, such as chord distance, chord direction, arc length, radius, tangent length, and side, for curved features. The current direction type and angular units are used when populating the attributes. The current coordinate system linear units are used when populating distance attributes.

The features must be either straight lines or circular arcs. They typically have two vertices, but more are allowed as long as each feature is consistently straight or consistently curved.

This command only works on line features that have the appropriate COGO attributes. A message appears when you try and use the command if these attributes are not present.

**Note:** Update COGO Attributes was known as Inverse prior to ArcGIS 9.2.

**Steps:**
1. Click the **Edit** tool on the **Editor** toolbar and select the features.
2. Click **Update COGO Attributes** on the **COGO** toolbar.

### Reporting COGO descriptions

*This topic applies to ArcEditor and ArcInfo only.*

One important phase required before you enter COGO boundaries is examining the existing boundaries in the geodatabase and determining how accurate they are. Over time as you build your parcel layers, each new parcel that is added could require the boundaries to be adjusted. Understanding how the existing parcels fit together is essential in guiding you on how you fit new parcels.

You can use the COGO Report command to measure COGO directions and distances for features in your database, as well as the directions and distances between points in your map. The table below shows the COGO descriptions on which you can report:

<table>
<thead>
<tr>
<th>Icon</th>
<th>COGO description</th>
<th>What it reports</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Icon" /></td>
<td>Direction and distance of a line</td>
<td>Reports the direction and distance between two points you click on the map.</td>
</tr>
<tr>
<td><img src="image2.png" alt="Icon" /></td>
<td>Angle between two lines</td>
<td>Reports the acute angle between three points you click on the map.</td>
</tr>
<tr>
<td><img src="image3.png" alt="Icon" /></td>
<td>Orthogonal distance between a line and a point</td>
<td>Reports the orthogonal distance and direction between two points you click on the map and a third point.</td>
</tr>
<tr>
<td><img src="image4.png" alt="Icon" /></td>
<td>Area between points</td>
<td>Reports the area and perimeter of a series of the points you click on the map. The boundaries of the area are always straight lines.</td>
</tr>
</tbody>
</table>
Steps:
1. Click the COGO Report button on the COGO toolbar.
   The COGO Report dialog box opens.
2. Click the button for the COGO description you want to report.
3. Click on the map one or more times, following the directions on the COGO Report dialog box.

   Directions are reported in the current direction type and units. Distances are always reported in the units of the map’s spatial reference. If you currently have a ground to grid correction set, both the grid and ground COGO descriptions are displayed.

Tip: You can press the SPACEBAR to repeat the click on the previous report button. This saves you from moving the pointer back to the COGO Report dialog box to click again with the mouse.

Related Topics
- Calculating COGO area
- Calculating COGO curve parameters

Calculating COGO curve parameters

This topic applies to ArcEditor and ArcInfo only.

When you enter curves for a line or a polygon, you need to provide at least two curve parameters to create the curve segment. Occasionally, you might want to know what all the parameters are or calculate missing parameters.

The Curve Calculator lets you determine the complete characteristics of a curve from two known parameters. This illustration shows the parts of a curve:

- Chord—Also referred to as the chord distance, the straight line distance between the endpoints of the curve.
- Angle—The angle formed between the endpoints of the curve and the center point.
- Arc—The length along the curve.
- Radius—The length from the center point to the curve.
- Tangent—The distance between the endpoint and the point of intersection. The point of intersection is determined by intersecting a perpendicular line from each of the endpoints of the curve.
- Chord height—Also referred to as the arc height, this is the distance between the curve and the chord segment.

There are several cases where the curve calculated is based on an angle greater than 180°:

- The angle is greater than 180°.
- The chord distance is greater than the arc length.

In these cases, the tangent distance is negative and represents the point of intersection on the opposite side of the curve.

Steps:
1. Click Curve Calculator on the COGO toolbar.
2. Click the drop-down arrows and choose two parameters to determine the curve.
3. Type the appropriate values for the parameters. Angles are reported in the current direction type and units. Distances are always reported in the units of the map’s spatial reference.
4. Click **Calculate**. The curve is calculated and shown in the list below the **Calculate** button.

### Related Topics
- Calculating COGO area
- Reporting COGO descriptions

---

**About calculating COGO area**

*This topic applies to ArcEditor and ArcInfo only.*

When you initially create parcel boundaries, you need to ensure that the geometries form closed polygons. Over time, as you build your parcel layers, each new parcel that is added could require the existing boundaries to be adjusted. The result can be that the area you calculate from the parcel boundary geometries may start to differ from the legal area—the area you calculate from the parcel boundary attributes. You can use this difference to check whether the parcel boundaries in ArcGIS (left image) accurately represent the original legally defined shape (right image). While the geometry of the boundaries may change, the attributes you read from the original legal document should remain unchanged.

You can use the COGO Area command to calculate the area for selected COGO lines. To enable the COGO Area command, you must do the following:

- Ensure each line feature has valid COGO values.
- Ensure each line feature is a COGO line that is either completely straight or completely circular.
- Select line features that form a single closed polygon shape.
- Ensure the geometry of the selected lines.

If the selected lines do not satisfy these conditions, you need to correct the problem before you can open the COGO Area dialog box. For example, union the selected lines into another line feature class and double-click to modify the shape. Make sure there is only a single part, and the coordinates of the start point are the same as the end point.

To calculate the area, the COGO Area command arranges the selected lines into an adjacent order and creates a traverse from the COGO attributes. Since it is possible, and quite likely, the traverse from the COGO attributes will not form a closed polygon, you need to specify a method for closing the polygon.

### COGO Area report

The report lists a number of aspects:

<table>
<thead>
<tr>
<th>Reported item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lines: 6</td>
<td>Number of selected lines</td>
</tr>
<tr>
<td>Grid - Area: 10466.7 Square Feet Perimeter: 418.4 Feet Ground - Area: 10477.1 Square Feet Perimeter: 418.6 Feet</td>
<td>Grid Area and Perimeter: Calculated by creating a polygon from the geometry of the selected lines. Ground Area and Perimeter: If there is currently a ground to grid correction, these are calculated by dividing the grid area and perimeter by the distance factor.</td>
</tr>
<tr>
<td>Attribute Length: 418.4 Mislosure As Direction/Distance: 148-34-29, 0.1 Relative Error Ratio: 1:21977</td>
<td>Attribute Length: Calculated as the sum of the DISTANCE attribute values when the feature is straight or the ARCLENGTH attribute values when the feature is a circular arc. Misclosure As Direction/Distance: The line between the calculated endpoint of the traverse and the start point of the traverse. Relative Error Ratio: The misclosure length/attribute length.</td>
</tr>
<tr>
<td>Adjustment Method: Compass Attribute Ground - Area: 10467.8 Square Feet Perimeter: 418.4 Feet Attribute Grid - Area: 10457.4 Square Feet Perimeter: 418.2 Feet</td>
<td>Attribute Ground Area and Perimeter: The area of the adjusted traverse. Attribute Grid Area and Perimeter: If there is currently a ground to grid correction, these are calculated by multiplying the grid area and perimeter by the distance factor.</td>
</tr>
</tbody>
</table>

**Sample COGO Area report**

When there are differences between the COGO attributes and the geometry

The outline of the adjusted traverse is drawn over the selected lines. You can use this outline to help you understand how well the COGO attributes fit to the geometry of the selected lines.

The table below shows some of the common problems and what you can check for to try to solve them.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>The outline is exactly the same shape as the selected lines, relative error ratio is small (1:10,000 or smaller), and the attribute ground area is close to the grid area (within several feet).</td>
<td>The COGO attributes match closely to the geometry of the selected lines.</td>
</tr>
<tr>
<td>The outline is exactly the same shape, but it appears rotated or smaller/larger than the selected lines.</td>
<td>Check that the ground to grid correction is correctly set to the values you used when you entered the boundaries.</td>
</tr>
<tr>
<td>The relative error ratio is small (1:10,000 or smaller), but there is a large difference between the attribute ground area and the grid area.</td>
<td>Check that the ground to grid correction is correctly set to the values you used when you entered the boundaries.</td>
</tr>
<tr>
<td>The outline is generally the same shape as the selected lines, but there are obvious differences. Also, the relative error ratio is large and there is a large difference between the attribute ground area</td>
<td>Check the attributes of the selected lines. Look for large differences between the Shape_Length and the DISTANCE values for lines and ARCLENGTH value for curves. Also, check that the direction of the selected lines is not flipped.</td>
</tr>
</tbody>
</table>
Ways to handle cases where there are differences between the COGO attributes and the geometry

<table>
<thead>
<tr>
<th>Ways to handle cases where there are differences between the COGO attributes and the geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>The outline is very different from the shape of the selected lines.</td>
</tr>
<tr>
<td>Check that the direction type and direction units are correct for the selected line features. Also, check for gross errors in the attributes of the selected lines.</td>
</tr>
</tbody>
</table>

Related Topics

Calculating COGO area

This topic applies to ArcEditor and ArcInfo only.

Steps:

1. Click the Edit tool on the Editor toolbar.
2. Click the line features for which you want to calculate an area.
3. Click COGO Area on the COGO toolbar. The COGO Area dialog box appears and describes the area of the selected lines.

Tip: To select the line features surrounding a parcel polygon, you can select the polygon, then use the Select By Location dialog box. There are several different selection methods you can use, including the Share a Line Segment With method or the Are Completely Within method with a small buffer tolerance.

Related Topics

About calculating COGO area
Calculating COGO curve parameters
Reporting COGO descriptions

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