EXERCISE 1: EXPLORE THE SPATIAL ANALYST INTERFACES

This exercise introduces you to each of the seven interfaces that may be used to run Spatial Analyst tools. Limited instruction is provided for the tools you will use; they will be covered in detail in later lessons

STEP 1: EXPLORE THE DESKTOP ADMINISTRATOR

In this step, you will use the ArcGIS Desktop Administrator utility to determine if you have a Spatial Analyst extension available for use and to determine your ArcGIS product (Arclnfo, ArcEditor or ArcView).

- □ Exit any ArcGIS applications that are running.

- □ On your desktop, click *Start> Programs > ArcGIS> Desktop Administrator.*

The tree on the left shows the ArcGIS Desktop with your computer name and three folders beneath it. When you click a tree entry, the right panel displays information about the selection. Review the information for each tree entry.

- □ Click each entry in the tree and for each, read the information in the right panel. Then answer the questions below.

NOTE: The answers to all questions are found at the end of the exercise.

Question 1: Where is your Application Data Folder?_____
Hint: Click ArcGIS Desktop.

Question 2: How many Spatial Analyst extensions are available?_____
Hint: Click Availability.

You can learn more about the Desktop Administrator by clicking Help. One of the more interesting topics is evaluating an ArcGIS extension, which tells you how to enable a free time-limited evaluation copy of an extension you have not purchased.

- □ Click *Cancel* to close the *ArcGIS Desktop Administrator*.

STEP 2: ENABLE THE SPATIAL ANALYST EXTENSION

In this step, you will start ArcMap, open an existing map, and enable the Spatial Analyst extension.

- □ Start *ArcMap* with *A new empty map*.

- □ On the *Standard toolbar,* click the *Open* button.

- ☐ In the Open dialog, browse to and open *C:\Student\SPAG\Exercise2\Ex02.mxd*.

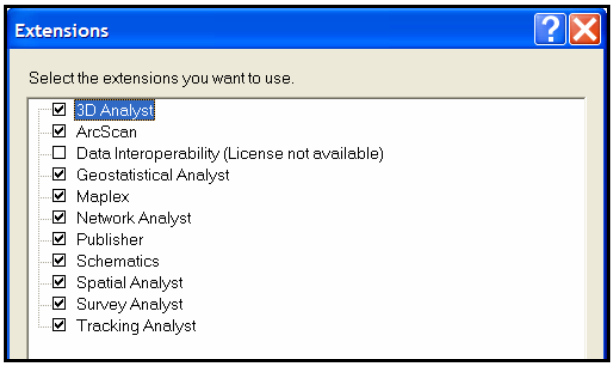
You will use the raster Elevation layer as input to the surface analysis tools you will run in this exercise. It references the ...\SPAG\Database\Tahoe\Base\All\arelev grid, in which each cell stores its elevation in meters. The map also contains a Visual Basic for Applications (VBA) script that you will run later.

Here are two quick methods of determining your ArcGIS product license that do not require using the Desktop Administrator; checking the application windows title bar, and checking the "About" help.

- ☐ Note the product in the ArcMap window title bar (Arclnfo, ArcEditor, ArcView).
- ☐ On the *ArcMap Main Menu* bar, click *Help > About ArcMap*.
- ☐ Note the *License Type* in the *About ArcMap* dialog.
- ☐ Click *OK* to close the *About ArcMap* dialog.

You must enable ArcGIS extensions the first time you use them. ArcGIS automatically tries to check out floating licenses for the extensions you have enabled when you start applications, like ArcMap, and releases them when you exit all your open applications.

- ☐ On the *Main Menu* bar, click *Tools> Extensions*.
- ☐ Check the *Spatial Analyst* check box.
- ☐ Click *Close* to close the *Extensions* dialog.

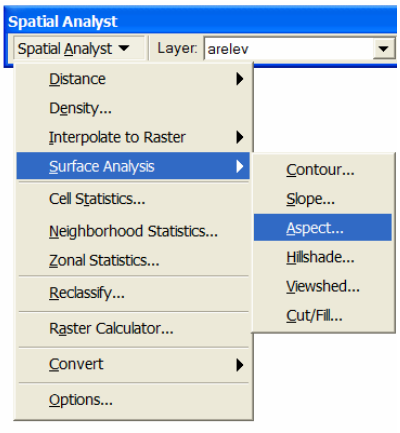


STEP 3: USE THE SPATIAL ANALYST TOOLBAR

In this step, you will use the Spatial Analyst toolbar to set an environment parameter and to run two tools. First add the toolbar.

☐ On the *Main Menu*, click *View> Toolbars > Spatial Analyst*.

☐ Dock the *Spatial Analyst toolbar* on the *ArcMap interface*, if you want.

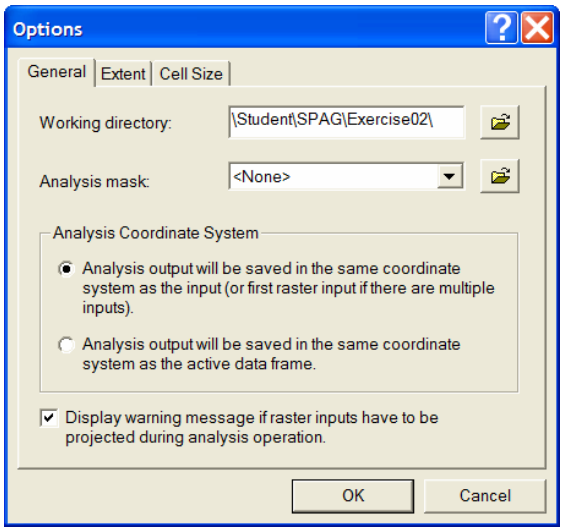


Most of the functionality of the Spatial Analyst toolbar is found under the Spatial Analyst pulldown. You use it to open dialogs for the most commonly used tools. Choices like Surface Analysis that are marked with an arrow represent a group of related tools. All other entries open a tool dialog.

☐ On the *Spatial Analyst toolbar*, click *Spatial Analyst*.

☐ Slowly move the pointer over each menu choice. Do not click any of the tools.

The Options choice opens a dialog in which you set environment parameters that control how new rasters are created—their cell size, extent, and so on. These environments are normally set before you start any analysis.



Next you will open and run the Hillshade tool.

☐ Click *Spatial Analyst> Options*.

☐ Click each tab and briefly review the environments they set.

The only environment you will set is the Working directory, so that new rasters are created in your Exercise02 folder. The other environments will be presented in the next lesson.

☐ On the *General* tab, set the *Working directory* to your *Exercise02 folder*.

☐ *Click OK* to close the Options dialog.

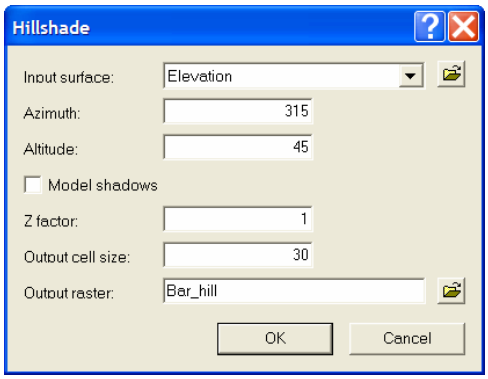
- ☐ Click *Spatial Analyst> Surface Analysis > Hillshade.*

The Hillshade dialog is typical of a Spatial Analyst toolbar tool. The dialogs have various controls for setting tool parameters, like browsers for input and output data, text boxes, check boxes, and so on.

Most parameters will have default values, like Azimuth and Altitude in the graphic. The dialogs provide help for parameters, but you must use the ArcGIS Desktop Help for details or to learn about the tool itself.

The Hillshade tool will be discussed in a later lesson, but briefly it "illuminates" a surface to create shadows, resulting in map that has the illusion of depth. Now set the Input surface and the Output raster parameters and run the tool.

- ☐ In the *Hillshade dialog*, click the *Help* button and then click *Azimuth*.
- ☐ For the *Input surface*, choose the *Elevation layer*.
- ☐ For the *Output raste*r, overtype the <Temporary> entry with ***Bar_Hill***
- ☐ Click *OK*.



Like most other Spatial Analyst toolbar tools, the Hillshade tool automatically added the output raster to the Table of Contents as a new layer.

- ☐ Examine the map of the output *Bar_Hill* layer.

A nice feature of Spatial Analyst tools is that they usually assign appropriate symbols and legends to their outputs. This is best illustrated by the Aspect tool (it calculates the orientation of cells relative to north for a surface).

- ☐ Run the Aspect tool with the *Elevation layer* and name the output ***BarAsp***
- ☐ Review the ***BarAsp*** legend, noting that the aspect directions are named.
- ☐ Turn off all layers and collapse their legends.

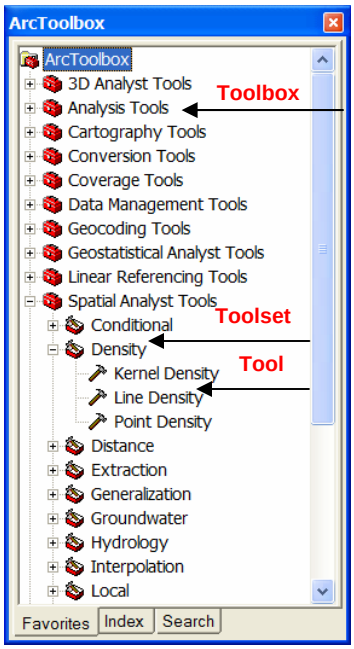
STEP 4: USE THE ARCTOOLBOX

In this step, you will use the ArcToolbox to run and manage ArcGIS tools. ArcToolbox is the central application in the ArcGIS geoprocessing framework. In addition to using it to run any of the hundreds of vector and raster processing tools, you also use it to manage

the tools. You can create your own toolboxes and copy tools into them, create your own tools from models and scripts, and export toolboxes for others to use.

- ☐ On the *Standard toolbar*, click the *Show/Hide ArcToolbox* Window button.

The ArcToolbox organizes the geoprocessing tools into toolboxes and toolsets. Extensions like the Spatial Analyst have their own toolboxes, even if they are not enabled—the tools just will not run. Now spend a few minutes exploring the ArcToolbox.



- ☐ Expand several toolboxes and their toolsets. Do not run any tools.
- ☐ Collapse all the toolboxes and toolsets when you are done.
- ☐ Expand the *Spatial Analyst Tools* toolbox and several of the toolsets it contains.

As you can see, there are a great many Spatial Analyst tools. By the end of this class, you will know how to use most of them.

Question 3: Can you clip a raster dataset?_____
Hint: Look in the Data Management Tools toolbox.

- ☐ Collapse all the toolboxes-and toolsets except *Spatial Analyst Tools> Surface.*

Before you use a tool, you should set the appropriate geoprocessing environments. These environments are not shared with the Spatial Analyst toolbar, which predates the ArcGIS geoprocessing framework. The Environments dialog may be opened from a context menu in the ArcToolbox.

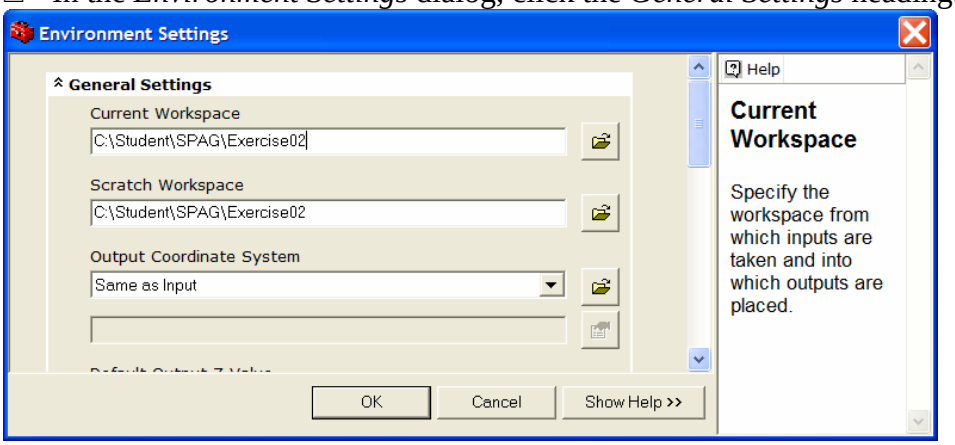
- ☐ Right-click in the *ArcToolbox* background, away from any tools.

The context menu has choices to create new toolboxes, add toolboxes, and so on. You will perform these operations later. Right-clicking on toolboxes, toolsets, and tools raises context menus with other choices. For example, there are options to copy and paste tools from one toolbox to another.

- ☐ Click *Environments* in the context menu to open the Environments Settings dialog.

The geoprocessing framework has more environments than does the Spatial Analyst toolbar because it includes those used for vector processing as well. The environments you set here are used by all geoprocessing tools, whether you run them in ArcToolbox, the Command Line, in the Model Builder, or in a script. The dialog organizes the environments under headings, like General Settings.

☐ In the *Environment Settings* dialog, click the *General Settings* heading.



☐ For *Current Workspace*, use the browser to select your *Exercise02* folder. This folder is searched for input datasets and new datasets are written to it.

☐ For *Scratch Workspac*e, use the browser to select your *Exercise02* folder. This folder is used to store temporary datasets.

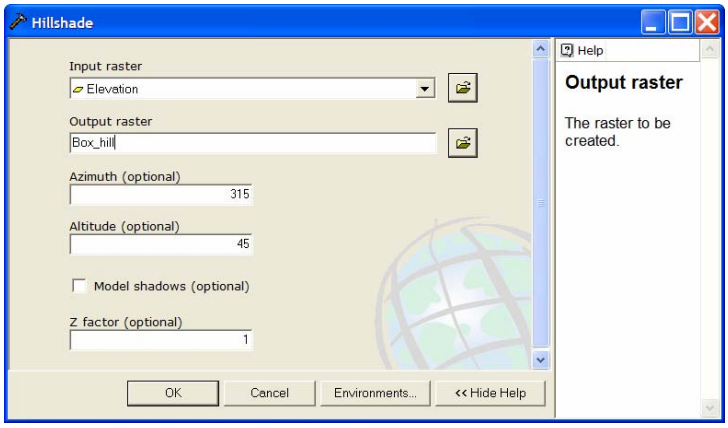
☐ Click in several dialog controls and observe how the *Help* area changes.

☐ Click ***OK*** to close the *Environment Settings* dialog.

Environment settings are stored in the ArcMap MXD file if you save your map. Also, the ArcToolbox context menu has choices for saving and loading settings from a file if you want to use them in other ArcMap or ArcCatalog sessions.

Running an ArcToolbox tool is easy; you find the tool, double-click it to open its dialog, fill in the dialog, and run it. Now you will run the Hillshade tool.

☐ Double-click *Spatial Analyst Tools> Surface > Hillshade*.



A green dot next to a parameter name indicates that the parameter is required; the dot disappears when you provide a value for the parameter. Tool dialogs have a help area that describes a parameter when you click its control. Also, you can use the dialog to open the ArcGIS Desktop Help for the tool.

- □ In the *Hillshade dialog*, click *Help* to open the ArcGIS Desktop help.
- □ Briefly review the Hillshade help; then close the ArcGIS Desktop Help window.
- □ In the *Hillshade dialog*, set the *Input raster* to **Elevation**.

Notice that the dialog automatically created a name for your output raster, and that it used the path name you had set for the Current Workspace environment. If you need to, you can override environment settings for a tool by clicking the Environments button, but the changes only apply to the tool you are running.

- □ In the *Hillshade dialog*, overtype the *Output raster* path with **Box_Hill**
- □ In the *Hillshade dialog*, click *OK* to run the tool.

Notice that as the tool runs, its progress is displayed in another dialog.

- □ Review the contents of the Hillshade status dialog; then close it.
- □ Turn off the new *Box_Hill layer* and collapse its legend.

The large number of geoprocessing tools may make it challenging to find the tool you want. Fortunately, the ArcToolbox has features to help you find tools.

- □ In the *ArcToolbox*, click the *Index* tab.

The Index tab displays an alphabetized list of all the tools. Spatial Analyst tools have "(sa)" after their name.

- □ Scroll to the bottom of the list.
- □ In the *Type in...* field, type the first letters of **ASPECT** (the field is not case sensitive).

Once you have found the tool you are looking for, you start it by double-clicking its name. If you do not remember the name of a tool, you can use the Search tab to type in key words that may help you to find it.

- □ In the *ArcToolbox*, click the *Search* tab.

You can type in key words in the top text box that might be related to the tool you want. The key words may or may not appear in the tool name.

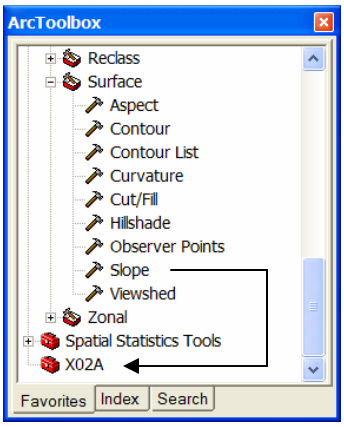
- ☐ In the *Type in...* field, type surface and click **Search**.

The tools that meet your criteria are shown in the list control. You can double-click the tool you want to run, or you can find its location in the ArcCatalog tree.

- ☐ Select the Slope tool that is in the *Spatial Analyst Tools* toolbox and click *Locate*.

After you clicked Locate, the ArcCatalog switched back to the Favorites tab, where it selected the tool for you in the tree, opening toolboxes and toolsets as needed. As the last task in this step, you will create a new toolbox with a new toolset and copy a tool into it. This feature helps you to organize your frequently used tools. You can not, however, modify any of the standard toolboxes.

- ☐ In the *ArcToolbox*, click the *Favorites* tab, if necessary.
- ☐ *Right-click* in the *ArcToolbox* and click *New Toolbox* in the context menu.
- ☐ Rename the new toolbox **X02A** (Right-click on the new toolbox, if necessary)
- ☐ *Right-click X02A* and click *New> Toolset*.
- ☐ Rename the new toolset **MyTools**
- ☐ Right-click S*patial Analyst Tools* > *Surface*> *Slope* and click *Copy*.
- ☐ Right-click *X02A* > *My Tools* and click *Paste*.
- ☐ Expand your *X02A* > *MyTool*s toolset.



The context menus for toolboxes and toolsets have various management options, like choices to rename them or delete them. Also, toolboxes have an Edit Documentation choice for setting metadata about themselves and the toolsets and tools they contain. Your new toolbox is stored in your Application Data folder as a file called XO2A.tbx (see the answer to Question 1). You could share your toolbox with other users if you wanted. You will learn more about managing tools with the ArcToolbox a little later.

- ☐ Close the ArcToolbox window.

STEP 5: USE THE COMMAND LINE

In this step, you will use the Command Line window to run a Spatial Analyst tool and to explore some of its capabilities. Each geoprocessing tool in the ArcToolbox has a corresponding command, which is what you use when you write scripts. Models and scripts that you add to the ArcToolbox can be ran as commands as well.

- ☐ On the Standard toolbar, click the *Show/Hide Command Line* Window button.

You type commands and their parameters in the command area at the top. Messages appear in the message area at the bottom as the command executes. You may drag the bar between them to resize the areas.

An important feature of the Command Line is code completion. That is, various aids appear as you type a command and its parameters. A command list appears when you type the first character, and the first matching command is selected in the list. The selection changes as you type more characters. You may select a command by clicking it, if you want. You enter a selected command with the Tab key, by double-clicking it, or just by finishing typing it in.

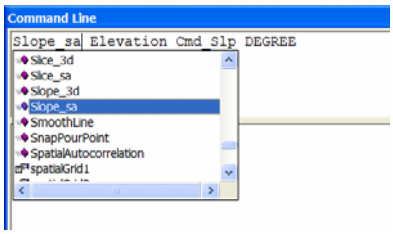
> Note: The command list also contains all the geoprocessing environments, like spatial Grid I in the graphic above. You may set environments in the command line by entering the environment name and a value, like this: *Workspace C:\Student\SPAG\Exercise02*

> Note: You can drag tools from the ArcToolbox and drop them into the command area. This is a quick way to discover the command name for a tool, which is sometimes different (shorter) than the tool name.

A message box appears showing the command syntax. As you type, the current parameter becomes highlighted. Required parameters have "<xxx>" delimiters, like <in_raster>, and optional parameters have "{xxx}" delimiters, like {z_factor}.

Pulldown lists appear for parameters that expect input datasets or keywords. You may double-click a choice from the list, or type enough characters to match the choice you want and press the Tab key to enter the choice. Now run the Slope command.

- ☐ Type the command **Slope_sa Elevation Cmd_Slp DEGREE**, using the code completion features as you want (the dialog is not case sensitive).
- ☐ Press the *Enter key* at the end of the line to run the command.



> Note: You can type multiple commands in the Command Line window. Press Shift + Enter at the end of each line and then Enter after the last line.

Messages appear in the bottom half of the window as the command processes. The messages repeat the syntax, show the start and end time, and the elapsed time.

□ Scroll to the top of the *message area*.

Notice that the command line you typed is in a different color. You may recall commands that have been previously issued.

□ In the *message area*, double-click *Slope_sa Elevation Cmd_Slp DEGREE* (the command line should be in blue).

You may edit the parameters and rerun the command, if you want. If the Command Line window is open; it will show messages from all the tools ran from the Command Line, the ArcToolbox, or in a model. Context menus may be raised in the command area and in the message area by right-clicking. Text editing options like Cut, Copy, Paste, Clear, Select All, and Replace are found in both areas. Also, both areas have a Format option for controlling the text font.

In the command area, the Save As option lets you save a command to a text file—before you run it—which you may later load to run again. You may create variables for use in commands with the Insert Variable option, like the path to a specific dataset. You manage the variables you create with the Variables option.

In the message area, the Recall option is the same as double-clicking a command in the message area; it reloads a command into the command area. The Open option opens the tool dialog for the selected command. The Show History option opens the Model Builder in which each command you have ran appears in the model.

□ Close the *Command Line* window.

□ Turn off all layers and collapse their legends.

STEP 6: USE THE MODEL BUILDER

In this step, you will use the Model Builder to build and run a simple model. Creating a model is perhaps the easiest way to design and run a complex series of geoprocessing tasks-without doing any programming. The Model Builder is a visual environment into which you drag and drop geoprocessing tools and datasets. You connect datasets and tools together into a processing flow, set parameters for the model elements, save the model, and run it. The greatest benefit is that you can easily edit a model and run it again.

You create a new model in ArcToolbox by right-clicking on a toolbox or toolset that you have previously added (you cannot modify the standard toolboxes).

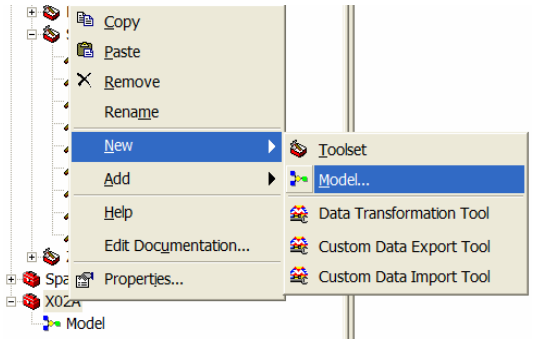
□ Open the *ArcToolbox* window.

□ *Right-click* on your *X02A* > *MyTools* toolset.

□ Choose *New* > *Model* from the context menu.

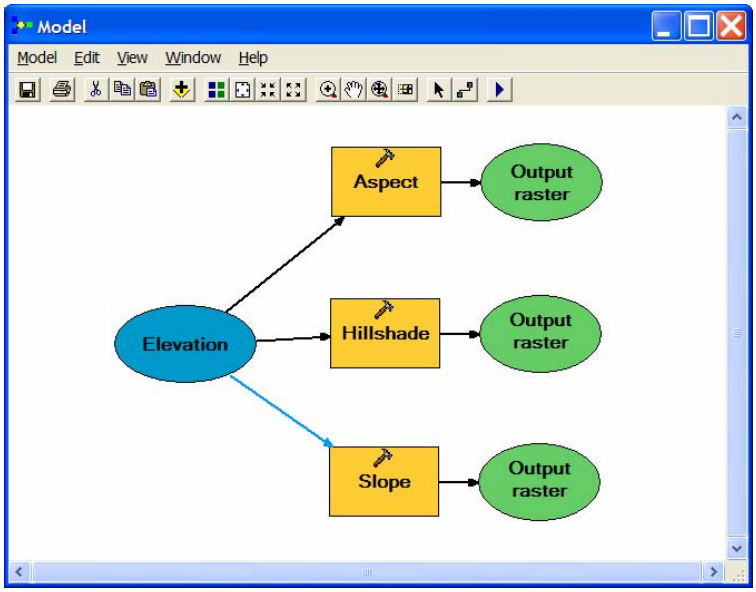
The Model Builder window has a menu bar and a toolbar. The tools are identified in the graphic above (there are no ToolTips). You build a model by dragging and dropping data from ArcCatalog or ArcMap into the window, and tools from ArcToolbox.

- ☐ From the ArcMap Table of Contents, drag and drop the *Elevation layer* into the model.
- ☐ From the *ArcToolbox*, drag the *Aspect, Hillshade, and Slope* tools into the model.



Model elements are unshaded until they have enough information to run. The tools in your model will be shaded after you connect them to the input Elevation dataset.

- ☐ In the *Model window* toolbar, click the *Add Connection* button.
- ☐ In the model, click the *Elevation* dataset and then the *Aspect tool*.
- ☐ Now connect *Elevation* to both the *Hillshade and Slope tools*.



You can arrange the model graphically by selecting and dragging and dropping model elements.

- ☐ In the *Model window* toolbar, click the *Select* button
- ☐ In the model, drag a box over the *Aspect tool* and its output dataset to select them.
- ☐ In the model, drag the selected elements to move them.

- ☐ Arrange your model so that it is similar to the graphic above.

All model elements have context menus that appear when you right-click them. You will now use the context menus to rename the output dataset elements.

- ☐ *Right-click* on the *Aspect output* and rename it to **output Aspect**

- ☐ Rename the other two outputs: **Output Hillshade** and **Output Slope**

Double-clicking a tool opens its dialog interface, which is how you set its parameters, or you may right-click a tool and choose the Open option from the context menu.

Question 4: Can you run individual tools without running the whole model?_____
Hint: Right-click on a tool.

You could run your model now, but the dataset names are built into it. You may mark them as parameters so that you will be prompted for them when you run the model.

- ☐ *Right-click* on *Elevation* and click *Model Parameter* in the context menu.

- ☐ Also set *Output Aspect*, *Output Hillshade*, and *Output Slope* as parameters.

Model outputs are not added to the map by default; you must indicate which outputs should be automatically added.

- ☐ *Right-click* on *Output Aspect* and select *Add to Display* from the context menu.

- ☐ Repeat the above action for *Output Hillshade* and *Output Slope*.

There are still some properties you could set to make your model more user-friendly, like a better name, but it is good enough the way it is. Now save your model and run it.

- ☐ In the *Model window* menu bar, *click Model > Save*; then *close* the Model window.

- ☐ In the *ArcToolbox*, double-click *X02A>MyTools > Model*.

Models use standard tool dialog interfaces. The datasets that you marked as parameters are displayed.

- ☐ Set the *Elevation layer* as the *input*.

- ☐ Set the outputs to **Mdl_Asp**, **Mdl_Hill** and **Mdl_Slp**

- ☐ Click *OK* to run the model.

- ☐ Review and then close the status dialog.

- ☐ Turn off all layers and collapse their legends.

STEP 7: USE A SCRIPT

In this step, you will create and run a simple script. Scripting is an efficient way to turn a complex workflow into an easy-to-use tool. Scripts can incorporate loops and conditions (IF tests) to make them more flexible.

Instruction in writing scripts is beyond the scope of this class, so you will create a script by exporting your model to Python. Then you will add it to the ArcToolbox and give it a standard tool dialog interface. Start by editing your model.

- ☐ In the *ArcToolbox*, right-click on *X02A* > *MyTools* > *Model* and choose *Edit*.

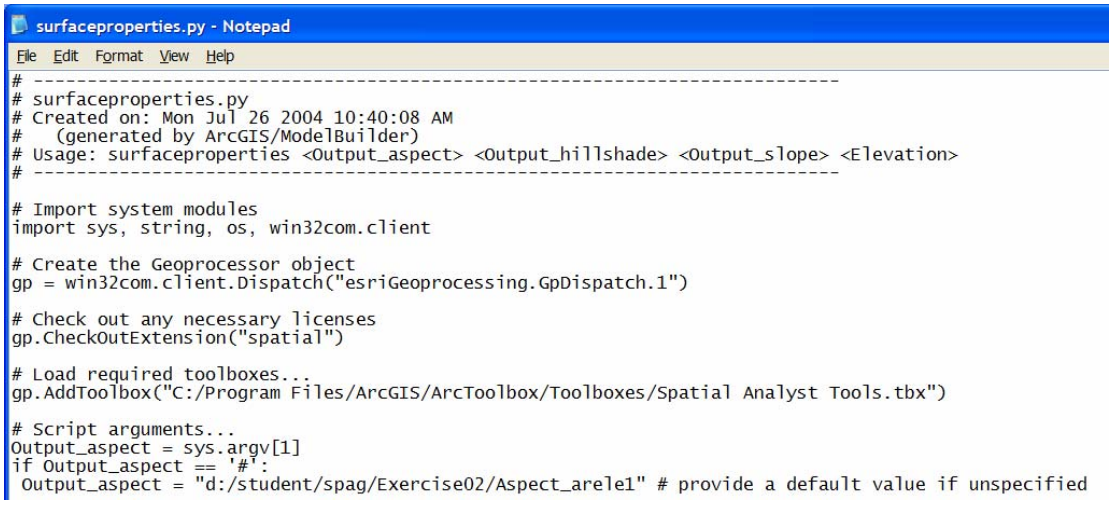
- ☐ In the *Model window*, click *Model* > *Export* > *To Script* > *Python*.

- ☐ In the *Save As* dialog, save the script as..*Exercise02****SurfaceProperties.py**

Note: You can write scripts in many languages, like Python, JScript, and VBScript. Scripts are text tiles and can be written or edited in any text editor, although most languages provide specialized editors like PythonWin.

- ☐ Close the Model window without saving the changes.

- ☐ Start *Windows Notepad* and open your ..*Exercise02**SurfaceProperties.py* file.



Take a moment to review the script. Like most, it starts by importing some standard code modules, like win32com.client. Then it creates the geoprocessor object and names it "gp". This is the object that implements the ArcGIS geoprocessor commands, like Slope_sa. The script has code to read arguments from the command line because you had marked the input and output datasets as parameters in the model; otherwise, the actual dataset names would have been used in the script. At the bottom of the script, you see the code that runs the Spatial Analyst commands.

- ☐ Exit *Windows Notepad*.

You could run your script from the Windows command line, entering the input and output dataset names as arguments, like this:

C:\Surfaceproperties.py "C:\arelev" "C:\outasp" "C:\outhil" "C:\outslp"

Hint: This assumes that the script and data are in the root directory of your C drive.

Some of the disadvantages of running the script from the command line are that it has no code to test the arguments for errors (you could add such code) and that it cannot use a layer name for the input elevation dataset, and of course, the script has no dialog interface to make it easy to use.

Installing a script as a tool in the ArcToolbox solves these problems. It will have a standard dialog interface, and the dialog will check the arguments (you must define a parameter for each argument). Now install the script using the Add Script wizard.

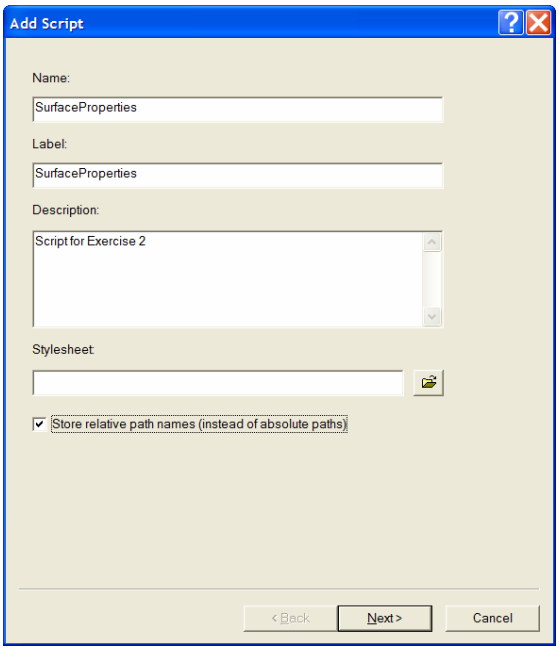
- ☐ In the *ArcToolbox*, right-click on *X02A > My Tools* and click *Add>Script*.

- ☐ For Name, type **SurfaceProperties** (no spaces).

This will be the scripts command name for use in the Command Line and other scripts.

- ☐ For Label, *type* **Surface Properties** (include the space).

This will be the tool name that appears in the ArcToolbox.



- ☐ Check the check box for Store relative pathnames.

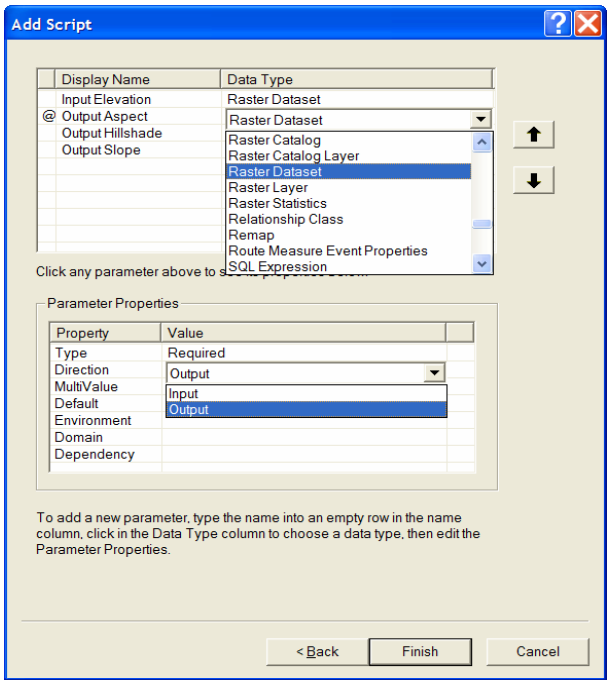
The script tool will look for files and data relative to the location of the X02A toolbox.

- ☐ *Click Next*.
- ☐ For *Script File*, browse to and open ... *\Exercise02\SurfaceProperties.py*.
- ☐ *Click Next*.

The last panel of the wizard defines parameters for the scripts arguments. The name you type in the Display Name field will appear in the tool dialog for the parameter. You must define the Data Type for each parameter by selecting it from the pulldown list (if you type a letter, like "R", the list will automatically position to the first data type that starts with that letter).

You may need to set properties in the bottom half of the wizard panel for a selected parameter. You will generally set the Type (Required or Optional) and the Direction (Input or Output). Now set the parameter for the input Elevation argument.

- ☐ For Display Name, click the field on the first row and type **Input Elevation**
- ☐ For Data Type, type a in the field and then scroll to and click Raster Layer.
- ☐ For the Type property, select *Required*.
- ☐ For the Direction property, select *Input*.



Click the Help tool (question mark) and use it to click anywhere in the Parameter Properties area for a description of each property.

- ☐ On your own, set the three output parameters using the information below:
  - **Output Aspect:** *Raster Dataset; Required; Output*
  - **Output Hillshade:** *Raster Dataset; Required; Output*
  - **Output Slope:** *Raster Dataset; Required; Output*

☐ Click *Finish* to close the *Add Script* wizard.

The new script tool should now appear in the ArcToolbox under your MyTools toolset. If you intend to give your toolbox to other users, you may want provide Help text for the script and its parameters, which you do by choosing Edit Documentation from the scripts context menu. Now run your new script tool.

☐ In *ArcToolbox*, double-click *X02A* > *MyTool* > *Surface Properties*.

☐ Use *Elevation* for the input and **Scr_Asp**, **Scr_Hill**, and **Scr_Slp** for the outputs.

☐ *Click OK* to run the script tool. Then close the status dialog, close ArcToolbox, and turn off and collapse all layers.

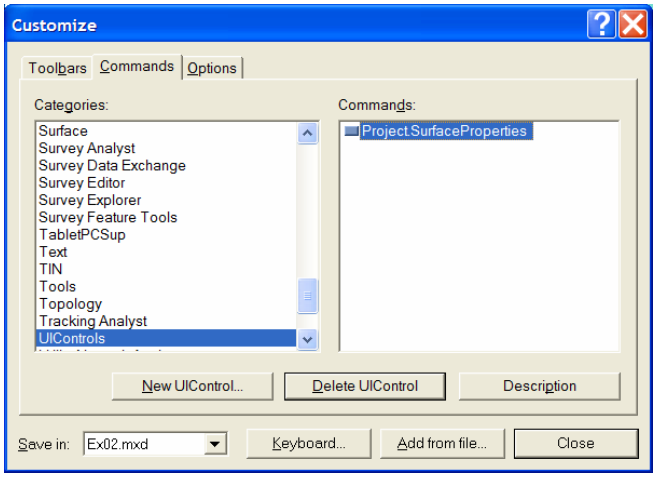
Note: You can install and run AML scripts—without modification—in the ArcToolbox using the techniques presented in this step. You must have Workstation Arclnfo installed to run them. Hint: Make sure that the AML starts the appropriate Arclnfo modules, like GRID or ArcPlot.

STEP 8: USE AN ARCOBJECTS PROGRAM

In this step, you will run and view a Visual Basic for Applications (VBA) script that is stored in your Ex02 map. It uses the ArcObjects to run Slope, Aspect, and Hillshade. Every ArcGIS tool and command is written with the ArcObjects. All the classes used by ESRI to create ArcGIS are available to developers, allowing them to build custom tools in existing applications like ArcMap, to create geodatabase feature classes that have custom behavior and to build stand-alone applications similar to ArcMap.

The ArcObjects can be used in VBA scripts in ArcMap and ArcCatalog, both of which have the VBA editor built into them. Now you will expose the Surface Properties script as a tool, run it, and view its code.

☐ On the ArcMap Main *Menu bar*, click *Tools>Customize*.

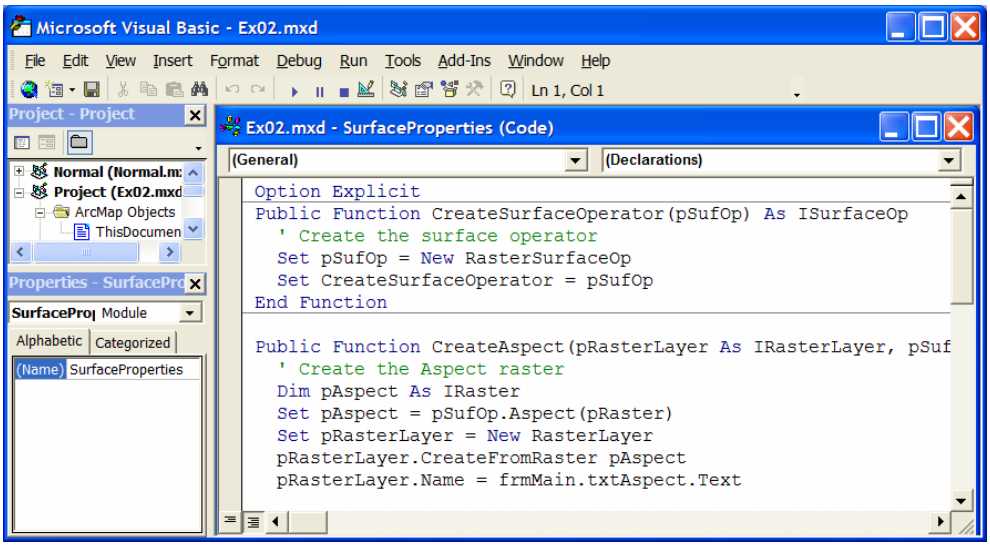


The VBA script has been attached to a button. All you must do to install it is to drag the button from the Customize dialog and drop it on a toolbar, as shown above.

- ☐ In the *Customize dialog*, click the *Commands tab*.
- ☐ In the *Categories list*, scroll to the bottom and *click* on the *UlControls* category.
- ☐ Drag *Project.SurfaceProperties* from the *Commands area* and drop it on the end of the *Spatial Analyst* toolbar.
- ☐ Close the *Customize* dialog.
- ☐ Click the new *Surface Properties* button to run the *VBA script*.
- ☐ Set the *Input Elevation* to your *Elevation layer*.
- ☐ Use these names for the output rasters: *AO_Asp*, *AO_Slp*, and *AO_Hill*
- ☐ Click *OK* to run the script.
- ☐ The VBA script is very basic; it just uses default symbology for the layers.

Now you will open Microsoft Visual Basic and view the source code for the script in its editor. One way to open the VBA editor is by right-clicking on the button.

- ☐ On the *Spatial Analyst* toolbar, right-click on the *Surface Properties* button and choose *View Source* from the context menu.
- ☐ In the *Project Explorer*, double-click *Modules* > *SurfaceProperties*.



Spend a minute or two viewing the source code for the script and then close the VBA editor. Note that much of the code is actually in the form (frmMain) and that only the code needed to execute Aspect, Slope, and Hillshade is in the SurfaceProperties module.

- □ In the *VBA editor*, click *File> Close* and Return to ArcMap.

- □ Turn off all layers and collapse their legends.

STEP 9: USE MAP ALGEBRA

Map Algebra is the real 'core' of Spatial Analyst. The majority of the tools you use in the toolbar, ArcToolbox, and Model Builder, the commands you use in the Command Line and scripts, and ArcObjects, simply provide interfaces for the over 200 operators and functions that make up the Map Algebra language.

While using Map Algebra directly is a little more complicated than using the tools, it does offer several advantages. For instance, you may use the output of a function as the input to an argument for another function, like this relatively simple example:

Hillshade(FocalMean(C:\Myflata\Elevation, Circle, 5), 315, 45)

The expression first executes the FocalMean function (gray text) and then passes its result as the input to the Hillshade function (black text). The effect is that the surface is 'smoothed' before the Hillshade is computed. All of the Spatial Analyst environments provide tools for writing Map Algebra, like the Raster Calculator in the Spatial Analyst toolbar, the Single Output Map Algebra tool in the ArcToolbox, or the RasterMapAlgebraOp coclass in the ArcObjects. Now you will use the Single Output Map Algebra tool to enter the expression shown above.

- □ Open the *ArcToolbox*.

- □ *Double-click Spatial Analyst Tools > Map Algebra > Single Output Map Algebra.*

The Usage button opens a dialog that shows the syntax for the Map Algebra operators and functions. Now use it to discover the syntax of the FocalMean function.

- □ On the *Single Output Map Algebra* dialog, click the *Usage* button.

- □ In the *Grid Map Algebra Usages* dialog, click in the scrolling list and type ***F*** to skip to the first function or operator that begins with the letter "F".

- □ In the scrolling list, scroll to and click on *FOCALMEAN*.

The highlighted <CIRCLE> syntax in the graphic above is the variation that you will use in your expression. You can copy and paste text from the Usages dialog into the expression area of the Single Output Map Algebra dialog, but you will not.

- □ In the *Grid Map Algebra* Usages dialog, click *Cancel*.
- □ In the *Single Output Map Algebra* dialog, click *Input raster* or *feature data* to reveal the Input Raster or feature data (optional) controls.

If you add the input raster or feature datasets (or layers) to this list, then you may use just their name in the Map Algebra expression instead of their full path name. Also, if you are using the Single Output Map Algebra tool in a model, the inputs will appear as inputs to the tool in the model where they may be marked as parameters.

- □ For *Input raster* or feature data (optional), use the pulldown to select Elevation.
- □ For Map Algebra expression, type:

```
Hillshade(FocalMean(Elevation, Circle, 5), 315, 45)
```

- □ For *Output raster*, replace the existing path name with ***MA_Hill***
- □ In the *Single Output Map Algebra* dialog, click *OK:*
- □ In the status dialog that appears after the tool has run, click *Close*.

You may compare the smoothed Hillshade with one of those you created earlier.

- □ Turn off all layers except *ma_hill* and *scr_hill*.
- □ Ensure that the *ma_hill* layer is at the top of the *Table of Contents*.
- □ Toggle the *ma_hill* layer on and off to compare it to *scr_hill*.

You may have noticed earlier that the ArcToolbox also has a Multi Output Map Algebra tool. As their names imply, the “Single” tool can only create a single output raster while the “Multi” tool can create many outputs.

In the “Single” tool, you declare the output in the Output raster field and you may only enter one expression that returns a raster as its output, although the expression may be quite complex. Only expressions that return raster datasets are allowed, and the output is automatically added to the ArcMap Table of Contents. The input datasets will be projected on-the-fly if they have different spatial references. This tool is designed for compatibility with the Model Builder and may be linked with other processes.

In the “Multi” tool, you can have expressions on multiple lines, and each must assign its result to a named dataset, like “outslp= Slope(Elevation)”. The expressions may return nonraster data (some Map Algebra functions return tables and other types of data), but the outputs are not automatically’ added to the Table of Contents. All the input datasets must be in the same spatial reference. While the “Multi” tool more fully supports the capabilities of Map Algebra, it cannot be linked with other processes in the Model Builder and cannot expose its input and output datasets in the model.

- □ Turn off all layers and collapse all legends.

- □ Close the *ArcToolbox*.

STEP 10: INSTALL SPATIAL ANALYST UTILITIES

The ArcObjects can be used to do much more than create processing tools; they can also be used to create specialized utilities. You will now use the Customize dialog to install several utilities that will be used throughout the class.

The Copy/Paste Raster Symbology utilities were written especially for this class and are used to copy the symbology from one raster layer to another. You will install them on the Raster Layer Context Menu.

- □ On the *ArcMap Main Menu*, click *Tools* > *Customize*.

You want this customization to be stored in the master ArcMap template—not just in the current map document—so they will be available in all future ArcMap sessions.

- □ In the *Customize dialog*, click the *Commands* tab.

- □ For *Save in* (in the lower-left corner), select *Normal.mxt*.

You must open the Context Menus toolbar and reveal the Raster Layer Context Menu. Then you will add the new commands from a Dynamic Link Library (DLL) and drag and drop the added commands from the Customize dialog onto the Raster Layer Context Menu.

- □ Move the *Customize dialog* to the top-left corner of your screen.

- □ In the *Customize dialog*, click the *Toolbars* tab and check *Context Menus*.

- □ Drag and drop the *Context Menus* toolbar just to the right of the *Customize dialog*. Do not let the toolbar dock itself to the ArcMap interface.

- □ In the *Context Menus* toolbar, click *Context Menus* > *Raster Layer Context Menu.*

The context menus should stay open; if they do not, then just reopen them after you have added the commands from the DLL.

- ☐ On the *Customize dialog*, click the *Commands tab*.
- ☐ On the *Commands tab*, click *Add from file*.
- ☐ Navigate to the folder ... *SPAG\Software\CopyRasSym.*
- ☐ Select *CopyFasteRasterSym.dll* and click *Open*.
- ☐ Close the *Added Objects* message.

The new commands were automatically added to the Layer command category.

- ☐ Drag the *Copy Raster Symbology* command from the *Layer* category and drop it on the *Raster Layer Context Menu* just below *Zoom To Raster Resolution.*
- ☐ Drag the *Paste Raster Symbology* command from the *Layer* category and drop it on the *Raster Layer Context Menu* just below *Copy Raster Symbology*.

You have finished installing the copy/paste raster symbology commands. Close the Customize dialog and then see how you use them.

- ☐ On the *Customize* dialog, click *Close*.
- ☐ Turn on the *Bar_Asp* and *Scr_asp* layers and expand their legends.
- ☐ *Right-click* on *Bar_Asp* and click *Copy Raster Symbology* in the context menu.
- ☐ *Right-click* on s*cr_asp* and click *Paste Bar_Asp symbology* in the context menu.

Notice that the Bar_Asp layer symbology has been applied to the scr_asp layer. This capability is useful when you create one raster from another (like filtering a raster of land use) and you want to use the same symbology for the new raster.

- ☐ Turn off all layers and collapse their legends.

The Cell Tool utilities are distributed as samples in the ArcGJS Developer Kit, which is an optional component of the ArcGIS installation. All samples are also available for download from the Web at http://arcgisdeveloperonline.esri.com.

A copy of the DLL that contains the Cell Tool utilities has been placed in your class data folder. You will use the Customize dialog to add the utilities and then use them.

- □ Open the *Customize* dialog.
- □ In the *Customize dialog*, click the *Commands* tab.
- □ For Save in, select *Normal.mxt*.

(This customization should be stored in the master ArcMap template as well).

Now add the commands from the CellTool.DLL.

- □ On the *Commands* tab, click *Add from file*.
- □ Navigate to the folder ... *\SPAG\SoftwareCellToo1*.
- □ Select *esriCellTool.dll* and click *Open*. Close the *Added Objects* message.

A new CellTool category has been added with five commands in it. The DLL also created a toolbar for them.

- □ Close the *Customize dialog* and open the *Cell Tool toolbar*.
- □ In the *Customize* dialog, click *Close*.
- □ On the *ArcMap Main Menu*, click *View> Toolbars> Cell Tool*.

The tools work with the raster layer that is at the top of the Table of Contents and work best if you are zoomed in on a small area.

- □ Drag *Bar_Asp* to the top of the *Table of Contents*, turn it on, and expand its legend.
- □ On the *ArcMap Standard toolbar*, for the *Map Scale* type **2000** and press *Enter*.
- □ Use each command, from left to right, by clicking or dragging a box on the map.

Note: The Flow Arrows command will not work properly; it is intended for use with rasters created by the Flow Direction tool.

- When you are done, exit *ArcMap* without saving your changes.

EXERCISE END

ANSWERS TO EXERCISE 1 QUESTIONS

Question 1: Where is your Application Data Folder?

Answer: The location may vary, but you can click the ArcGIS Desktop entry in the tree to find the answer. This folder is where ArcGIS stores your custom ArcToolbox toolboxes and the master templates for ArcMap (Normal.mxt) and ArcCatalog (Normal.gxt).

Question 2: How many Spatial Analyst extensions are available?

Answer: This also varies with the installation, but you can click the Availability folder to find the answer. Extensions with floating licenses become unavailable to other users when you enable them and then are returned to the pool of available licenses when you disable them or when you exit all ArcGIS applications.

Question 3: Can you clip a raster dataset?

Answer: Yes. The Data Management Tools has a Raster toolset that contains, among other things, a Clip tool. The tools in the Raster toolset are part of the core ArcGIS product and are available without the Spatial Analyst extension.

Question 4: Can you run individual tools without running the whole model?

Answer: Yes. Right-click on a tool to raise its context menu, where 'Run' appears as a choice for the tool.