IApioneer v3.0.3 Demo Manual

Powered by the GeoSPHERIC™ v3.0.3 Common Code Foundation

CONTENTS

1 INTRODUCTION

Welcome to the IApioneer training course. This course is designed for new and experienced users of remote sensing and digital photogrammetry software.

In this course you will master the basics of 3D feature extraction using overlapping imagery. In addition, you will learn more about exporting data into common formats used by other geospatial processing software.

There are six modules in this training manual. Each module contains lessons that you work through in class with the help of your instructor. The lessons are built upon basic tasks that you are likely to perform in your regular production workflow. They provide instruction for using the IApioneer software to developed exploit aerial and satellite imagery, including annotation, precision point mensuration, and creation of accurate 3D site models.

1.1 ABOUT THIS MANUAL

The IApioneer training manual is for use in a classroom setting with a qualified instructor. Your instructor is available throughout the course to answer any questions you may have.

Each module in this manual contains a series of hands-on lessons that let you work with the software and a set of sample data. Lessons have brief introductions followed by tasks and procedures in numbered steps.

2 CONFIGURATION

In this lesson, you learn to set personal preferences within the IApioneer environment by:

- Setting measurement preferences
- Setting data directories
- Setting default parameters for viewers and annotations

2.1 CUSTOMIZING IAPIONEER

IApioneer settings are saved on a per-user basis. Therefore, you will need to configure your personal settings every time you sit down at a new installation of IApioneer.

To customize the IApioneer settings:

1. Go to the Backstage by clicking on the *Home* tab on the Ribbon.
2. Click on the **[Settings]** option to launch the user settings dialog.

There are three (3) primary categories of settings: Configuration, Viewers, and Analysis (IApioneer). The Configuration section allows you to customize your geolocation and measurement formats, as well as your data repository sources. The Viewers section allows you control over how images load into the viewer, and some custom viewing options. The Analysis (IApioneer) section gives you control over how annotations are initially created.

2.2 CONFIGURATION OPTIONS

Configuration options give you control over the geolocation and measurement formats for both display and input. Also, there are options for setting the DTED and data repositories for direct ingestion into IApioneer.

To edit the Geolocation Display Formats:

1. From the tree view on the left of the Settings dialog, select *Geolocation Formats.*
2. The *Projection Type* can be chosen from Geographic (latitude/longitude), UTM, or Native. Native projections include custom local projections such as State Plane or country-specific projections. Set the option to Geographic
3. The *Geographic String Format* is where you specify the output string format for latitude and longitude configurations, in a variety of degree-minutes-seconds formats. Set the option to DDD.D for a decimal degrees output.

4. The *Vertical Datum* type can be chosen from HAE (Height Above Ellipsoid) or MSL (Mean Sea Level). IApioneer uses the EGM96 tables for MSL elevations. Choose MSL (EGM96).
5. The *Vertical Units* type controls what units the elevation values are displayed in. Choose from Meters, Foot (international), or Foot (US) for the most common units. Set the option for Meters.

To edit the Input Formats:

1. From the tree view on the left of the Settings dialog, select *Geolocation Formats.*
2. The *Projection Type* can be chosen from Geographic (latitude/longitude) or Cartesian (UTM, State Plane, etc.). Choose Geographic.
3. The *Geographic String Format* is where you specify the output string format for latitude and longitude configurations, in a variety of degree-minutes-seconds formats. Set the option to DDD.D for a decimal degrees input.

Note: *These formats apply to viewers and dialogs within IApioneer only, and not to any third party tools such as the GTI precision mensuration workflows.*

Measurement options give you control over the measurements made using the built-in measurement and analysis tools in IApioneer.

To set the measurement units:

1. From the tree view on the left of the Settings dialog, select *Measurement*.
2. The *Length* type controls what units the elevation values are displayed in. Choose from Meters, Foot (international), or Foot (US) for the most common units. Set the option for Meters.
3. The *Angles* type controls what units angular measurements are displayed in. Choose from Degrees or Radians. Set the option for Degrees.
4. The Area type controls what units the area measurement values are displayed in. Choose from Acres, Square Meters, or Square Feet (US) for the most common units. Set the option from Square Meters.

The Data discovery options allow you to set the data repositories for the data discovery dialog. Older versions of IApioneer may not contain options for data discovery.

To set the data repositories for discovery:

1. From the tree view on the left of the Settings dialog, select *Data Discovery*.
2. Use the *Add* button to add a local or remote directory to the data discovery repository.
3. Use the *Remove* button to remove a directory from the data discovery repository.

Note: *When directories are first added to the data repository, IApioneer may take some time to build the metadata tables for lookup, depending on the number of files in the repository and the types of the files. This process runs in the background, and should not impact performance, except in the Data Discovery dialog.*

The Terrain options allow you to set the terrain repositories for the DTED catalog. IApioneer uses the DTED files in the priority order specified in this setting, with the highest priority coverage listed first in the dialog.

To set the DTED data directories:

1. From the tree view on the left of the Settings dialog, select *Terrain*.
2. Use the *Add* button to add a local or remote directory to the DTED repository.
3. Use the *Remove* button to remove a directory from the DTED repository.
4. Use the *Up* and *Down* arrows to adjust the priority order.

2.3 VIEWER OPTIONS

The Viewer options allow you to configure parameters for how images are loaded in to the viewers, pixel cursor appearance, and overlays.

To edit the pixel cursor:

1. From the tree view on the left of the Settings dialog, select *Pixel Cursor*.
2. Select the *Inner* and *Outer Color* for the pixel cursor. Contrasting colors chosen here help distinguish the cursor across all image color configurations.
3. Select the size (Small, Medium, or Large) to reflect the cursor size.

To specify the default orientations of images when they are loaded into the viewer:

1. From the tree view on the left of the Settings dialog, select *Display*.
2. From the *Image Orientation* dropdown, select the desired orientation (Image is Up, North is Up, or Z is Up).

Gridline overlays provide contextual reference for the image's geospatial location, and can aid in some exploitation tasks.

To set the properties for the gridline overlays:

1. From the tree view on the left of the Settings dialog, select *Gridlines*.
2. Under the *Grid Lines* section, select the *Line Color* and *Line Style* for the gridlines.
3. Set the *Major Axis* for the major gridlines, including the *Line Weight* and *Interval*.
4. Set the *Minor Axis* for the tick marks, including the *Line Weight* and *Interval*.
5. Set the label appearance by selecting the desired *Label Color*, *Font*, *Size*, and *Label Format*.

Note: Whenever the Grid overlay is selected for display in a viewer, it will pull from these settings.

The Region of Interest overlay controls a number of capabilities, from highlighting areas of importance, to providing a rubber-band functionality for selecting areas to be chipped or processed.

To set the visible properties for the ROI mechanism:

1. From the tree view on the left of the Settings dialog, select *ROI*.
2. Set the *Line Color* for the ROI box.
3. Set the *Line Weight* and *Style* for the ROI box.

2.4 ANALYSIS (IApioneer) OPTIONS

The Analysis (IApioneer) options specify the default properties of the IApioneer annotation objects, including: footprints, mensuration tools, points, point markers, polygons, polylines, target rings, and textboxes.

To set the properties for the mensuration tools:

1. From the tree view on the left of the Settings dialog, select *Mensuration Tools*.
2. Use the *Font* controls to specify the *Font*, *Font Style*, and *Size* properties of the text labels.
3. Set the *Effects* desired for the font in the text labels (Strikeout or Underline).
4. Use the *Color* pickers to choose the foreground (text color) and background colors for the text labels.
5. Set the *Line Properties* by choosing the *Color*, *Style*, and *Weight* of the mensuration graphics.

Note: Changes made to the text settings can be previewed in the Sample section of the textbox settings.

A point is a single annotation calling out a specified location with a closed circle.

To set the properties for a point:

1. From the tree view on the left of the Settings dialog, select *Point*.
2. Use the *Point Color* property to specify the color of the point annotation.
3. Use the *Point Style* and *Weight* properties to specify the appearance of the point annotation.

A point marker annotation is the point circle with an attached textbox callout defining the point marker's location. The text properties are pulled from the Textbox settings (see below).

To set the properties for a point marker:

1. From the tree view on the left of the Settings dialog, select *Point Marker*.
2. Use the *Marker Color* property to specify the color of the point annotation.

To set the properties for a polygon:

1. From the tree view on the left of the Settings dialog, select *Polygon*.
2. Set the *Line Properties* by choosing the *Color*, *Style*, and *Weight* of the polygon annotation.
3. Check the *Show Endpoint Direction* box to show the direction the polygon was drawn.
4. Check the *Show Centroid* box to display the centroid of the polygon.
5. For a filled polygon, choose the appropriate *Fill Color*.

Note: When a polygon is copied or subdivided, all of its properties will pass down to the newly created objects.

To set the properties for a polyline:

1. From the tree view on the left of the Settings dialog, select *Polyline*.
2. Set the *Line Properties* by choosing the *Color*, *Style*, and *Weight* of the polygon annotation.
3. Check the *Show Endpoint Direction* box to show the direction the polyline was drawn.

To set the properties for target rings:

1. From the tree view on the left of the Settings dialog, select *Target*.
2. Set the *Marker Color* for the center of the target rings.
3. Set the *Damage Ring Units*.
4. Specify the *Radius* and *Color* for each ring.

5. Add new rings by clicking the *Add Ring* button and specifying their radii and colors.
6. Remove existing rings by clicking the *Remove* button beside the ring.

Note: *Ring radii do not have to be ordered.*

To set the properties for textboxes:

1. From the tree view on the left of the Settings dialog, select *Textbox*.
2. Use the *Font* controls to specify the *Font*, *Font Style*, and *Size* properties of the text labels.
3. Set the *Effects* desired for the font in the text labels (Strikeout or Underline).
4. Use the *Color* pickers to choose the foreground (text color) and background colors for the text labels.
5. Set the *Line Properties* by choosing the *Color*, *Style*, and *Weight* of the mensuration graphics.

Note: *Changes made to the text settings can be previewed in the Sample section of the textbox settings.*

3 DATA PREPARATION

In this lesson, you learn to setup your session by:

- Creating a new project
- Adding your images to the project
- Specifying math models and spatial referencing information
- Creating new vector layers
- Saving your project

In this lesson, you will set up a new project using digital aerial optical images. The procedures are similar for working with scanned film or satellite images.

Before beginning, ensure that the Raleigh Demo Set has been loaded onto your machine. This dataset consists of eight high-resolution aerial images over the Raleigh, NC area, with supporting metadata files. For simplicity's sake, we suggest you create a folder in the root directory for ease of access (e.g., C:\3DFE Aerial Data\). Hereafter, we will refer to this set of imagery as the Demo Data, and this location as the Demo Data folder.

3.1 STARTING A NEW SESSION

IApioneer works on a Session – a group of images and vector files that you use to create your product. Therefore, you need to open a new session or create a new session before you can access the IApioneer functionality. IApioneer is always working with a session, even when no data are loaded.

To create a new session (when data is already loaded):

1. Go to the Backstage by clicking on the *Home* tab on the Ribbon.
2. Click **[Close Session]**.

3.2 ADDING IMAGES TO THE PROJECT

This section describes how to add aerial images to the session.

To ingest images into the session:

1. From the Backstage, select **[Load Data]**.
2. Locate the Demo Data folder.
3. Select all the images in the Demo Data folder.
4. Click **[OK]**. The images will load into the Session section of the Backstage.

3.3 SPECIFYING SENSOR MODEL INFO

This lesson describes how to prepare eight aerial images for processing, as part of the Data Preparation stage. To set up the sensor models for your data, you will need the following:

- Aerial images
- Camera calibration (interior orientation) information
- Camera positioning (exterior orientation) information
- Spatial referencing information

To specify the sensor model information for a batch of aerial images:

1. Ingest the images, as per Lesson 3.2.
2. From the Backstage, select **[Batch Aerial Workflow]**.
3. Open the Raleigh-IO.txt file from the Demo Data folder, using a text editor.
4. Since the demo images are from a digital sensor, under the *Sensor Affine* grouping, select the *Digital* radio button.
5. Enter the values given in the Raliegh-IO.txt file into the appropriate fields in the *Batch Aerial Workflow* dialog.
6. Select **[Next]**.
7. Set the Spatial Reference System for the images to that provided. In this case, the images were acquired in the NAD83 State Plane NC (3200) US Feet system.
8. Set the exterior orientation *File Format* to *ImageID X Y Z Omega Phi Kappa*.
9. Set the *Input Angular Unit* to *Degrees*.
10. Using the browse button beside the *Text File* field, navigate to the Demo Data folder, and select the Raleigh-EO.txt file. Click **[Open]**. The Data table will show the parsed EO information contained in the text file.
11. Select **[Next]**.
12. Data pairing is done automatically from the image IDs, which are identical to the filenames of the images in the demo dataset. If the image names in the session did not match the image names in the EO file, here is where you would pair the ingested images with the EO IDs.
13. Select **[Next]**.
14. The sensor models for all the loaded images have been specified. There will be an asterisk indicating that the sensor model, for the loaded image, has been changed.

Checkpoint

You have now ingested images and specified the sensor models for the images for your session. It is time to save the session, so that we can proceed to exploiting the imagery.

1. From the Backstage, select **[Save Session]**.

2. A *Save Data* dialog will launch, asking if you want to save the data for the individual data items in the session. Selecting **[Yes]** will save the metadata for the images whose sensor models you just specified.
3. The next dialog is the *Save Session* file dialog, where you can specify a filename and location for the session file.

4 VIEWING DATA

In this lesson, you learn to interact with your data by:

- Loading images into the viewers
- Linking viewers
- Viewer manipulation
- Setting the active/visible layers

4.1 IMAGE VIEWING

Interacting with your imagery is the first step towards image exploitation, and the first step to interacting with the imagery is to look at the imagery. IApioneer works around the premise that most image processing workflows require, at most, two overlapping images of the feature to be collected. Thus, there are two image viewers: the Left Viewer and the Right Viewer. Additional context viewers can be launched to provide access to more than two images simultaneously.

To visualize the imagery:

1. Click on the *Home* tab of the Ribbon. You will see a gallery of image thumbnails for the data loaded in the current session.
2. Hover your cursor over a thumbnail. The image filename will be displayed. Locate the image with the name "SA1_058_59_hr4.tif."
3. Right click on the thumbnail and choose *"Send to Left Viewer."* The image will be loaded into the Left Viewer of the application and a small arrow will appear in the bottom corner of the thumbnail in the Image Gallery to indicate which Viewer the image is loaded in.
4. Locate the thumbnail of the image with the name "SA1_058_60_hr4.tif."
5. Right click on the thumbnail and choose *"Send to Right Viewer."* The image will be loaded into the Right Viewer of the application and a small arrow will appear in the bottom corner of the thumbnail in the Image Gallery to indicate which Viewer the image is loaded in.

Now that the images have been loaded into the Viewers, you can interact with them in preparation for your exploitation. You can change the brightness/contrast, pan and zoom, rotate, and more.

To navigate the imagery:

1. Click into the Left Viewer to make it active. A border will appear on the inside edge of the Viewer to indicate that it is the active Viewer.
2. Use the mouse's scroll wheel to zoom in and out.
3. Click and drag with the middle mouse button (scroll wheel) to pan around the image.

4. From the *Rotation* group in the *Home* tab, use the pre-specified orientation buttons to rotate to a given position, or use the slider under **[Compass]** to set a custom orientation.
5. From the *Camera* group in the *Home* tab, click **[Camera Lock]** to geospatially lock the Viewers.
6. Pan and zoom in one Viewer, and note that the other Viewer maintains a geospatial link across viewers.

Hint: Locking the cameras is a great way to maintain features in view for both Viewers while exploiting, especially when zoomed in.

4.2 LAYER MANAGEMENT

Data layers are types of data that can be overlaid on top of imagery to provide additional exploitation capabilities. IApioneer works with vector layers, tie point layers, and annotation layers. Data layers can be ingested like any other data, or created within IApioneer from the Session section of the Backstage. Layer management in IApioneer is accomplished in two ways, through visible and active layers. Any number of data layers can be visible, but only one layer can be active (editable) at one time. In this lesson, you will learn how to manage your data layers.

Before we begin, let's make sure that you have some layers to manage:

1. From the Session section in the Backstage, click **[Add Vector Layer]**. A new vector layer will be added, "Unnamed Feature Set 1."
2. Right click on the vector in the list and choose *"Save Data."*
3. Set the data filename as "demo data.gvf."
4. Now, add a new vector layer and name it "demo data 2.gvf," following the steps above.
5. Next, add a new annotation layer by clicking **[Add Annotation Layer]**. A new annotation layer will be added, "Unnamed Annotation Document 1.gad."
6. Right click on the annotation layer and choose *"Save Data."*
7. Set the data filename as "demo annotation.gad."

Managing the data layers:

1. Click on the *Home* tab.
2. From the *Data* group on the *Home* tab, click on **[Layer Manager]**. This will expand the Layer Manager on the left side of the application, showing our two vector layers, each with a checkbox and radio button beside it.

Hint: You can also show/hide the Layer Manager by clicking on the thin button nub on the left hand side of the Left Viewer.

3. Select the checkboxes for all data layers. This makes all layers visible in the Viewers (though they contain no data for now).

4. Select the radio button for "Demo Data.gvf." This makes the "Demo Data.gvf" the active, editable layer.

Hint: *If you need to quickly hide all the data layers, you can use the* **[Hide All]** *button on the Home tab, rather than individually deselecting each layer.*

5 EXTRACTING 3D FEATURES

Let's start with a discussion on how our eyes perceive 3D in the world around us. Your eyes are separated, thus each perceives your surroundings from slightly different perspectives. Your brain interprets the different perspectives and combines the information into a 3D view of the scene. This allows you to perceive the 3D structure of your environment, determine depth and relative distance, and estimate height and elevation angles.

In the same way, given any two images – with appropriate sensor model metadata – we can match features to provide accurate 3D information about those features. 3D FeatureXtract shrouds the complex equations and models of photogrammetry behind an easy-to-use user interface. 3D FeatureXtract does not require special hardware, as all the modeling is done in separate viewers, making the process simple, effective, and affordable – without the strain that comes with prolonged usage of active or passive stereo viewing hardware.

In this lesson, you learn to extract features by:

- Learning the creation and manipulation tools
- Collecting 3D features
- Editing features

The Feature Extraction *Creation* group contains the basic geometries used to extract complex 2D and 3D features from the imagery. The types of geometries supported include: polygons, points, polylines, and circles. The creation tools are modal, meaning that one creation mode is active at all times. This allows you to quickly draw many items of the same geometry without having to return to the Ribbon.

The *Manipulation* group contains the tools necessary to convert the drawn geometries to accurate 3D shapes by visibly aligning the geometries in the images. Making 3D models is simply a matter of drawing the shapes in one image, and then visibly aligning them in another. The available manipulation actions are: epipolar, z-axis, freehand, and rotation. Like the *Creation* tools, the *Manipulation* tools are modal, with one *Manipulation* mode active at all times.

Hint: To jump to the coordinates of the features specified in the stages below, use the **[Jump to Location]** *option on the Home tab of the Ribbon. Set the coordinate system to Image Pixels, and type in the appropriate coordinates.*

To add a 3D polygon to the active layer:

1. In the *Creation* group, select the **[Polygon]** gallery and choose **[Draw Polygon]**.
2. Zoom in on the imagery to find a rectangular building. A good one to start with is at [x: 4600, y: 7000] on image SA1_058_59_hr4.tif.
3. In the left viewer, hold CTRL and click to set a vertex on a corner of the building's roof.
4. Release control and click on the next vertex of the building's roof.

5. Continue clicking until all four vertices of the building's roof have been measured.
6. Right click to finalize the polygon.
7. In the *Manipulation* group, set the manipulation mode to **[Move Epipolar]**.
8. In the right image, click on the newly drawn polygon and drag it so that the polygon aligns with the roof edges of the building.
9. Release the mouse button to set the 3D location of the polygon.
10. Repeat steps 2-9 to add multiple polygons.

Hint: Mis-click a point? You can use the Backspace key to remove the last vertex you placed. Or, if you wish to start completely over, use the ESC key.

A circle is a special form of polygon that can be defined by designating any three points on its perimeter.

To add a 3D circle to the active layer:

1. In the *Creation* group, select **[Circle]**.
2. Zoom in on the imagery to find a circular feature. A good one to start with is at [x: 4560, y: 6530] on image SA1_058_59_hr4.tif.
3. In the left viewer, hold CTRL and click to set a vertex on the perimeter of the circular feature.
4. Release control and click on two more points lying on the circular feature's perimeter.
5. In the *Manipulation* group, set the manipulation mode to **[Move Epipolar]**.
6. In the right image, click on the newly drawn circular polygon and drag it so that the polygon aligns with the perimeter of the circular feature.
7. Release the mouse button to set the 3D location of the circular feature.
8. Repeat steps 2-7 to add multiple circles.

To add a 3D polyline to the active layer:

1. In the *Creation* group, select **[Line]**.
2. Zoom in on the imagery to find a linear feature.
3. In the left viewer, hold CTRL and click to set a vertex for the first endpoint of the polyline.
4. Release control and click on the next vertex of the polyline.
5. Continue clicking until all vertices of the polyline have been measured.
6. Right click to finalize the polyline.
7. In the *Manipulation* group, set the manipulation mode to **[Move Epipolar]**.
8. In the right image, click on the newly drawn polyline and drag it so that the polyline aligns with the feature in the image.

9. Release the mouse button to set the 3D location of the polyline.
10. Repeat steps 2-9 to add multiple lines.

To add a 3d point to the active layer:

1. In the *Creation* group, select **[Point]**.
2. Zoom in on the imagery to find a point feature.
3. In the left viewer, hold CTRL and click to set the location of the point in the image.
4. In the *Manipulation* group, set the manipulation mode to **[Move Epipolar]**.
5. In the right image, click on the newly drawn point and drag it so that the point object aligns with the feature in the image.
6. Release the mouse button to set the 3D location of the point.
7. Repeat steps 2-6 to add multiple points.

Snap to vertex locks the cursor to the nearest vertex within 5 pixels of the cursor. Moving the cursor more than 5 pixels "breaks" the snap.

To snap to a vertex:

1. Position the cursor close to an existing vertex.
2. Begin a new geometry object by holding CRTL.
3. While holding down the CTRL key, press and hold the SHIFT key to initiate snapping.
4. Click to snap to the existing vertex.
5. Release the CTRL and SHIFT keys and position the cursor close to another existing vertex.
6. Press and hold the SHIFT key to initiate snapping.
7. Click to snap to the existing vertex.

5.1 EDITING 3D VECTORS

To remove the last vertex placed in an object:

- Press the Backspace key.

To cancel drawing the current feature:

- Press the ESC key.

To reverse the last action:

- Undo (CTRL+Z)

To redo the last action:

- Redo (CTRL+Y)

To select overlapping features:

1. Click on an overlapping feature.
2. In the *Select Feature* dialog, choose the feature you wish to select. The features are displayed in descending elevation order, and will be highlighted as you select them.
3. Click **[OK]** to finalize the selection.
4. Hold the SHIFT button and repeat steps 1-3 to add features to the selection.

To delete a feature:

1. Select the feature.
2. Press the Delete key.

6 BUILDING SIMPLE 3D MODELS

In this lesson, you learn to create a simple 3D model by:

- Extracting a building's gutterline
- Setting the 3D location of the gutterline
- Extruding to ground
- Adjusting elevations

To extract the building:

1. In the *Creation* group, select the **[Polygon]** gallery and choose **[Draw Polygon]**.
2. Zoom in on the imagery to find a rectangular building with a superstructure. A good one to start with is at [x: 4600, y: 7000] on image SA1_058_59_hr4.tif.
3. In the left viewer, hold CTRL and click to set a vertex on a corner of the building's roof.
4. Release CTRL and click on the next vertex of the building's roof.
5. Continue clicking until all four vertices of the building's roof have been measured.
6. Right click to finalize the polygon.
7. In the *Manipulation* group, set the manipulation mode to **[Move Epipolar]**.
8. In the right image, click on the newly drawn polygon and drag it so that the polygon aligns with the roof edges of the building.
9. Release the mouse button to set the 3D location of the polygon.
10. Select **[Extrude Polygon(s)]** from the *Detailing* group. The selected polygon will be extruded to an underlying elevation source, giving you a 3D building.

To extract the superstructure:

1. In the left viewer, hold CTRL and click to set a vertex on a corner of the building's superstructure.
2. Release CTRL and click on the next vertex of the building's superstructure.
3. Continue clicking until all four vertices of the building's superstructure have been measured.
4. Right click to finalize the polygon.
5. In the Right Viewer, click on the newly drawn polygon and drag it so that the polygon aligns with the edges of the superstructure.
6. Release the mouse button to set the 3D location of the polygon.
7. Select **[Extrude Polygon(s)]** from the *Detailing* group. The selected polygon will be extruded to an underlying elevation source, giving you a 3D structure.
8. In the *Manipulation* group, set the manipulation mode to **[Move Z-Axis]**.
9. In the Right Viewer, click inside the bottom polygon of the extruded superstructure.

10. In the *Select Feature* dialog, choose the feature corresponding to the bottom of the extruded superstructure.
11. Press **[OK]**.
12. Click inside the selected polygon and drag the polygon up and down until the polygon aligns with the bottom of the superstructure.
13. Release the mouse button to set the 3D location of the polygon.

7 BUILDING COMPLEX 3D MODELS

In this lesson, you learn to create more complex 3D models by:

- Combining simple shapes to make complex ones
- Using the snapping tool to attach new geometry to existing vertices
- Using the Detailing tools to add geometry to simple structures

In the previous lesson, we covered how to extract simple 3D geometries. In this lesson, we will model more complex structures using combinations of simple geometries and the editing and detailing tools.

To begin, we will focus on generating a building with a truncated pyramid roof, such as that found at [x: 6800, y: 5800] on image SA1_058_59_hr4.tif. We will do so using two methods: using the snapping tool, and using the lofting tool.

To extract a truncated pyramid using the snapping tool:

1. Navigate to the building with a truncated pyramid rooftop.
2. Extract the outer (larger) gutterline, as in Lesson 7, and Move Epipolar in the other image to set the 3D location.
3. Extract the inner (smaller) gutterline.
4. Hold the SHIFT (snapping) key and the CTRL key to snap to one vertex of the outer polygon.
5. Release the CTRL key, but remain holding the SHIFT key and click on the corresponding vertex on the inner polygon.
6. Continue in an anti-clockwise fashion, holding the SHIFT key while clicking on the next inner vertex, then the next outer vertex.
7. Release the SHIFT key and right-click to finalize the polygon.
8. Repeat steps 4-7 for the other three faces of the truncated pyramid.

To extract a truncated pyramid using the lofting tool:

1. Navigate to the building with a truncated pyramid rooftop.
2. Extract the outer (larger) gutterline, as in Lesson 7, and Move Epipolar in the other image to set the 3D location.
3. Extract the inner (smaller) gutterline.
4. Drag-select both polygons.
5. From the *Detailing* group on the *FeatureXTract* tab, select **[Loft Feature]**. The two features will be connected with a set of polygons forming the four faces of the truncated pyramid.

3D FeatureXtract contains a number of pre-defined roof surfaces that can be used to speed up the process of roof extraction. Currently, you can use these tools to quickly generate Pitched (single- or multi-sloped) and Cylindrical (barracks, Quonset, etc.) roofs from rectangular base features. You can also

generate domes from circular base features. In this example, we will build a pitched roof, with a single hip, using the parametric roof building dialog and the freehand movement tools.

To parametrically build a pitched roof:

1. Zoom in on the imagery to find a rectangular building with a pitched roof. A good one to start with is at [x: 7300, y: 5200] on image SA1_058_59_hr4.tif.
2. Extract the gutterline, as in Lesson 7, and Move Epipolar in the other image to set the 3D location.
3. Ensure that the polygon is selected and choose Pitched from the **[Build Roof]** gallery on the *Detailing* group of the *FeatureXTract* tab.
4. Set the Roof Axis to align with the feature in the image. For this building, the roofline lies along the *Long axis*.
5. In the *Create Pitched Roof* dialog, use the up/down arrows in the *Height* field to set the roof height. As the value is changed, a preview of the roof structure will be shown in the Viewers. Align the roof ridgeline in both viewers to set the height of the roof. In this example, the roof height is about 1.5 meters.
6. Set the *# Layers* field to 1, as this roof has only a single slope. For buildings with multiple roof slopes (e.g., barns with Gambrel-style roofs), set the field accordingly.
7. Press **[OK]** to finalize the roof structure. The eastern roof peak is set properly, but the western side is hipped in by several meters. So, we need to adjust the western peak.
8. Set the *Manipulation* mode to **[Move Freehand]**.
9. Select only the vertex corresponding to the western peak of the roof.
10. Click and drag the vertex until it aligns with the western roof peak in both images.
11. Release the mouse button to finalize the single hipped pitched roof.

Putting all of this together allows you to extract complex 3D structures from combinations of simple 3D geometries. As an example, we will extract the roofs of a building with several overlapping parts, using a combination of lofting and snapping. The building can be found at [x: 6500, y: 3800] on image SA1_058_59_hr4.tif. In most cases, it can be easier to model a structure if you start at the center top and work your way down and to the outsides.

To build a complex structure with overlapping parts:

1. Set the Creation mode to Polygon.
2. Extract the gutterline of the main (square) part of the building, and Move Epipolar in the other image to set the 3D location.
3. Extract the rectangular part of the peak of the main roof, and Move Epipolar in the other image to set the 3D location.

4. Select the polygons created in steps 2 and 3.
5. Click **[Loft Features]** to create the main roof of the building.
6. Extract the gutterline of the long rectangular attached structure on the left, and Move Epipolar in the other image to set the 3D location.
7. Change the Creation mode to Line.
8. Draw the ridgeline of the attached structure, and Move Epipolar in the other image to set the 3D location.
9. Use the snapping tool to connect the long side of the rectangular structure to the closest point of the ridgeline, making a triangular face. Place the points in anti-clockwise order to preserve the face normal.
10. Repeat step 9 for the two narrow slanting faces of the attached structure's roof.
11. Repeat steps 6-9 for the two attached structures on the right.

8 EXPORTING YOUR 3D FEATURES

In the previous lesson, you learned how to generate complex 3D models. In this lesson you will learn how to save your models and to export them into formats suitable for further exploitation in other applications.

To save your vector layer:

1. Go to the Session panel in the Backstage, accessed from the *File* tab.
2. Right-click on the vector layer in the Vectors list, and choose the "Save Data" or *"Save Data As"* option.
3. Provide a file name, and save the file.

Note: The GVF format is a 3D FeatureXtract format optimized to work with our data structures.

To export your data to another file format:

1. Go to the Session panel in the Backstage, accessed from the *File* tab.
2. Right-click on the vector layer in the Vectors list, and choose the "Export" option.
3. Choose the desired *Output Format*.
4. Click export to save the vector data as a new file in the specified format.

Note: For ingestion into the True Ortho process, export in ESRI Shapefile format.

To export your data to a textured format:

1. Go to the Session panel in the Backstage, accessed from the *File* tab.
2. Right-click on the vector layer in the Vectors list, and choose the "Export" option.
3. Choose the desired *Output Format* that supports textured 3D models (such as Keyhole Markup Language).
4. Check the *Include Textures* box.
5. Click the *Change* button to specify the textures used for the automatic texturing process.
6. From the GeoData list, select the textures to use for automatic texturing, and press **[OK]** to finalize the selection.
7. Click export to save the vector data as a new file in the specified format.

9 ANNOTATING IMAGES

In this lesson, you learn to annotate images by:

- Placing simple annotation objects
- Editing annotations
- Using the MIL-STD-2525B clipart database
- Performing linear and angular mensurations
- Using the counting tool

Before we can work with annotations, we need to make sure that we have an annotation layer as the active data. Use the **[Layer Manager]** on the *Home* tab to set an annotation layer as the active data layer by clicking on the radio button beside the annotation layer (demo annotation.gad). Select the *Analysis* tab to access the annotation layer tools.

9.1 INSERT ANNOTATIONS

To insert a new ellipse annotation:

1. Select *Ellipse* from the **[Shapes]** menu.
2. Click in the image and drag out the ellipse in a bounding box fashion.
3. Release to set the ellipse.

To insert a new point annotation:

1. Select *Point* from the **[Shapes]** menu.
2. Click in the image to place a circular point annotation.

To insert a new polygon annotation:

1. Select *Polygon* from the **[Shapes]** menu.
2. Click in the image to set the first point of the polygon.
3. Continue clicking to set the vertices.
4. Right-click to finalize the polygon.

To insert a new polyline annotation:

1. Select *Polyline* from the **[Shapes]** menu.
2. Click in the image to set the first point of the polyline.
3. Continue clicking to set the vertices.
4. Right-click to finalize the polyline.

To insert a new rectangle annotation:

1. Select *Rectangle* from the **[Shapes]** menu.
2. Click in the image and drag out the rectangle in a bounding box fashion.
3. Release to set the rectangle.

To insert a new textbox annotation:

1. Select *Textbox* from the **[Shapes]** menu.
2. Click in the image to set the textbox location.
3. Type your desired text in the textbox.
4. Click outside the textbox to finalize the text.

To insert a new point marker annotation:

1. Select *Point Marker* from the **[Shapes]** menu.
2. Click in the image to set the point marker location.
3. The point marker's textbox callout is populated by the geospatial location of the point marker.

To insert a new target circle annotation:

1. Select *Target Circles* from the **[Shapes]** menu.
2. Click in the image to set the target circles location.
3. The target circle's textbox callout is populated by the geospatial location of the point marker, and the rings are pulled from the default settings.

To insert a new north arrow annotation:

1. Select *North Arrow* from the **[Shapes]** menu.
2. Click in the image to set the north arrow location.

To insert a new clip art annotation:

1. Select **[Clip Art]** to launch the Clip Art dialog.
2. Navigate through the graphics library to find the desired clip art graphic.
3. Click on the desired graphic and drag it into the viewer to the desired location.

9.2 MEASUREMENT ANNOTATIONS

To measure a separation angle:

1. Click **[Separation Angle]** on the ribbon.
2. Click in the image to set the first endpoint.
3. Click in the image to set the pivot point.
4. Move mouse to final location and click to set the final endpoint.

To measure a length:

1. Click **[Length]** on the ribbon.
2. Click in the image to set the first endpoint.
3. Click in the image to set the second endpoint point.

 To count objects in the scene:

1. Click **[Counting Tool]** to launch the counting tool dialog.
2. In the counting tool dialog, click **[Add]** to get a new category for counting.
3. Click on the shapes dropdown to set the shape for the current marker.
4. Set the color for the current marker.
5. Click in the image to place a marker and increment the count for that category.
6. Click **[Add]** to get another new category for counting.
7. Set the marker style and color for the new category.
8. Use the radio button to set the currently active category.
9. Place a few markers in the image.
10. Use **[Remove]** (x button) to remove all markers for the selected category.
11. Set the active category to one with several markers already placed (or place some).
12. Click on the eraser tool.
13. Remove individual markers by clicking on them with the eraser tool active.

To measure area, centroids, or perimeters of polygon objects:

1. Click on an existing polygon annotation to select it.
2. Right click on the selected annotation and choose *Properties*.
3. Go to the *Mensuration* tab to see the measurement parameters for the selected annotation.

9.3 EDITING ANNOTATIONS

To edit the appearance of an annotation object:

1. Create a new polygon annotation.
2. Select the polygon by clicking on it.
3. Right click on the annotation and choose *Properties.*
4. Edit the display parameters such as the color, line style, or line weight for the annotation object.
5. Click **[OK]** to finalize the new properties for the polygon display.
6. Create a point marker annotation.
7. Select the point marker annotation by clicking on it.
8. Right click the annotation and choose Properties.
9. Go to the Textbox tab of the properties dialog.

10. Edit the font styles, effects, and colors for the annotation. Note that the Sample text will update according to your selections.
11. Click OK to finalize the new textbox properties.
12. Double click inside the textbox for the point marker annotation.
13. Type some new text to replace the existing location information.
14. Click outside of the textbox to finalize the new text.

Note: *There are three categories of annotation properties: polygon, mensuration, textbox. Depending on the annotation object chosen, you may see more than one of these categories for editing.*

To edit the vertices of a polygon object once placed:

1. Create a new polygon annotation.
2. Select the polygon by clicking on it.
3. Right click the selected polygon and choose Edit Points. The vertices of the polygon will be highlighted.
4. Click and drag on a highlighted vertex to move it to a new position.
5. Double click outside the selected polygon to finalize the new vertex position.

A quadrilateral is a special form of polygon with four sides. IApioneer has the ability to subdivide a convex quadrilateral into a number of regularly sampled rows and columns.

To subdivide a quadrilateral:

1. Create a new convex four-sided polygon (such as a rectangle).
2. Select the polygon by clicking on it.
3. Right click the selected polygon and choose Properties.
4. Right click the selected polygon and choose *Subdivide* to launch the Subdivide Polygon dialog.
5. Use the up-down boxes to set the desired number of rows and columns for the subdivided polygon. See how the subdivisions change as you adjust the columns and rows.
6. Click **[Apply]** to finalize the subdivision. The original polygon will be replaced with the new smaller polygons.

Note: *The parent polygon's properties will propagate to the child polygons. This is a great way to regularly sample a grid, including the centroids for every sub-region.*