Exercise 4: Spatial Reference

In this exercise you will:
- Determine and change the spatial reference of your data
- Determine and change the spatial reference of your data frame
- Learn troubleshooting skills when projecting data.

Spatial referencing is tricky. One of the main complications is that so many different coordinate systems are used in developing data. Understanding the relationship between your data, the data frame, and the spatial referencing systems of the two can get complicated.

To better understand this idea, assume that you were to measure your classroom and each student was given the coordinates of their seat. Your seat might be 20 feet from the side wall and 15 feet from the front of the classroom, so your coordinate would be at (20,15). Your friend, sitting next to you, was at (25,15). Most spatial data has coordinate values. In this example, your coordinate is based on feet within your classroom.

You then went outside to a huge field that had been marked off every yard. The grid was numbered with (0,0) being in the northwest corner. Each of the students then went to stand at their coordinate. Would you be the same distance from your classmates? No. What if your class was then assigned to go to their coordinates based on latitude and longitude. It would be costly field trip, but most of your class would end up spread across Africa.
So you each had coordinates, but the coordinate system, or, as ArcGIS calls it, the spatial reference was much different between being inside the classroom or out in a huge field or over the entire world.

Your data is no different. If your data has coordinate values, but does not have an assigned spatial reference, then it will project itself in whatever spatial reference is being used in the data frame.

One of the most frustrating things that happens as you begin to add data to an ArcMap document is when all of your data is together, but one layer is way off in the distance. (Remember when you were trying to find your seat in class, but ended up off in Africa?) The table below should be helpful in determining the condition of your data and what you may need to do to correct your data if the spatial referencing in giving you trouble.

### Does your data have...

<table>
<thead>
<tr>
<th>...real-world coordinate values?</th>
<th>...a spatial reference (coordinate system)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

- **Yes, Yes**
  - Your data will automatically project correctly, regardless of the data frame projection.

- **Yes, No**
  - Data will project, but maybe not in the right location. It will project using its coordinate values but use the coordinate system of data frame. You need to assign your data a spatial reference.

- **No, No**
  - Your data is probably a scanned image or data that was generated without spatial reference. For vector data, you will need to use *Spatial Adjustment*. For raster data, you will need to use *Georeferencing*.
Determining the spatial reference of data

1. Open ArcCatalog and navigate to your data.
2. Right click the data layer in the catalog tree and select Properties.  
   This will open the Data Properties dialog box. The following steps apply to vector data. For raster data, simply scroll down the section entitled Spatial Reference.
3. Click the XY Coordinate System tab.  
   Your spatial reference will appear in the pane on this page. If the spatial reference name is given as Unknown, you will need to assign a spatial reference, as outlined in the next task.
4. Click OK to close the Data Properties dialog box.
Assigning a spatial reference to data

If your spatial data does not have an assigned spatial reference, you will need to assign one. The spatial reference you use must match the coordinate system of the data. If you do not know the spatial reference of the data, you may need to return to the source of your data or refer to a look-up guide as outlined later in this exercise.

1. On the Data Properties dialog box, click Select. This will open the Browse for Coordinate System dialog box with an Open dialog, jumping directly to a file containing most pre-defined spatial reference systems.

   The files are organized based on Geographic or Projected. Geographic deals mainly with Cartesian, or latitude/longitude coordinate systems. Projected deals mainly with UTM, State Systems, and other, regional projected systems.

2. Navigate to the spatial reference for your data and select the spatial reference system.

3. Click Add to assign the specific spatial reference system to your data.

4. Click OK on the Data Properties dialog box to close the Data Properties dialog box.

If you are aware of another spatial data file that uses the same spatial reference, you may import that spatial reference system using the Import button on the Data Properties dialog box.

Typically, only advanced users will generate a new spatial reference system using the New button.
Changing the spatial reference of data (Project)

If your data has a spatial reference assigned, but you would like to have it in a different spatial reference, use the Project tool in ArcToolbox to change the spatial reference of the data set.

1. In ArcToolbox, Click the Show ArcToolbox Window button found on the Standard toolbar. An Additional window will open, displaying ArcToolbox.
2. In ArcToolbox, Navigate to the Data Management Tools toolbox / Projections and Transformations toolset/ Features tool set.
   You will notice that the Projections and Transformations toolset is organized based on tools for Features or Rasters. Features refers to vector-based data.
3. Open the Project tool by double clicking the tool name.
4. Specify the data set you wish to modify in the Input Data set or Feature Class field.
5. Specify the name and the file path for the new re-projected data set you wish to create in the Output Data set or Feature Class field.
6. Specify the new spatial reference system you wish to use to re-project your data set.
7. Click OK to begin the geoprocessing function.
Determining the spatial reference of your data frame

1. Open your ArcMap document.
2. Right click the data frame name and select Properties. By default, the data frame name is “Layers”. The Data Frame Properties dialog box will open.
3. Click the Coordinate System tab. The spatial reference of the data frame will be displayed.

Helpful Hint
A new ArcMap data frame has no default spatial reference. The data frame adopts the same spatial reference as the first layer you add to the data frame.
Assigning and changing the spatial reference of your data frame

1. Open the Data Frame Properties dialog box and click the Coordinate System tab.
2. Navigate to and select the coordinate system you wish to use in the Select a Coordinate System pane.
3. Click Apply to change the data frame coordinate system or click OK to apply the changes and close the data Frame Properties dialog box.

Helpful hints
- If you would like to use the same spatial reference as a layer in your ArcMap document, you may select that layer in the Layers folder, found in the Select a Coordinate System pane.
- If you would like to import a spatial reference from another data set not used in the ArcMap document, use the Import button found on the right side of the window.
Establishing a look-up guide for coordinate systems

As you attempt to determine the spatial reference of your data set, you may not have access to any information that will indicate to you what spatial reference system is used.

You may wish to establish a look-up guide, indicating the coordinates of a predominate feature using many different coordinate systems.

With such a look-up table, you will be able to find that predominant feature in your data while previewing in ArcCatalog. The “unknown” coordinate values will appear in the lower right corner of the application. Comparing the coordinates of the data set with your look-up table, you should be able to determine the spatial reference of the data set.

1. Open an ArcMap document and add a layer that displays the predominant feature.
   For a county, this might be a specific corner of the county, a geographic feature, or other feature highlighted on most county data.

2. Scroll your cursor over the predominate feature and make note of the coordinate values displayed in the lower right corner of the application.

3. On the Data Frame Properties dialog box, make note of the coordinate system being used.
   You now know the coordinates of that predominant feature using that specific spatial reference.

4. Modify the coordinate system for the data frame to another, commonly used system.

5. Repeat steps 2 to 4 until you have a look-up guide for all of the major coordinate systems used in your area.