Quick Start Guide and User's Manual

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LOAD GEOSPATIAL DATA

To load geospatial data into GeoGenesis®, simply select Load Data from the File menu item in the main toolbar and select the file(s) you wish to load. You may also select the Load Data icon  as well. Once your data is loaded, you will see the filename in the **Session Explorer**.

SAVE/LOAD SESSION

The Save Session feature is located in the File tab of the main tool bar. This feature lets you save the data you are working with into a project folder. By doing so, you only have to load the one project and not individual files.

SAVE SESSION

To save the current session, left click on Save Session from the File menu in the main tool bar. Once the **Save Session** window opens, name your session and save it to the location of your choice. All the files currently in the **Session Explorer** will be saved to your session file.

LOAD SESSION

To load a session, simply select Load Session from the File menu item in the main tool bar. Navigate to the directory where you previously saved your session, click on your session folder and it will load into GeoGenesis®. Once your session is loaded into GeoGenesis® the data will appear in the **Session Explorer**.

SESSION EXPLORER

The **Session Explorer** is an interactive data displayer. This area is set up in a data tree format with four categories:

- Image
- DEM
- Vector
- Tie Point

With your data loaded into the **Session Explorer** you may access multiple features by right-clicking on the filename. Depending on the type of data selected, these features may include

- Save Metadata
- Remove
- Generate Overviews
- Crop and Resample
- Data Conversion
- Reprojection
- Export
- Sensor Model Configuration
- Spatial Referencing Configuration
- Properties…

SAVE METADATA

This function saves any changes to your sensor model or spatial referencing configuration. Any change in your data is noted by a asterisk (*) at the end of your data file name.

REMOVE

To remove data from the session, right click on the filename in the **Session Explorer** and select **Remove**. The file is not deleted on disk, but is removed from the GeoGenesis® session.

GENERATE OVERVIEWS

To enhance performance when viewing large raster data, you may generate overviews. GeoGenesis® will notify you if overviews are not available by displaying an icon to the left of the filename in the **Session Explorer**. If you see this icon, you may generate overview simply right clicking on the filename in the **Session Explorer** and selecting **Generate Overviews**.

CROP AND RESAMPLE

This function is used to chip and resize an image. There are three ways to define the cropping region. First, is by clicking your mouse and dragging the red box around the area you want to work with. Alternatively you can manually enter your coordinates in the assigned windows. The third method is to define the crop region By Geospatial Data. Selecting a geospatially referenced data set from this drop down box sets the crop region to the geospatial bounds of the selected item.

After this step is finished, name your new file and select the directory where you want it save. If a new file name is not assigned a default name with the original file name and (_crop) will appear. Next, select Run. When the images is finish it will appear in the **Session Explorer** with the other data noted by the new file name.

DATA CONVERSION

Data may be converted between varying bit depths and formats using this option. Select the output data type, whether you wish to scale the data, the output format. Next select Run to complete the process.

REPROJECTION

Georeferenced data can be reprojected into another spatial reference system using the **Reprojection** dialog. Change the spatial referencing to the desired output, select the resampling method[1], and output image format.

EXPORT

GeoGenesis® allows you to export raster and vector data to multiple formats.

[1] For best tradeoff in performance and visual quality, IAVO recommends Bilinear Interpolation.

RASTER DATA

To export raster data, right click the filename in the **Session Explorer** then select **Export**. Raster data may be exported to Erdas Imagine, TIFF, and NITF formats. Select your export file format, choose the location where you want to save it, and select Run.

VECTOR DATA

To export vector data, right click the filename in the **Session Explorer** then select **Export**. GeoGenesis® supports several vector formats:

- GeoVectorFile[2] (*.gvf)
- ESRI Shapefile (*.shp)
- MultiGen Paradigm OpenFlight (*.flt)
- Collada Document (*.dae)
- Keyhole Markup Language (*.kml, *.kmz)
- Wavefront OBJ (*.obj)
- Common Data Base (CDB)
- TerraVista Feature Set with Models

The output format determines the availability of other output parameters, including the Output Spatial Reference System, and Texturing.

SENSOR MODEL CONFIGURATION

GeoGenesis® currently supports three basic sensor models for raster data. These are Collinear, RPC, and Ortho. For many raster data sources, GeoGenesis® automatically ingests and assigns the appropriate sensor model. However, you may manually establish sensor models. To do so, first right click on the filename in the **Session Explorer** and select **Sensor Model Configuration**. You may insert the appropriate parameters for all three sensor models and select OK when done.

[2] The GeoVectorFile format is the internal format used by the GeoGenesis® suite.

SPATIAL REFERENCING CONFIGURATION

GeoGenesis® currently supports multiple spatial referencing systems. For many data sources, GeoGenesis® automatically ingests and assigns the appropriate reference system. However, you may manually establish the spatial referencing system. To do so, first right click on the filename in the **Session Explorer** and select **Spatial Referencing Configuration**. You may insert the appropriate parameters and select OK when done. NOTE: This does not "Reproject" the data. This simply assigns the appropriate spatial reference system for the data.

PROPERTIES

To view the general properties of raster data, click on the filename(s) in the **Session Explorer** and select **Properties**. Once this window opens, there are two tabs to select from:

Info: Gives the basic information about the data selected. (File Size, Type, Classification, Pixel Dimensions). It also indicates if the data already has preloaded Internal Spatial Reference, Geo Transform, and Sensor Model by displaying a check in the boxes that apply.

Band Setup: Allows you to customize your Color Bands for multispectral imagery. Each Band can be assigned by using the drop down menus to change the Band to best fit the Color Channel. Color Levels for the image can also be adjusted manually or with the Histogram feature. Parameters set in this dialog affect how the data is viewed initially in all viewers. These parameters may be locally overridden by some viewers.

GLOBAL VIEWER

The **Global Viewer** workspace provides the ability to see the geospatial relationships between the data in the project. As each file is loaded with an appropriate sensor model and coordinate system, a bounding box appears in the **Global Viewer** designating the boundaries of the object. The **Global Viewer** is the

default view when GeoGenesis® is launched, along with the **Session Explorer**. Double clicking on a file in the **Session Explorer** will zoom the viewer in to the extents of the object and highlight the object's boundary. Clicking inside a boundary in the **Global Viewer** highlights the file name located in the **Session Explorer**.

WORKSPACES

Workspaces are the visual workshops of the GeoGenesis® suite. Here is where you view imagery and vector data, and perform the various exploitation tasks. There are three main workspaces: the **GIS Workspace**, the **Mono(scopic) Workspace**, and the **Stereo(scopic) Workspace**.

USING THE WORKSPACE

The workspaces have been designed with maximum flexibility in use, and intuitive drag and drop interfaces for exchanging data between windows. Some functionality (listed below) is the same for all workspaces, while some is specific to individual workspaces. Common functionality includes: drag and drop data loading, docking, pan and zoom controls, and the **Ribbon** interface into specific menus.

DRAG AND DROP DATA LOADING

Using your mouse, select the data that you wish to load into the viewer and drag it onto the viewing area of the workspace. Drop the data into the viewer by releasing the mouse button and the data will begin to load. It is important to note that not all viewers support all data types. As each workspace is introduced in the following sections, the types of data it supports will also be given.

DOCKING

Docking is the joining of workspaces to the main application or to each other, and is an important part of the GeoGenesis® interface. It allows users to split workspaces across multiple monitors, attach workspaces with related data to each other for simple process grouping, and generally manage the flow of information on the screen.

To **Dock** a viewer to the main interface left click in the title bar and drag it onto the main application or another workspace until the docking symbol appears. Once it appears, choose where you would like to dock your viewer window (on the left, right, top, bottom or center) by moving it onto the icon and placing the cursor arrow in the chosen box coinciding with the position you want.

NAVIGATING THE DATA IN THE WORKSPACE

Navigation consisting of panning (or roaming), zooming, and rotation is the same in all workspaces. To pan through the data, click and hold the middle mouse button and drag the mouse. The data will follow your mouse cursor. Alternatively, click the middle mouse button once to center the viewer on that location. If you do not have a middle mouse button, simultaneously clicking the left and right mouse buttons has the same effect. Zooming can be done by scrolling the mouse wheel in and out, or by selecting predefined zoom levels from the **Ribbon**. In all viewers, rotation is accomplished through the **Ribbon** controls.

THE RIBBON INTERFACE

The **Ribbon** interface is an exciting new way to manage tools. Users of Microsoft Office 2007 and higher products should already be familiar with the way the **Ribbon** works. Components in the **Ribbon** are arranged in groups of like functionality to facilitate the workflow process.

The **Ribbon** consists of three main components: the application menu, tabs, and groups. The application menu can be accessed by clicking on the circled icon in the upper left corner of the **Ribbon**. This area is where GeoGenesis® allows the user to manage the data layers in a workspace: add new layers, choose the active layer, and remove layers when done. The tabs delineate groups of production tools contained within that workspace. Production tool sets such as Feature Extraction, Data Control, Exploitation, and Product Generation are segmented into their own tabs. Within each tab are groups of common functionality. For example, all data display functions are located in the Home tab, under the Display group.

GeoGenesis® LITE

GeoGenesis® LITE is a free geospatial viewer and exploration tool. It consists of the main application windows discussed previously, as well as a GIS-like exploration tool called the **GIS Workspace.**

The GIS Workspace

The **GIS Workspace** is the only data viewer available for the GeoGenesis® Lite package. It contains all the functionality required to load multiple overlapping datasets and view them in a pseudo-orthorectified setting. Data exploration is the main function of the **GIS Workspace**. This workspace is primarily used to display and explore Image, DEM, and Vector data.

The Home Tab

The **GIS Workspace** Home tab consists of three groups: Display, Camera, and Rotation. These are the main sets of functionality present in the **GIS Workspace**.

Display

The Display group includes three options Brightness, Contrast, and Filter. The Brightness and Contrast options can be adjusted two ways. They can be adjusted by clicking on the button to display the pull down menu. Once the pull down menu is open, move the cursor over the Brightness or Contrast values to preview a fixed percentage adjustment. Click on the adjustment value to set the value in the viewer. Alternatively, scroll down to the bottom of the drop down menu to the adjust menu. Once the track bar pops out, move your cursor from left to right to change your Brightness or Contrast value. The Filter option can be activated by clicking on the button and selecting the desired option.

Camera

The Camera group contains the options for changing the view of the camera. Zooming and Camera Projection are the main tasks for this group. As discussed

previously, zooming can be accomplished through use of the mouse scroll wheel, or by selecting a pre-defined Zoom level from the Camera group.

For your convenience, there is a 1:1 button available to zoom the camera to 100%. In practical terms, this means that 1 pixel of the image takes up 1 pixel of monitor space. There are also buttons on the Camera group to view the full extents of the visible data loaded in the **GIS Workspace**, and a Zoom to Box option. To use the Zoom to Box feature, click on the button and then click and drag a highlight box in the viewer. A blue rectangle appears to show the area that will be zoomed to.

The Camera Projection button allows the user to change the projection of the viewer from image-centric to orthographic-centric. By default, when single images are loaded in the viewer, the data is displayed in an image based projection. When multiple images are loaded, the projection switches to orthographic.

The navigation mechanism of the viewer is controlled by the Pan Mode and Roam Mode buttons. Pan Mode allows the user to click and drag to move the image. Roam Mode smoothly moves the image in the direction of the mouse cursor.

ROTATION

The rotation group contains controls for freeform rotation about the center of the display, as well as pre-defined rotations. When the projection is set to image-based mode, the Image Up and North Up buttons are active. Image Up sets the rotation so that the rows and columns of the image match those of the display. North Up sets the rotation so that North (in the image's spatial reference system) is to the top of the screen. Freeform rotation about the center of the viewer can be accomplished by clicking the Rotation button and dragging the slider right and left for positive and negative rotations, respectively.

THE GIS VIEWER DATA TREE

The data layers loaded into the **GIS Workspace** appear in a data tree view to the left of the viewer area. The data is organized into groups for vectors and imagery. DEMs are treated as images for the purposes of the **GIS Workspace**. The

checkbox beside the data layer name in the tree view indicates whether the data is currently visible.

The order of data layers in the **GIS Workspace** viewer is as listed in the tree view from top to bottom. Thus, the lowest (backmost) layer in the viewer is the image furthest down the list. To change the order, simply click on the item(s) that you wish to move and drag them to their new order in the list. To remove a data layer from the **GIS Workspace**, right click on the layer in the tree view and select Remove from context menu options.

LAYER PROPERTIES

The other option on the right click context menu is Layer Properties. For vectors, this allows the user to change the display color of the vectors in view. For imagery, this option launches a dialog with many more options. The Raster Layer Properties dialog has two tabs: Display, and Band Setup.

The Display tab allows the user to control the appearance of individual images in the **GIS Workspace** viewer. Here the Brightness and Contrast of the image can be set, as well as the layer transparency and tint.

The Band Setup tab has the same functions as the one from the **Session Explorer**, allowing the user to specify channels per band of the source data for multispectral imagery. There is also the option to make a background color transparent by checking the box and filling in the RGB null values. This is especially useful for clearing solid color background fill, from data such as orthos, when layering multiple images.

The last tool in the Band Setup tab is the ability to set the Color Levels of the histogram channels. The three pre-defined color levels are: Default, Linear 2%, and Custom. Default uses the actual minimum and maximum data values found in the image data to set the color levels. Custom allows the user to manually enter min and max values they wish the color bands to display, or edit the values directly from the data using the Histograms button.

GeoGenesis® SOLO

The SOLO version of the GeoGenesis® suite adds the **Mono(scopic) Workspace** and a whole list of data control and large scale ortho production functions. The production tools include the ability to create tie point sets, control the raw imagery to known reference data, and process the final output. In addition, there are a number of conversion tools added to the software. The specific menu items added under the SOLO toolkit are:

- Automatic Tie Point Extraction
- Bundle Adjustment
- Resection
- Grayscale Conversion
- Pan Sharpening
- Color Correction
- Orthorectification
- Mosaicking
- Band Stacking

The Mono(scopic) Workspace in SOLO

The **Mono Workspace** is the main workspace of GeoGenesis®. It is the home of the GeoGenesis® monoscopic and split-screen stereo production tasks for: data control, feature extraction, image exploitation, and product generation. The **Mono Workspace** handles all forms of data in the GeoGenesis® suite.

The Ribbon

The tabs available in the **Mono Workspace** ribbon depend on the GeoGenesis® license level. Users with GeoGenesis® Solo will only see the Home and Data Control tabs, while GeoGenesis® Ensemble users see the Home, Data Control, FeatureXTract, IAPioneer, and Product Generation tabs.

The Application Menu of the **Ribbon** allows the user to create new Feature Sets, Tie Point Sets, and Annotation Layers. The **Active Layer** of the viewer can be set

in the Application Menu by selecting an existing data layer, and is denoted by a check mark to the left of the data layer name. Finally, data layers can be removed from the viewer by choosing the appropriate option in the Application Menu.

THE ACTIVE LAYER

The **Active Layer** of the **Mono Workspace** is the set of data that is currently selected for editing. **Active Layers** include feature sets, tie point sets, and annotation layers. The type of data that is the **Active Layer** determines the functionality of the creation and editing capabilities of the Mono Workspace. Active tie point layers allow you to select, create, and manipulate tie points. Active feature layers allow the creation and editing of 3D and planimetric features. Annotation layers that are active allow the creation and editing of annotation objects.

Active Layers are shared across all **Mono Workspaces**, allowing an easy way to perform side-by-side multi-image processing tasks such as tie point creation and 3D modeling. All layers are drawn simultaneously, with non-active layers drawn as semi-transparent for ease of viewing.

THE HOME TAB

Like the **GIS Workspace**, the Home tab consists of three groups: Display, Camera, and Rotation.

DISPLAY

The Display group includes the options Brightness, Contrast, Filter, Histogram Adjustment, Reset, and Image Overview. The Brightness and Contrast options can be adjusted by clicking on the button to display the pull down menu. Once the pull down menu is open, move the cursor over the Brightness or Contrast values to preview a fixed percentage adjustment. Click on the adjustment value to set the value in the viewer. Alternatively, scroll down to the bottom of the drop down menu to the adjust menu. Once the track bar pops out, move your cursor from left to right to change your Brightness or Contrast value.

The Filter option can be activated by clicking on the button and selecting the desired option.

The Histogram Adjustment button launches a dialog that allows the user to interactively specify the minimum and maximum display values for each data channel.

The Reset pop out menu allows the user to reset the Filter applied to the image in the viewer, reset the Histogram Adjustments that have been performed, or Reset ALL values to their original parameters.

The Image Overview button launches a small window containing a thumbnail of the **Mono Workspace's** base image, along with a red bounding box that shows the bounds of the data in the current view. The user can also select a point in the Image Overview window to center the **Mono Workspace** on that point.

CAMERA

The Camera group contains the options for changing the view of the camera. Zooming, Movement Modes, and Window Locking are the main tasks for this group. As discussed previously, zooming can be accomplished through use of the mouse scroll wheel, or by selecting a pre-defined Zoom level from the Camera group.

For your convenience, there is a 1:1 button available to zoom the camera to 100%. In practical terms, this means that 1 pixel of the image takes up 1 pixel of monitor space. There are also buttons on the Camera group to view the full extents of the visible data loaded in the **Mono Workspace**, and a Zoom to Box option. To use the Zoom to Box feature, click on the button and then click and drag a highlight box in the viewer. A blue rectangle appears to show the area that will be zoomed to.

The Jump to Location button allows the user to input a geographic or pixel location that the viewer is to center on. The location can be entered in a variety of geographic formats. Users will be warned if the values entered appear beyond the calculated bounds of the imagery.

The Camera Lock functionality provides a geographic link between multiple **Mono Workspaces**. Each **Mono Workspace** with the Camera Lock enabled will pan and zoom in sync. Simply turn the Camera Lock button on for each **Mono Workspace** that you wish to have synchronized. Alternatively, holding down the shift button activates or deactivates the Camera Lock for all **Mono Workspaces**.

The navigation mechanism of the viewer is controlled by the Pan Mode and Roam Mode buttons. Pan Mode allows the user to click and drag to move the image. Roam Mode smoothly moves the image in the direction of the mouse cursor.

ROTATION

The rotation group contains controls for freeform rotation about the center of the display, as well as pre-defined rotations. Freeform rotation about the center of the viewer can be accomplished by clicking the Rotation button and dragging the slider right and left for positive and negative rotations, respectively. Image Up rotates the data in the viewer so that the top of the image is at the top of the screen. North Up rotates the data in the viewer so that North is at the top of the screen. Z Up uses the image's sensor model to calculate an approximate direction for vertical (Z) distances. This mode is quite useful when viewing oblique imagery.

THE DATA CONTROL TAB

The Data Control tab is used for the creation and exploitation of tie point sets. The three groups of the Data Control tab are: Display, Tie Points, and Image Correction.

DISPLAY

In this group you can change the symbols of your tie points and GCP (Ground Control Points). Click on the Tie Point Symbol icon or the GCP Symbol icon. Once the drop down menu appears select your new tie point symbol.

TIE POINTS

The Tie Points group allows the user to explore the active tie point set through the Tie Point Manager and the Tie Point navigation controls.

The Tie Point Manager button launches the Tie Point Manager. This dialog allows the user to explore the active tie point set, see which images a point is connected to, and view its associated measures. The Tie Point Manager allows the user to organize the points by Tie Point or by Image. For Ground Control Points (GCPs), the Tie Point Manager will show the world coordinates in bold green text, to more easily distinguish them from standard Tie Points.

The Previous Tie Point and Next Tie Point buttons allow the user to easily navigate through a tie point set by skipping from one point to another. When these buttons are used, the viewer will readjust to position the newly selected point at the center of the display. You can also select a tie point by its name in the Current Tie Point drop down menu to have the viewer select and center on that point.

*Hint: Use the tie point navigation tools together with multiple **Mono Workspaces** and Camera Locking to easily vet a tie point set between two or more images.

IMAGE CORRECTION

Tie point sets are typically used for image correction tasks. GeoGenesis® currently supports three main image correction processes, as seen in the Image Correction group: Image Update, Bundle Adjustment, and Data Warping.

The Image Update button performs a single or multi-point update on a pair of images, either to each other (relative) or to the ground (absolute). A typical image update scenario is taking a pair of RPC satellite images that are accurate relative to each other, and controlling them to an underlying DEM to provide absolute accuracy.

The Bundle Adjustment button launches the Bundle Adjustment – aerotriangulation – process. This process uses a combination of tie points and GCPs to refine initial sensor model parameters to accurate, controlled ones. More information on Bundle Adjustment can be found in the discussion of GeoGenesis® SOLO functionality.

The Data Warping button allows raster or vector data to be warped onto a reference image through use of tie points. The resulting output can be used for tasks such as contextual visualization of data coverage, or orthographic correction of planimetric vector data. For raster images, the resulting warp function is used to create a copy of the warped data onto the reference image's sensor model, which yields an image that can be used in the **GIS Workspace** for overlay purposes. The planimetric vector data has its geospatial coordinates modified by the warp function to overlay exactly on the reference image.

LOADING A TIE POINT SET

To work on a tie point set previously loaded into the project, click on the dataset name in the **Session Explorer** and drag it into the **Mono Workspace** viewer area. Then, go to the Application Menu to set the tie point set as the **Active Layer**.

CREATING AND EDITING A TIE POINT SET

To create a new tie point set, go to the Application Menu of a **Mono Workspace** and click on New Tie Point Set. A new Unnamed Tie Point Set will appear in the **Session Explorer**, and the Application Menu of the **Mono Workspace** will show a new tie point set. The **Active Layer** of the **Mono Workspace** will be set to the new tie point set.

Bring up a second **Mono Workspace** and drag a new image into its viewer. Create a new tie point between the images by holding down the Control (Ctrl) key on the keyboard and left clicking in one image – we refer to this process as a Ctrl-click. A yellow cross (tie point symbol) will appear where you clicked. Ctrl-click on the same feature in the other workspace viewer to set the tie point in the other image. If you misplace the point, simply Ctrl-click on the correct location. Once the point has been placed in both images, right click to set the point. If later you find that the point needs to be moved in one image, select the point by clicking on it in the viewer, then Ctrl-click to its new location.

This process can be used across as many viewers as you have available – system resources notwithstanding – to tie a single point to many images. Alternatively, you can load a new image into one of the two viewers currently open, select a

pre-existing point in the original viewer, and Ctrl-click to place the tie point in the new image. Now all three images are tied together at a single point.

Ground Control Points can be placed in the same manner, using a source DEM and an ortho image as the reference data. In the Tie Points group in the Data Control tab of the Ribbon use the Source DEM combo box to select the reference DEM from the elevation models loaded in the project. Next, place an ortho image covering the region of interest in one of the viewers. Create a new tie point in the same manner as in the previous paragraph. Notice that when the tie point is selected in the ortho reference image, instead of a cross (tie point symbol), a circled cross (GCP symbol) appears. The point is now tied to the ground and has geospatial world coordinates assigned to it.

GeoGenesis® SOLO Processes

Automatic Tie Point Extraction

An alternative to manually selecting a large set of tie points between images for bundle adjustment is to use the Automatic Tie Point (ATP) Extraction process included in GeoGenesis®. The ATP process can be accessed from the SOLO menu option of the main application.

Select the images that are to be tied together and set an output file for the tie point results to be written to. The process uses the initial camera parameters to garner a best guess estimate of overlap between images, both within and across flight lines. Innovative algorithms are used to find the matching points between images. IAVO has used this process on very large image sets with better than 97% accuracy reported. Upon completion, the new tie point set appears in the **Session Explorer**.

Bundle Adjustment

The Bundle Adjustment process uses a set of tie points and GCPs to refine the accuracy of a set of images *en masse.* The algorithms involved minimize the triangulation errors across an entire set of images at the same time, which is why the process is often referred to as block bundle adjustment or aerotriangulation.

Access the Bundle Adjustment dialog from the SOLO menu in the main application or from the Data Control tab in the **Mono Workspace Ribbon**.

First, select the tie point set used for bundle adjustment from the Control Points combo box. The number of GCPs and Tie Points will be displayed immediately below the selection. Next, select the images that are to be processed. Choose a convergence value and a maximum number of iterations to provide the minimal set of parameters for the Bundle Adjustment process. A detailed report of the process can be generated by checking the box for Save Detailed Results to File and choosing an output file.

More control over the Bundle Adjustment process can be achieved by selecting the More>> button and assigning known or assumed values for the standard deviations of the measured points and initial camera values.

RESECTION

Resection is the process of determining the exterior position and orientation of the camera for an image, given at least 3 non-coplanar target points. In GeoGenesis®, this means at least 3 GCPs can be used to accurately determine the Position and Orientation of the camera at the time of image acquisition, using the Resection process found in the SOLO menu of the main application.

The dialog for the Resection process is the same as that for Bundle Adjustment, with appropriate default values changed. There is also an option to Use Current Camera Parameters as a Starting Position. By default this option is disabled, as the algorithm typically finds much tighter results when you allow it to choose its starting location from the control points. Also, unless the data is covering a wide ranging terrain elevation, more than 3 GCPs is unnecessary and often yields worse overall results than the minimal 3 points does.

GRAYSCALE CONVERSION

Grayscale Conversion takes a multispectral image and allows the user to convert it to a single band image. The Grayscale Conversion process is launched from the SOLO menu in the main application window. Select the image to be converted from the combo box, select the bands to be merged, and the scaling factors for

conversion for each band. Select an output file name and run the process. The result will be added to the **Session Explorer** upon completion.

PAN SHARPENING

In typical satellite imaging, multispectral imagery is of much lower resolution than panchromatic imagery. Pan(chromatic) Sharpening is the process of fusing the panchromatic and multispectral imagery to give a true color image of the same resolution as the panchromatic image. The Pan Sharpening process can be access from the SOLO menu in the main application. Select the Panchromatic and RGB images from the appropriate drop down boxes, select the bands for data fusion, and specify an output file. The result will be added to the **Session Explorer** upon completion.

COLOR CORRECTION

Color Correction, accessed from the SOLO menu on the main application window, attempts to remove color casts and general lighting trends from a set of images to provide a more uniform color palette for comparison and mosaicking processes. Select the images for color correction, specify filename suffix for batch processing, and an output directory. The results will be added to the **Session Explorer** upon completion. Note: this process should be run on raw frame data for optimal results.

ORTHORECTIFICATION

Orthorectification is the process of creating a uniformly geospatially scaled image devoid of distortion due to underlying topology. The result is an ortho – orthophoto – and is seen as an accurate product for measurement. Access this process from the Solo menu on the main application. Choose the images orthorectification in the imagery list. Select the DEM for topology removal from the DEM list or select Planar rectification and set an elevation to rectify to. Choose the Resolution and Interpolation method for the output ortho. Use the checkboxes to Create Overviews and Add Files to Project for the output products. Finally, choose an output directory for the output before running the process. If the Add Files to Project box was checked, the results will be added to the **Session Explorer** upon completion.

MOSAICKING

To mosaic a set of orthos into a large format image product, select Mosaicking from the SOLO menu in the main application. Select the images to be added to the product in the Ortho Images list. Choose either the Plane or Disparity Cutline mosaicking methods. Choose the Intensity Correction for the output product, and the output post spacing. The resulting product will be placed in the file specified and added to the **Session Explorer** upon completion.

The Plane mosaicking method simply stacks all the orthos together and uses the image boundaries as the cutlines. For an output product with minimal distortion at the seams between images, use the Disparity Cutline method. This method takes significantly longer to run, but yields results with cutlines chosen to minimize the disparity between adjacent images.

Average intensity correction attempts to remove color cast and general trends of illumination difference between images before generating the output product. This yields a smoother product, but takes significantly longer to run than no intensity correction.

Band Stacking

Sometimes multispectral imagery is stored in one band per image. To combine these band images in a single multispectral product, use the Band Stacking process in the SOLO menu from the main application. From the Available Images list, select the bands for processing. The output bands list shows the order in which the bands will be placed in the output product. The topmost file in the list will be set as the first band. Use the up and down arrows to change the band order as necessary. The resulting product will be saved in the specified file and the results will be added to the **Session Explorer** upon completion.

GEOGENESIS® ENSEMBLE

The ENSEMBLE version of the GeoGenesis® suite adds a **Stereo(scopic) Workspace**, a number of new feature extraction and production tabs to the

Mono Workspace, and a host of scene generation functions. The added functionality to the **Mono Workspace** includes: FeatureXTract – a set of tools for 2D and 3D modeling from a pair (or more) of overlapping images; IA Pioneer – a set of exploitation tools that allow the user to annotate products with graphics, text, and perform some basic mensuration tasks; Product Generation – a set of tools focusing on exporting the modeled and annotated scenes to formats suitable for delivery in a number of formats. The specific menu items added under the ENSEMBLE toolkit are:

- Epipolar Rectification
- Area Correlation
- Vector Interpolation
- DEM Fusion
- DEM to Vector

THE MONO(SCOPIC) WORKSPACE IN ENSEMBLE

The Mono Workspace in ENSEMBLE has all of the functionality previously described under the SOLO toolkit, in addition to monoscopic and split-screen stereo production tasks for 2D and 3D feature extraction, exploitation and annotation, and scene product generation. The **Mono Workspace** handles all forms of data in the GeoGenesis® suite.

THE RIBBON

The tabs available in the **Mono Workspace** ribbon depend on the GeoGenesis® license level. GeoGenesis® Ensemble users see the Home and Data Control tabs (which have been covered in the GeoGenesis® SOLO sections), in addition to the FeatureXTract, IAPioneer, and Product Generation tabs.

The Application Menu of the **Ribbon** allows the user to create new Feature Sets, Tie Point Sets, and Annotation Layers. The **Active Layer** of the viewer can be set in the Application Menu by selecting an existing data layer, and is denoted by a check mark to the left of the data layer name. Finally, data layers can be removed from the viewer by choosing the appropriate option in the Application Menu.

THE FEATUREXTRACT TAB

The FeatureXTract tab is used for 2D and 3D modeling using one or more overlapping images. The four groups of the FeatureXTract tab are: Selection, Creation, Manipulation, and Detailing.

SELECTION

When the Active Layer is a feature set, the Selection Mode describes how objects are selected in the modeling workspace: by feature, by point, by edge, or by group.

Feature Selection allows for the selection of any of the basic feature types: feature points, polylines, and polygons. These are objects that were created using the various Creation mechanisms discussed in the next section. Feature points are points that were created using the Draw Point feature creation command.

Point Selection allows for the selection of the points that compose the more complex features.

Edge Selection allows for the selection of edges – lines that connect two points in a more complex feature.

Group Selection allows for the selection of a collection of features contained in a group.

Selecting an object can be accomplished by left clicking on the object. A group of objects can be selected by dragging a selection window over the desired objects. If more than one feature lies beneath the cursor during a selection action, a dialog will pop up for the user to pick which feature is to be selected. Clicking on a feature in the dialog highlights it in the viewer, making selection of overlapping features simple. The features are placed in the dialog from highest elevation to lowest. The top of a building, for example, would be the first element in the list, while the bottom of the building would be the last element. Multiple object selection can be accomplished by holding down the Shift key during selection.

CREATION

When the **Active Layer** is a feature set, the Creation Mode describes what feature will be drawn when the user initiated a drawing action. The basic feature types available for creation are: Polygon, Point, Line, and Circle. Under the Polygon button, there are two types of polygons: a standard polygon, and a box – a polygon where all edges are at right angles to each other.

MANIPULATION

When the **Active Layer** is a feature set, the Manipulation Mode describes the mechanics of the click and drag event on a selected item. There are three manipulation modes in FeatureXTract: Epipolar, Z-Axis, and Freehand.

Epipolar movement moves the selected items along the epipolar line between viewers. In essence, dragging an object along the epipolar line sets the geospatial coordinates of that feature. More discussion about epipolar manipulation can be found in the Creating and Editing a Feature Set section.

Z-Axis movement adjusts the elevation value of the selected features.

Freehand movement moves the selected features in the X-Y plane.

DETAILING

The Detailing group contains common 3D modeling functionality for actions such as: extruding polygons, lofting features, and reversing normals. There is also a button to automatically generate a roof structure for a selected roofline.

The Extrude Polygons button is used to extrude a selected polygon to the underlying DEM. It is typically used to create a 3D structure from a selected roofline.

The Loft Features button is used to connect the vertices of two simple shapes to create more complex geometries. There are two types of lofting that GeoGenesis® currently supports: polygon to point, and polygon to polygon. Polygon to point lofting can be used to create geometries such as cones and

pyramids. Polygon to polygon lofting can be used to create tapering cylinders, truncated pyramids, etc. For polygon to polygon lofting, both polygons have to have the same number of vertices.

The Reverse Normal button is used to change the facing of the selected polygon. The Reverse Normal button is often used in conjunction with the **3D Model Viewer** to control the appearance of a 3D model.

The Build Roof button is the entry point to a future set of enhanced modeling capabilities in the GeoGenesis® suite. Currently, the Build Roof button will attempt to automatically build a simple pitched roof from the selected polygon. The generated roof can be edited to fit the exact geometries of the structure as seen in the covering imagery.

LOADING A FEATURE SET

To work on a feature set previously loaded into the project, click on the dataset name in the **Session Explorer** and drag it into the **Mono Workspace** viewer area. Then, go to the Application Menu to set the feature set as the **Active Layer**.

CREATING AND EDITING A FEATURE SET

To create a new feature set, go to the Application Menu of a **Mono Workspace** and click on New Feature Set. A new Unnamed Feature Set will appear in the **Session Explorer**, and the Application Menu of the **Mono Workspace** will show a new feature set. The **Active Layer** of the **Mono Workspace** will be set to the new feature set.

Bring up a second **Mono Workspace** and drag a new image into its viewer. Make sure that at least two of the **Mono Workspace** images overlap the region you wish to model in. For clarity, the two workspaces will be referred to as left viewer an right viewer, respectively. Now it is time to create some features.

Create a Polygon - Click on the Polygon button in the Creation group. Begin a new polygon by holding down the Control(Ctrl) key and clicking on the starting location (Ctrl-click) in the left viewer. Release the Ctrl key and go around the polygon, left clicking on each point. When you have placed the last point, right

click to end drawing. If you misplace a point, press the Backspace key to remove the last point drawn. To cancel a drawing action entirely, press the Escape (Esc) key.

Holding down the Ctrl button while drawing a polygon forces the drawing tool into right angle mode. All edges drawn while in right angle mode are orthogonal to the previous segment. Release to the Ctrl key to return to freeform drawing mode.

Create a Box – Select the Draw Box option from the Polygon drop down button to set the drawing mode. Begin drawing by Ctrl-clicking on the starting location in the left viewer. Move to the next point in the box, and left click to set the initial leg of the box. All subsequent edges will be either parallel or at right angles to this line.

Create a Point- Select the Create Point button to set the drawing mode. Ctrl-click on the point you want to create in the left viewer.

Create a Line- Select the Create Line button to set the drawing mode. Polyline creation is exactly the same as polygon creation, except that the last point does not automatically close the shape.

Create a Circle- Select the Create a circle button to set the drawing mode. To create a circle you need to select three points around the perimeter of the chosen area. Start by Ctrl-clicking on the starting location in the left viewer, then click two more points anywhere on the circumference of the circle. Once the third point has been placed, the circle will be automatically generated from the points.

USING THE MANIPULATION TOOLS

To set the geospatial location of the shapes that were generated, set the Manipulation Mode to Move Epipolar. In the right viewer, select one of the features that were just created. Click and drag the feature until it lines up on the same points selected in the left image. The feature has now been set to a geospatial location and is suitable for further modeling.

To adjust the elevation of a feature or set of features, set the Manipulation Mode to Move Z-Axis. Click and drag on the selected feature(s) to raise or lower the elevation. This mechanism is useful for raising or lowering the bottom of a building to match the imagery.

To move an object around in the X-Y plane, use the Move Freehand Manipulation Mode. This is useful for copy/paste actions to quickly create a scene with lots of structures with the same geometry.

3D MODELING: PUTTING IT ALL TOGETHER

Begin by locking the viewers together. Go to the Home tab on one of the views and Shift-click the Camera Lock button to set the locking for all viewers. In the left viewer, find a building for modeling. Set the Creation Mode in the left viewer to Polygon, the Selection mode to Feature Selection, and the Manipulation Mode to Z-Axis. In the right viewer set the Selection Mode to Feature Selection, and the Manipulation Mode to Epipolar.

Ctrl-click a roofline corner in the left viewer and continue around the roof, clicking on each corner. Right click to finish drawing. The polygon will appear in both viewers, and will be offset somewhat in the right viewer. Go to the right viewer and select the polygon. Click and drag the polygon until it lines up with the roofline of the building in the right viewer (Epipolar movement). This sets the geospatial location of the building rooftop.

With the polygon selected, click on the Extrude Polygons from the Detailing tab. The roofline will be extruded to the underlying DEM, creating a 3D model of the building. The extruded building model may not lie flush with the bottom of the building as it appears in the imagery. This is due to data differences between the DEM and the Image Sensors. To match the building to the image data, click in the left viewer on the bottom of the building. The Select Feature dialog will appear and allow you select the bottom of the building. In the left viewer, click and drag the bottom of the building until it lines up with the image (Z-Axis movement).

With a few clicks and a few drag operations, a simple geometric model of a building has been created from the input imagery. Its location is as geospatially accurate as the underlying sensor model, as are its geometric measurements.

More complex models can be created using the Loft Features and Build Roof mechanisms. Also, adjacent features can be physically attached to the same point using Point Snapping. To use Point Snapping during the Feature Creation action, hold down the Shift key during the drawing process: as you near a point that can be snapped to, the cursor will jump to that point. Clicking while continuing to hold down the Shift key will attach the new feature to that point.

THE IA PIONEER TAB

The IA Pioneer tab is used to annotate and perform basic mensuration tasks on an image. The three groups of the IA Pioneer tab are: Insert, Inspect/Measure, and Show/Hide.

INSERT

The Insert group is used to add specific annotation objects to the active annotation document. The Shapes popup menu allows the user to draw simple and complex annotation graphics on the image. The ClipArt button brings up the Graphics dialog, which allows the user to insert some predefined bitmaps into the image. Currently, GeoGenesis® deploys with a set of MIL STD 2525b Warfighting Symbols.

INSPECT/MEASURE

The Inspect/Measure group has tools to perform basic mensuration tasks, such as Separation Angle measurement and length Mensuration.

SHOW/HIDE

The Show/Hide group contains persistent objects that do not need to be manually created, simply shown or hidden. The North Arrow button shows or hides the North Arrow in the upper left corner of the workspace viewer. The Gridlines shows or hides a set of geographic gridlines, based on the settings in **Preferences**. The Zenith Angle button adds the Zenith Angle of the sun for the image to the **Cursor Location** string at the bottom of the viewer.

LOADING AN ANNOTATION SET

To work on an annotation set previously loaded into the project, click on the dataset name in the **Session Explorer** and drag it into the **Mono Workspace** viewer area. Then, go to the Application Menu to set the annotation set as the **Active Layer**.

CREATING AND EDITING AN ANNOTATION SET

To create a new annotation set, go to the Application Menu of a **Mono Workspace** and click on New Annotation. A new Unnamed Annotation will appear in the **Session Explorer**, and the Application Menu of the **Mono Workspace** will show a new annotation set. The **Active Layer** of the **Mono Workspace** will be set to the new annotation set.

To add shapes to the annotation document, click on the Shapes pop out menu and select the appropriate shape to begin drawing:

Ellipse – Select Ellipse from the drop down menu. Click and drag the ellipse bounding box to draw the ellipse. The drawing properties of the ellipse are taken from the Polygon settings in the **Preferences**.

Point – Select Point from the drop down menu. Click on the location in the image to set the point. The drawing properties of the point are taken from the Point settings in the **Preferences**.

Polygon – Select Polygon from the drop down menu. Click on each vertex to draw the polygon. End the polygon drawing by right clicking. The drawing properties of the polygon are taken from the Polygon settings in the **Preferences**.

Polyline – Select Polyline from the drop down menu. Click on each vertex to draw the polyline. End the polyline drawing by right clicking. The drawing properties of the polyline are taken from the Polyline settings in the **Preferences**.

Rectangle – Select Rectangle from the drop down menu. Click and drag the rectangle bounding box to draw the rectangle. The drawing properties of the rectangle are taken from the Polygon settings in the **Preferences**.

Text Box – Add a text box to the image by clicking on the Text Box option from the drop down menu. Click on the image at the point where you want the text box to be centered. Edit the text by double clicking inside the text box. The drawing properties of the text box, including the font, are taken from the Text Box settings in the **Preferences**.

Point Marker – Select Point Marker from the drop down menu. Click on the image at the point where the marker should be dropped. A point marker will appear, with the Lat/Lon/Height of the point as calculated from the image's sensor model and the underlying DEM. The drawing properties of the point marker are taken from the Point Marker settings in the **Preferences**. The drawing properties of the text box, including the font, are taken from the Text Box settings in the **Preferences**.

Target Circles – Select Target Circles from the drop down menu. Click on the image at the point where the target should be dropped. A target marker will appear, with the Lat/Lon/Height of the point as calculated from the image's sensor model and the underlying DEM. Around it will be a number of rings, drawn at the specified radius and color. The drawing properties of the target rings are taken from the Target settings in the **Preferences**. The drawing properties of the text box, including the font, are taken from the Text Box settings in the **Preferences**.

North Arrow – Select North Arrow from the drop down menu. Click on the image at the point where the north arrow should be dropped.

Clip Art – Press the ClipArt button to launch the Graphics dialog. Navigate the tree structure to find the image you wish to insert. Click on the graphic and drag it into the viewer at the point where the graphic should be centered.

Once an annotation object has been drawn, the object's properties can customized by selecting it, right clicking, and going to the Properties option in the context menu. Set the properties for the current object and press OK. Only the

selected object's properties will be changed. For target rings, rings can be added or removed by right clicking on the Damage Rings grid and choosing the appropriate option.

MEASUREMENTS

GeoGenesis® currently supports a limited set of measurement functions. Specifically, you can use IA Pioneer to measure linear distances between two points, as well as measuring separation angles. The drawing properties of the measurement functions are taken from the Mensuration settings in the **Preferences**.

To measure an angle, the user needs to specify two rays, sharing a common endpoint. Select the Separation Angle button on the Inspect/Measure group. Next, click on the common point of the angle. Move the cursor to draw one of the legs of the angle and click to set the end point. Move the cursor to the other angle endpoint. Notice the angle drawing as you move and the angle measurement in degrees.

To make a linear measurement, select the Mensuration button in the Inspect/Measure group. Click on the starting point to begin the measurement. Move the mouse cursor to the end point of the measurement and click to end the measurement. The distance will be displayed in meters, with the height difference between the first and last measurements (according to the underlying DEM) shown in parenthesis.

THE PRODUCT GENERATION TAB

The Product Generation tab is used to generate geospatially accurate products for use in other software. The two groups of the Product Generation tab are: Region of Interest, and Scene Export.

REGION OF INTEREST

The Region of Interest (ROI) group has the controls to set and clear the region of Interest for a variety of tasks, including image chipping and scene export. To create a new ROI, select the New ROI button. Then, click and drag the bounding

rectangle of the ROI in the workspace viewer. To clear the ROI, press the Clear ROI button. If you wish to set the current view as the ROI, press the Full Screen ROI button.

The Image Chip pull down allows you to create an image chip either from the current ROI or from the current view by selecting Chip from ROI or Full Screen Chip, respectively. The image chipping functions offer shortcuts into the Crop and Resample process discussed earlier. When using the image chipping tools, the crop region is predetermined by the ROI or current view.

The Screen Capture button allows you to copy the visible contents of the viewer to a raster image file. This screen capture utility saves everything in the current view, including any annotation objects. This is a useful tool for creating graphics to be inserted into other products, such as a PowerPoint presentation.

SCENE EXPORT

The Scene Export group is a set of controls that together form the parameters of the Export Scene process. This process uses a specified ROI to output a single OpenFlight model containing all the features contained by the ROI and the DEM underneath. This scene product is the ultimate goal of the modeling, texturing, and DEM management tools contained in GeoGenesis®.

To export a scene, select an ROI that covers the area you wish to produce. Use the Features combo box to select the feature set to output. The combo box only pulls from layers present in the workspace, so if you do not see a feature set you have previously loaded into the project, click on it in the **Session Explorer** and drag it into the **Mono Workspace**. Select the DEM to export with the scene from the DEM combo box. Enter the post spacing and linear unit scale to complete the setup.

Press the Export Scene button to begin the scene generation process. A dialog will launch with a list of imagery that can be used to texture the output models. Select the images used for texturing and continue. Next, choose an output file to finish the Scene Export process.

GeoGenesis® ENSEMBLE Processes

Epipolar Rectification

The first step in the DEM generation process is often to take a stereo pair of images and epipolar rectify them to improve the performance of area correlation algorithms. Epipolar rectification is the process of using the sensor model information to resample the images so that matching features between resampled images lie on the same row in both images. The Epipolar Rectification process can be accessed from the ENSEMBLE menu option of the main application.

From the image lists, select the Left and Right images for the rectification process. Next, choose an interpolation method: Nearest Neighbor, Bilinear, or Cubic Convolution. Finally, choose an output directory for the generated files before running the process. The files will be placed in the output directory with the suffix _le and _re for the left and right images, respectively.

Area Correlation

Area Correlation is the process of finding a dense set of matching points in a grid on an image by searching a specified search region in a second image for a quality match. Area Correlation can be accessed from the ENSEMBLE menu of the main application.

Select the Primary Image from the provided list. This is the base image for the matching process. Select the Secondary Image to specify the image that will be searched for matching points.

The Post Spacing should be set to the grid size of the expected output. For a 5m post spacing DEM, set the value to 5.0. The linear units of the post spacing match that of the spatial reference system of the Primary Image.

The Confidence threshold can be a value anywhere between 0.0 and 1.0. A value of 1.0 signifies that only perfectly matched features should be considered valid matches. In practice, a value between 0.7 and 0.8 typically yields the best results.

If the images are an epipolar pair, such as the result from the Epipolar Rectification process, check the box to greatly improve the speed performance of the area correlation process.

Finally, specify the output file for the resulting area correlation vector results. Upon completion of the process, the resulting vector will be added to the **Session Explorer**.

VECTOR INTERPOLATION

To create a regularly spaced DEM product from a sparse or irregularly sampled vector, use the Vector Interpolation process. The Vector Interpolation process uses a form of inverse distance weighting to interpolate between sampled values and create an accurate, dense, and regularly sampled DEM product. To access the Vector Interpolation process, use the ENSEMBLE menu in the main application.

Choose the Vector Input for interpolation and set the desired output Post Spacing. Choose whether to output the product in vector or image (TIFF) format, and then specify the output filename. Upon completion of the process, the interpolation results will be added to the **Session Explorer**.

DEM FUSION

Sometimes no single DEM available covers the region of interest completely. This can make processing cumbersome, with the user having to constantly switch back and forth between DEMs. To solve this issue, GeoGenesis® has implemented a DEM Fusion algorithm that takes a set of input DEMs and creates a single fused product. The bounds of the final product are those of all the input DEMs combined. The resulting DEM can be used in any GeoGenesis® process involving elevation. DEM Fusion can be accessed from the ENSEMBLE menu item in the main application.

Use the >> and << buttons to add DEMs from the project into the parameter list. The ^ and v buttons can be used to move DEMs up and down in the DEM Priority list. In areas of overlapping data, the value contained in the DEM highest on the

priority list will be used. Specify a null value for any regions that are not covered by any of the selected DEMs and an output file. Upon completion of the process, the fused DEM will be added to the **Session Explorer**.

DEM TO VECTOR

Sometimes it is necessary to convert a DEM in image format into a vector. For those occasions, GeoGenesis® has a DEM to Vector conversion utility that can be accessed from the ENSEMBLE menu in the main application.

Choose the DEM from the combo box and a post spacing for the vector output. Specify a file name for the resulting output. Upon completion of the process, the DEM vector will be added to the **Session Explorer**.