Autodesk®
ImageModeler™
2009

User Guide

Autodesk®

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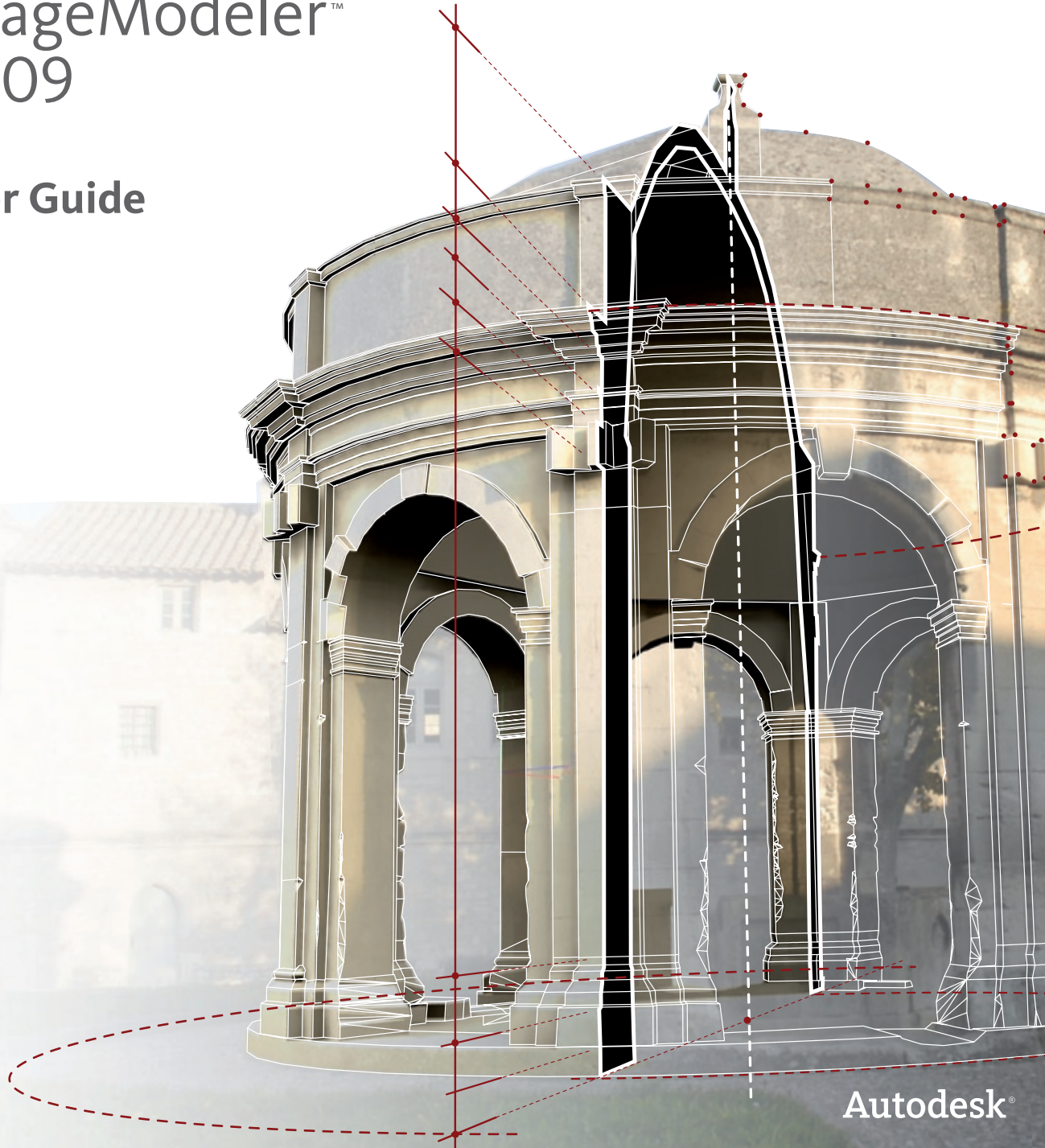
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Introduction

Introducing Autodesk® ImageModeler™ 2009

ImageModeler 2009 offers architects, designers and entertainment content creators a new approach to 3D modeling; by generating 3D models from 2D digital images or panoramas. Using advanced technology, ImageModeler 2009 extracts 3D information from still images to construct accurate 3D models and scenes with highly realistic textures automatically applied. The software also delivers a number of productivity-enhancing features including a rules toolset that enables you to make point-to-point measurements, and a mapping feature that allows you to define how each texture will be created. Additionally, ImageModeler 2009 offers support for Autodesk® 3ds Max® Autodesk® Maya® and AutoCAD® software.

How does ImageModeler work?

Typically, to create a 3D model of an object from photos, the object to be modeled should be shot from different viewpoints. By identifying common characteristics on the object in each of the images displayed, you provide the software with the information that it needs to automatically calculate the position, the orientation, and the characteristics of the camera (or cameras) used to take the photos. ImageModeler can then retrieve the spatial coordinates of any 3D element from its projections within two images at least.

If you are creating a model from a single image only, you can define the angles and perspectives in the shot so that ImageModeler can calibrate spatial coordinates from the single image.

By means of the 3D points rebuilt by triangulation, or using the image(s) as visual guides, ImageModeler enables you to create polygon-based 3D meshes. Textures extracted automatically from the images and mapped on to the model keep the realism of the original photos. You can also edit and modify these textures manually. Finally, export the resulting model to compositing, animation or CAD software, for further enhancement and animation or for use in web application.

What can you do with ImageModeler?

ImageModeler can be used for modeling scenes or buildings for architectural purposes, for calculations and 3D surveys from photographs, for creating 3D virtual visits and fast creation of photo-realistic backdrops, for human modeling, for industrial design, for animation and special effects, and for simple creation of photo-realistic objects for video games.

Architecture, archaeology and cultural heritage

ImageModeler is designed to allow you to model of scenes or buildings "as built", create 3D virtual visits, simulate and prototype projects in their final environment, calculate scenes and 3D surveys from photographs, and match the camera perspective for overlay of 3D over 2D pictures.

Industrial design

With ImageModeler, you can re-construct existing models from photographs, for example, create 3D models of a town, and integrate projects into their final environment. More specifically, ImageModeler is cut out for modeling "as built" and reverse engineering.

Video games

For the gaming industry, ImageModeler allows fast creation of photo-realistic environment, human modeling, virtual reality, and 3D virtual visits.

Reconstruct photo-realistic scenes

ImageModeler tools allow you to extract texture maps directly from photographs to produce photo-realistic scenes of these meshes and re-create a scene or an object in 3D as it is in reality.

Integrate projects into existing environments

ImageModeler helps you create photomontages of 3D projects in real environments, accurately and "at scale". You can add extensions to existing buildings, a street, a town by creating your 3D project or extension with your favorite tool (3ds max™, REVIT™, AutoCAD®, etc.), take several photographs of the environment, and then use ImageModeler to create an accurate photomontage in all pictures at once. The image below shows a reconstructed archeological site (Temple of Aphrodite, Aphrodisias site, Turkey):

Measure your scene

Another use of ImageModeler is to measure the 3D space from simple photographs. These measures, which are performed by a simple interaction with the images, do not require any prior information about the observed scene, or about the cameras that have been used.

You can use your computer offline to measure 3D distances and angles of real scenes from simple photographs: objects of any size, buildings, landscapes, far distances, inaccessible areas, crime scenes, etc.:

About this guide

This guide takes you step by step through every step of the ImageModeler process. Whether you have little or no understanding of polygonal modeling, or are an experienced 3D modeler, you will be able to find the information you need to quickly become proficient at generating 3D models from 2D digital images or panoramas.

Type conventions

This guide uses the following type conventions to help you quickly find and understand information:

- Key combinations are capitalized with bold type. For example, press **Ctrl+Z**. For a full list of keyboard combinations, see "Keyboard Shortcuts" on page 223.
- Words referring to items within ImageModeler menus and pop-up menus are shown with the symbol > indicating the path to a menu item. For example, when you see **Edit > Preferences**, go to the **Edit** menu and then the **Preferences** item.
- "Click" means click the left mouse button and "right-click" means click the right mouse button.

Using command shortcuts

ImageModeler provides the following types of command shortcuts:

- **Keyboard shortcuts**
  The keyboard shortcuts are shown next to the main menu commands or actions. Keyboard shortcuts are available all the time, regardless of the workflow stage you are in. See "Keyboard Shortcuts" on page 223 for a complete list of keyboard shortcuts.
- **Contextual (shortcut) menus**
  The contextual (shortcut) menus contain commonly used commands, depending on whether the cursor is located in the **Scene Browser** or the **3D Workspace**.
  To access the contextual menus, right-click in either the **Scene Browser** or the **3D Workspace**. The contextual menu options vary according to the point you're at in the

workflow (you'll have different tools available to you when you're modeling than when you're texturing, for example).

- **The Toolbars**
  The ImageModeler six-stage workflow and **Display** toolbars contain icons and tools that help you work quickly and efficiently in each stage of the project (see "Working with the ImageModeler tools" on page 19 for more details about the workflow and display icons in the toolbars).

Autodesk Product Support

Autodesk provides "Up and Ready" support for 30 days from your date of registration covering installation, configuration and licensing of your new Autodesk software.

User Guide and Online Tutorials

To access the ImageModeler user guide, online tutorials or basic product support, go to **http://www.autodesk.com/imagemodeler**

You can also access this site by selecting **Help** > **Go to Product Center.**

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Getting Started

New to 3D modeling or ImageModeler?

If you are new to 3D modeling or ImageModeler, consider browsing this guide and the tutorials to learn more about using the application. Here are some good places to start:

- "Loading images and panoramas" on page 24 and "Moving a shot into a viewport" on page 32. These sections give an overview how to start a project and work with images.
- "Calibration and the workflow" on page 41. This section and the following sections describe the calibration process.
- "Modeling and the workflow" on page 107. This section gives an overview of polygon modeling and the ImageModeler modeling workflow.
- "Autodesk Product Support" on page 9. This section explains how to use the ImageModeler online Help, how to get technical support, and how to view online Help resources.

Starting ImageModeler
Click **Start > Programs > Autodesk > ImageModeler 2009 > ImageModeler**

Choosing shots to calibrate

ImageModeler uses the shots you add to construct and texture your model. The models you create from these photographs can only be as good as the photos you take, so when you select shots to calibrate the cameras, use the same standards you used to shoot the photographs (see "Recommendations for taking shots" on page 238).

- **Choose shots that provide complete coverage of your subject's surfaces**. If part of the subject is masked in one image, make sure that you include another image that reveals the masked region. You cannot texture what you cannot see in the photos.
- **Choose shots that show good perspective and adequate spatial information**, rather than those that show only one side of the subject. ImageModeler gets the depth information of an object from the perspectives shown in the photographs.
- **Choose shots that are in focus and are well lit**. Sharp images produce visible detail, making it easier for you to create models that look more realistic. Ideally, all shots

should have the same brightness and color balance. This ensures that the model's textures blend together to give a natural appearance.

- **Choose shots that show good detail**. Shots taken close enough to the subject capture the level of detail you need, but need to be far enough from the subject to include some the subject's background.

- **Choose shots that have the same zoom lens setting**. If you use a constant zoom, the focal length is more constrained than when you use a zoom and ImageModeler finds the focal length of the image more precisely.

- **Choose shots that include physical markers in the scene**. Using shots with easy-to-identify reference points both on the subject you want to model and in the space surrounding the subject in the calibration and modeling processes.

- **Avoid choosing cropped images or images that have been modified** in an external graphics package because they introduce uncontrolled changes of the distortion correction, the principal point, and the focal length of the image.

TIP You can calibrate multiple shots of differing types (including 360° panoramas).

The ImageModeler interface

When you start ImageModeler, you are presented with the ImageModeler interface:

Workflow Toolbar

Display Toolbar

Scene Browser

Tool Properties

Thumbnail View

3D Workspace

Property Box
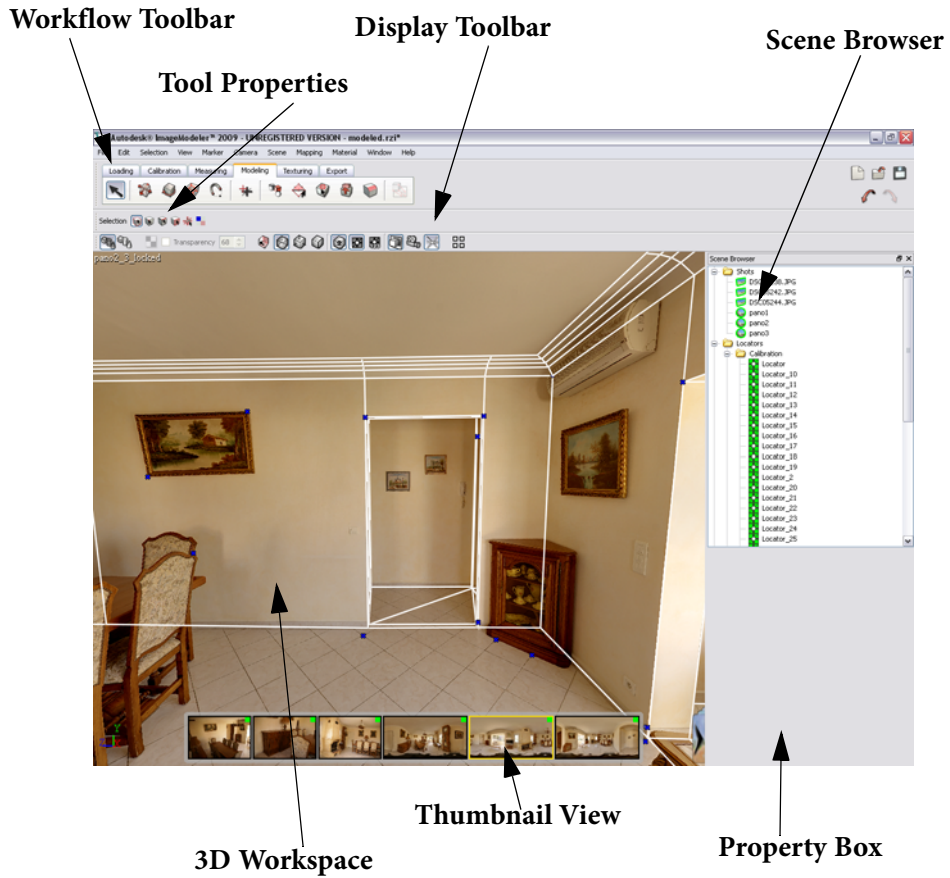
- The **Workflow toolbar** contains a set of contextual toolbars for working through the ImageModeler six-stage workflow (see "Working with the ImageModeler tools" on page 19). Almost all tools have their own tool properties that appear in the toolbar when you select a tool.

- The **Display** settings change the display for objects and components in the viewports.

- The **Scene Browser** allows you to track and change properties for camera shots and camera devices, view locators, select and edit objects, materials, and measure objects (see "Viewing camera shots and properties" on page 30).

- The **Tool Properties** contain information on the settings relevant to the selected object or component (see "Viewing camera shots and properties" on page 30).

- The **3D Workspace** is where you do most of your work, including calibrating cameras, modeling objects, and extracting textures (see "Working in the 3D Workspace" on page 29).

- The **Thumbnail View** only appears when working with a single viewport in a project that has multiple images. The **Thumbnail View** can be shown or hidden by using the open and close arrows on the bottom right of the **3D Workspace**, and you can change the horizontal position of the **Viewer** by dragging it left or right.

Customizable Interface

The ImageModeler interface can be customized to suit your screen real estate or working preferences. You can change the colour and position of the menus and toolbars. Drag and drop the toolbars where you prefer them (they snap to different edges of the screen)—or keep them floating.
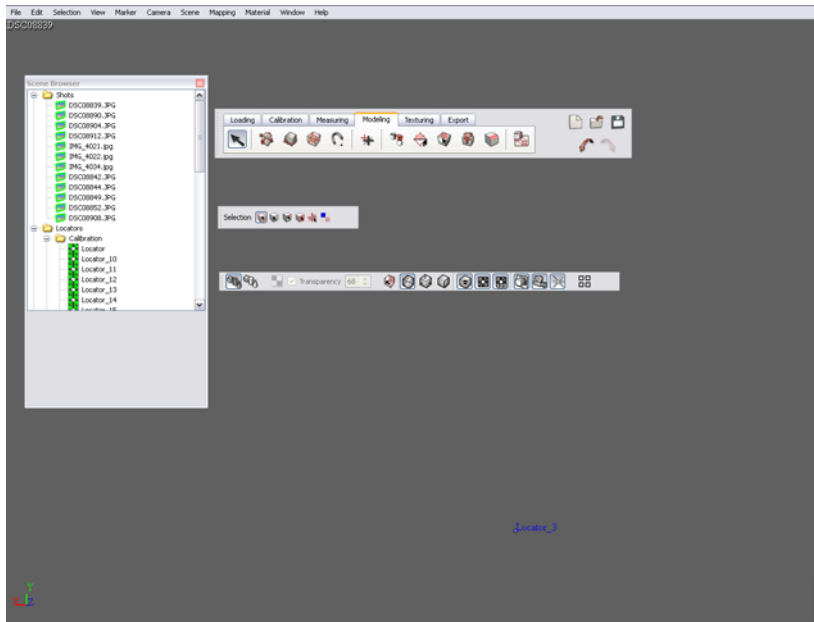
Using the Shortcut Manager

To create and edit shortcuts for ImageModeler functionality, select:

- Windows: **Edit > Preferences > Shortcuts** (or press "**P**" and select **Shortcuts**)
- Mac: **ImageModeler > Preferences > Shortcuts**
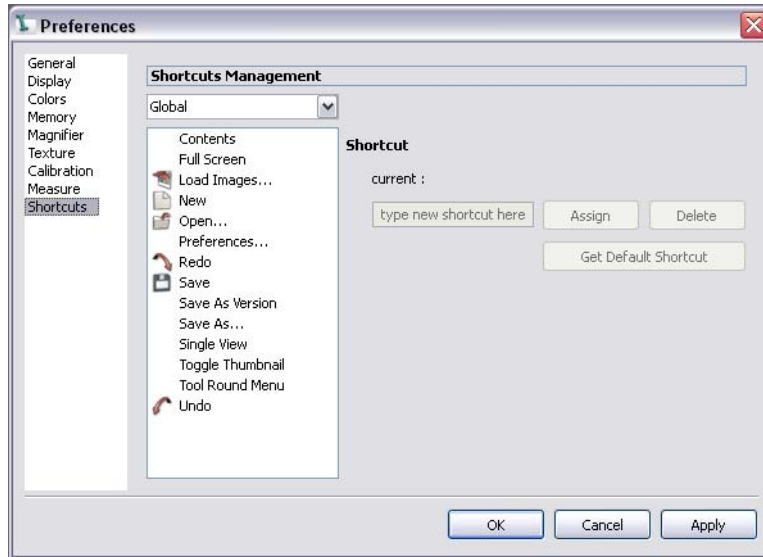
To create and edit keyboard shortcuts:

1 Select **Edit > Preferences** > **Shortcuts** (Windows) or **ImageModeler > Preferences > Shortcuts** (Mac).
2 Choose the toolset from menu to display a list of functions.
3 Select an action from the **Functions** list (you will see a short description of the function). If a shortcut has already been assigned, the key combination is shown in the **Current** information field (no shortcut will be displayed if the action has not yet had one assigned to it).

4 If you want to change the shortcut, click in the text field and enter your shortcut. Onscreen instructions will inform you about whether your chosen shortcut is free to use or not. Click **Assign** to activate the shortcut.

5 Click **Delete** to clear the text field. You can now define a new key combination for the shortcut in the blank text field. Click **Assign** to activate.

6 Click **Get Default Shortcut** to reset the shortcut back to the original system value. Click **Assign** to activate.

Working with the ImageModeler tools

Workflow tools and tool properties

The six-stage workflow is represented in the toolbar. When you select a tab in the toolbar to enter a new stage of a project, the tools you will need to work with in that stage of the project are displayed automatically.

Only one tool from the workflow toolbar is activated at a given time and almost all tools have their own tool properties that appear in the toolbar when you select them.

If the tool properties do not appear when you click on a tool, select **Window > Properties Toolbar**.

The workflow is described as follows:

1 **Load images**. When you create a new project, you must select whether you will be calibrating a single image (either a 360° panorama, or a normal shot) or a set of images (either a set of normal shots, or a mix of normal shots and panoramas). Then you load the shot(s) into a new project and create a camera device(s) (see "Loading images and panoramas" on page 24). When you select the **Load**ing workflow tab the following tools appear:
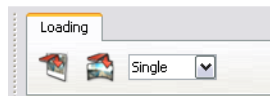
NOTE The calibration tools are different depending on whether you are working with a single shot or a set of shots. Calibrating a single image or panorama project uses **perspective** tools, instead of the **location marker** tools used in projects containing multiple shots of different angles of an object.

2 **Calibrate cameras**. You define the 3D space for your model from the 2D images and, if necessary, establish the properties of the camera(s) that were used to capture the photographs (see "Calibration and the workflow" on page 41). Select the **Calibration** workflow tab.

- When your project contains multiple shots, the **Multiple Calibration** workflow tab with the following tools appear:
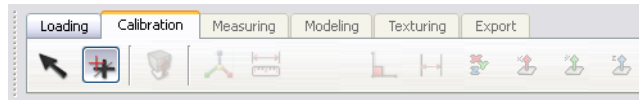
- When your project contains a single shot, the **Single Calibration** workflow tab with the following tools appear:
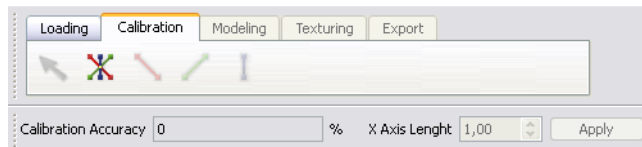
3 **Measure distances and angles**. You can add use a ruler to accurately measure 3D distances and angles by identifying the corresponding elements in the 2D images (see "Creating a new ruler to measure distances" on page 98 and "Creating a new ruler to measure angles" on page 100). When you select the **Measuring** workflow tab the following tools appear:
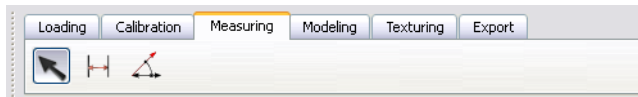
NOTE This workflow tab is only available in Multiple Image projects.

4 **Create a model**. You can create and edit polygonal meshes (see "Modeling and the workflow" on page 107). Select the **Modeling** workflow tab.

- When your project contains **multiple** shots, the following modeling tools appear:
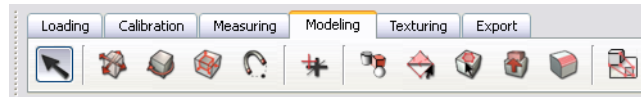
- When your project contains a **single** shot, the following modeling tools appear:
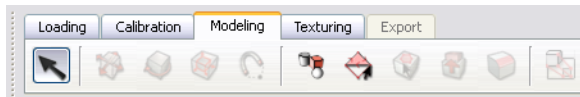
5 **Texturing a model**. After creating (or importing) a model, you can texture it by extracting the material from the background 2D images (see "Texturing a Model" on page 173). When you select the **Texturing** workflow tab, the following tools appear:
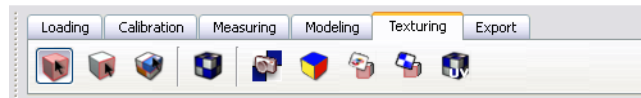
6 **Exporting a project**. You can export markers, locators, cameras, 3D objects, or textures, or any combination of them (see "Export file formats" on page 214). When you select the **Export** workflow tab, the following tools appear:
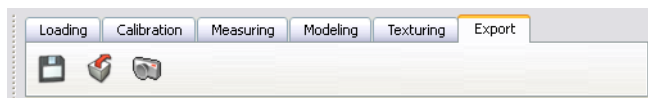
TIP At any time, you can create, open, and save a project, or undo and redo the last action by clicking on the tools available at each stage of the process:

NOTE To undo or redo the last action, you can also select **Edit > Undo** or **Redo**, respectively.

Display properties tools

In addition to the workflow tools, you can change the display options for 3D objects and locators differently in each viewport and set options that aid you at any time during the process. The display options are shown in the **Display** toolbar.

To show the toolbar, select **Window > Display Toolbar**.

- **Multiple Image** project **display toolbar** for calibration:

- **Single Image** project **display toolbar** for calibration:

ImageModeler projects

ImageModeler projects are XML files saved with the file extension *.rzi. An empty ImageModeler project is automatically created when you start ImageModeler.

Creating a new project

You can create an empty project when you start ImageModeler or at any stage in the workflow. To create a new project, do one of the following:

- Select **File > New**.

- Click (**New** icon) in the toolbar.

Opening an existing project

You can open an ImageModeler (*.rzi file from ImageModeler version 4.0 or higher) when you start ImageModeler or at any stage in the workflow.

To open an existing project:

1 Do one of the following:
   - Select **File > Open**.

   - Click (**Open** icon) in the toolbar.
2 In the **Open** dialog, select the file, and then click **Open**.

Saving a project

To save a project in its current status:

1 Select **File** > **Save As**.

2 In the **Save As** dialog, name the file, and then click **Save**.

Select **File** > **Save** or click ![Save icon] (**Save** icon) in the toolbar after you have saved the project once.

Loading images and panoramas

After creating a new project, the first step is to load images into a project. You should select images on the disk that correspond to the same "Group" with either the same camera used and the same image resolution (in pixels).

TIP You need to re-launch the "Load Image Wizard" to load several groups of images.

It is best to use uncompressed images, formats like TGA, and PPM for better quality textures. You can also load panoramic images created in Autodesk® Stitcher™.

NOTE The image size is unlimited, but loading many or large images can impact the software's responsiveness. Change the **Image Cache Size** in **Preferences** for faster pre-loading of images in the viewports.

Load image file formats

The table below describes the load file formats:

Load file formats	Extension
JPEG	*.jpg, *.jpeg
Maya® Image files#	*.iff,
Portable Network Graphics#	*.png
Portable Pixelmap	*.ppm, *.pgm, *.pnm
Tagged Image File Format#	*.tiff, *.tif
Truevision Targa	*.tga
Windows Bitmap	*.bmp

#8-bit and 16-bit images

The list below describes the panorama types supported:

- Spherical images (360° X 180°)
- Cylindrical images (360°)
- Cubical images: six square images (front, right, back, left, up, down)
- Spherical, cylindrical, and cubical QTVR panoramas

NOTE If you load a Quicktime panorama *.mov file, ImageModeler will convert it and create six cubical images automatically. The images (example_f.jpg, example_r.jpg, example_b.jpg, example_l.jpg, example_u.jpg, example_d.jpg) will be saved in the same place as the original Quicktime movie, so you must ensure that you have write permissions to the directory.

Loading camera shots into ImageModeler

To load images into ImageModeler:

1   Click the **Loading** workflow tab to show the toolbar:
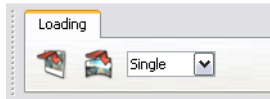
OR
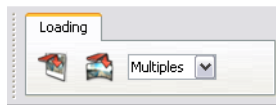
> **TIP** Choose **Multiples** for a modeling project that will use more than one image source (the images can have different resolutions, focal lengths or distortions, etc.), or choose **Single** for a project that will have only one source image (either a panorama, or a normal shot). ImageModeler functionality for calibrating shots changes according to the choice to load multiple, or single images so it is important to note what modeling requirements you have for the shot(s) when making this choice.

2   Do one of the following:
  - Select **File > Load Images** from the main menu.

  - Click (**Add Images to the project** icon) in the toolbar.

  - Click (**Add Panorama to the project** icon) in the toolbar.

3   Click **Add Images** to open either:
  - the **Load Images** dialog
  - the **Browse Location** dialog (to load a panorama)

4 Select the image(s) you want to add.

5 Click **Open**.

- If you are loading multiple normal shots, the selected images are loaded into the **Load Images** dialog:

- If you are loading a panorama, the image is added to the project and loaded into ImageModeler.

6 You can assign a camera device to the images that you are about to load. If you do not, ImageModeler will try to estimate the properties of the cameras that were used to take the shots and create a new camera device for the loaded shots.

Select from:

- **Select Used Camera** - If you have already loaded images into your project, you can assign these images to a camera device in the existing list. The option is only available for images that have the same ratio (width over height) and the same resolution in pixels.

- **Create a New Camera** - If no images are loaded and you do not want to import a camera, select this option to create a new camera device. Change the **Camera Name** in the text field. If all images were shot using the same zoom, check the **Images share the same zoom** option. If you are not sure, leave the option unchecked and ImageModeler will calculate one zoom value for each of your images. Similarly, if you know the **Focal Length** of your camera, enter a value. Otherwise, leave the default focal length.

- If your images are stitched images generated in Stitcher with the associated camera file (*.lens), click **Import Camera** to import the file that contains the focal length of the camera.

7 Click **OK**. The selected images are loaded into ImageModeler.

NOTE Although ImageModeler estimates the properties of the cameras, advanced users can control the information used to calibrate the cameras (see "Creating and modifying camera devices" on page 69).

The default focal length is set in the **Preferences** dialog. If the Read EXIF option is checked, ImageModeler will try to initialize the focal length data with the image data.

Working in the 3D Workspace

The **3D Workspace** is where you do most of your work, including calibrating cameras, modeling objects, and extracting textures:
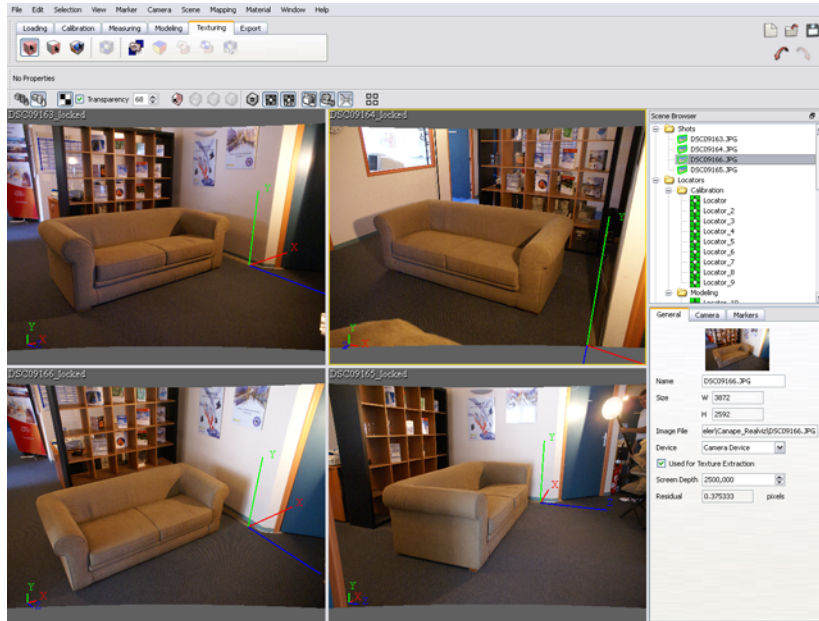
TIP To view the **3D Workspace** in the full screen, select **Window > Full Screen**. Select **Window > Full Screen** or Press **Ctrl + Shift + F** (Windows) or **Shift + Command + F** (Mac) to change the view back.

After loading images, ImageModeler automatically places the first image of a project in the **3D Workspace**.

You may need to change these images depending on the number of images in your project and on which images you want to place markers for calibration (see "Moving a shot into a viewport" on page 32).

In the **3D Workspace**, you can do the following:

- Split the default single viewport into two (either side-by-side or stacked) or four viewports by selecting **Window > Layout** from the main menu and choosing a view. Changing the layout of the viewport lets you see more than one image at a time or your model from different angles. From multiple viewports, press **Spacebar** to return to a single viewport.

- Set display options for each viewport (see "Display properties tools" on page 22). You can change the options to see your model with different shading options, such as wireframe or transparency.

- Frame the contents of your scene by changing the zoom or the camera position in the viewport (see "Framing the viewport contents" on page 76).

- Change the default colors for the **3D Workspace** background or elements, such as selected items, cameras, manipulator axes, locators and markers, and so on, by selecting **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac) and then the **Colors** tab.

- Store and restore up to five camera views (see "Navigating 2D images" on page 33).

TIP Click (**View Image Plane**) in the **Display** toolbar. ImageModeler hides the background 2D image, showing locators in the plane orthogonal to the viewing camera. You can then navigate through the camera views of the images in your project using the **Thumbnail View** (see "Navigating 2D images" on page 33).

Viewing camera shots and properties

When you select any project item in the **Scene Browser**, the **Property Box** shows information relevant to your selection.

You can track and change properties for camera shots and camera devices, view locators, select and edit objects, materials, and measure objects.

Show or hide the **Scene Browser** and the **Property Box** by selecting **Window > Scene Browser** to activate or deactivate the option.

To view project camera shots, either:

- Click **Cameras** in the **Scene Browser** to see thumbnails of all images in the **Property Box**.
- Click one of the camera shots to see its properties in the **Property Box**:
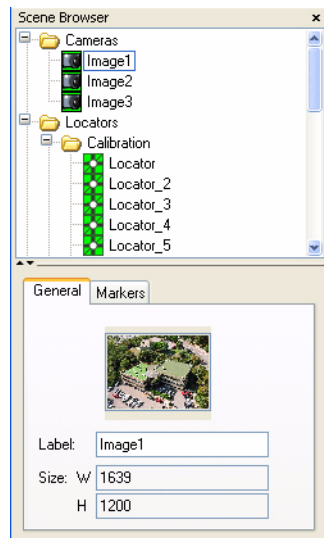
Relabeling shots
You can rename a shot to give a more meaningful name. To rename a shot:

1 In the **Scene Browser**, from the **Shots** folder, select the shot you want to modify.
2 Select the **General** tab in the **Property Box**.
3 In the **Label** field, type the new name.

TIP You can edit labels across multiple objects of the same type. For example, you can select several or all cameras and change the name in the **property box**—the selected objects will have the same name, ordered by a suffix number.

Moving a shot into a viewport

Each viewport shows the name of the shot it displays in the top left corner. By default, ImageModeler shows only one viewport containing the first loaded image, but you can see up to four viewports at a time (see "Working in the 3D Workspace" on page 29).

To assign a shot into a viewport:

1 Click the viewport to which you want to assign the shot. If only one viewport is shown, proceed to the next step.
2 Do one of the following:
   ▪ Double-click the shot name in the **Scene Browser**. The shot is assigned to that viewport.
   ▪ Click the **Shot** folder in the **Scene Browser**, and then double-click the shot in the **Property Box** you want to add.

■ Select a shot from the **Scene Browser** and drag and drop it into the viewport.
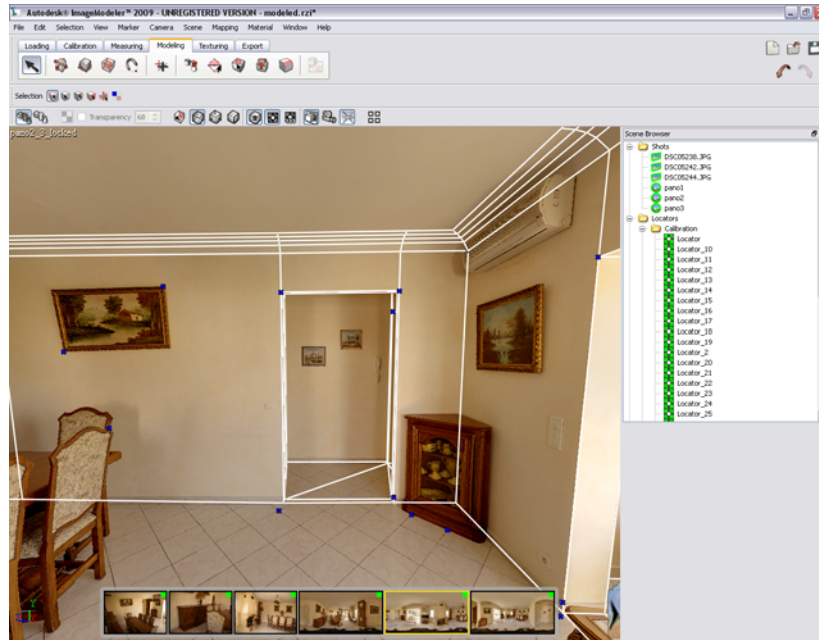
■ Hover the cursor over a shot in the **Thumbnail View**, and when the thumbnail enlarges, click it to assign it to the viewport.

Navigating 2D images

As you work with ImageModeler you can navigate the images using the **Thumbnail View**. You can use the **Thumbnail View** to navigate through images before cameras have been calibrated, but also in 3D once the cameras are calibrated (for details on locked and unlocked views, see "Locking and unlocking a view" on page 76).

To navigate images using the **Thumbnail View**:

1   Ensure that you have loaded more than one image for your **Multiple Image** project, and that the window layout is **Single View**.

2   Show the **Thumbnail View** by clicking [image] in the lower right corner of the **3D Workspace** (the viewer is displayed by default when more than one image has been loaded, but only one viewport is open).

   - Hide the viewer by clicking [image]

3   **Cycle backward and forward through the images**—drag the cursor to the right over the **Thumbnail View** to go forward or left to go back.

4   Hover the cursor over a thumbnail and it will enlarge—click it to see it displayed in the viewport (see "Moving a shot into a viewport" on page 32).

   TIP You can scroll through all images in your project and view them in sequential order in the viewport by selecting **View > Next Shot** (Ctrl + right arrow (Windows) or Command + right arrow (Mac)) or **Previous Shot** (Ctrl + left arrow (Windows) or Command + left arrow (Mac)).

To change the field of view in a 2D image

In the real world, a photographer, looking through the camera's eyepiece, pans up and down and from side to side and changes the field of view to frame a shot. As you work with ImageModeler you can navigate the images like a photographer using the navigation tools.

You use the navigation tools to navigate in an image before cameras have been calibrated, but also in a locked view after calibration (for details on locked and unlocked views, see "Locking and unlocking a view" on page 76).

- Zoom - Place the cursor over the part of the image you want to zoom and press the z-key. Press the z-key again to reset the view. Alternatively, using Windows, hold down the Ctrl+Alt keys, left-click and drag the cursor left to zoom out or drag right to zoom in. If you are using a Mac, use Command + Option + left-click. The camera moves forward and backward.
- Pan - If you are using Windows, hold down the Alt key, left-click and then drag up, down,left, or right to pan. On a Mac, use Option + left-click. Note that you can pan outside the viewport limits.

See also keyboard shortcuts (see "Keyboard shortcuts" on page 127).

NOTE You are not changing the object, only changing your view of it.

Using the Quick Zoom

The **Quick Zoom** option allows you to zoom in and out of the image under the cursor to rapidly view a magnification of your area of interest.

move the pointer over
the area of interest
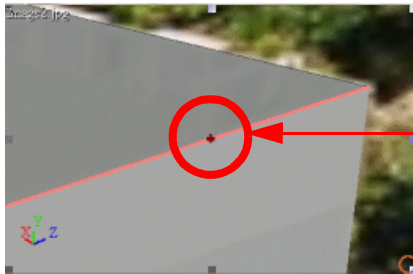
press the **Z** key to zoom
in on the area of
interest

Pressing the **Z** key again reverts to the original image size.

The active viewport is magnified by a factor set in the **Preferences** dialog:
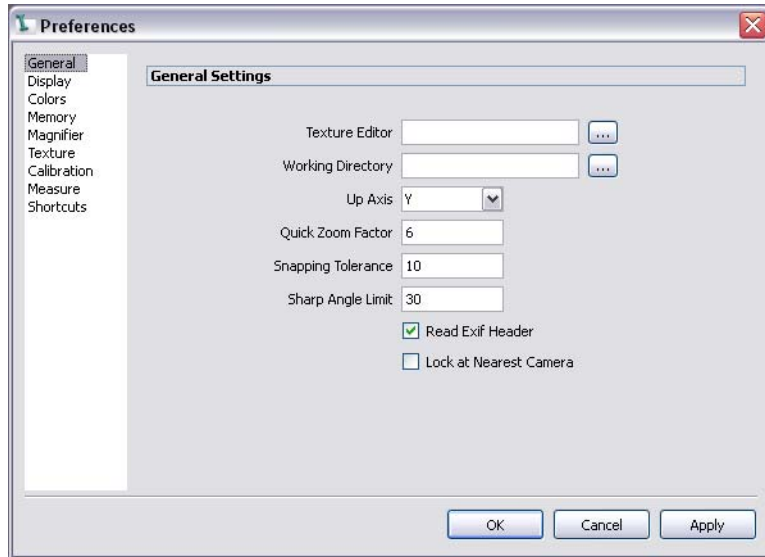
3

Calibrating Cameras in Multiple-Image Projects

Calibration and the workflow

In ImageModeler, calibration defines the 3D space for your model from the 2D images and establishes the properties of the camera(s) that were used to capture the photographs.

NOTE Calibration is an essential step in the ImageModeler workflow and you must complete it successfully before you can begin to create a 3D model. Carefully calibrating cameras is important because everything you do in subsequent stages relies on calibration.

Multiple image calibration workflow

For **Multiple Image projects**, by identifying the same features in different images ImageModeler can calculate the parameters (position, rotation, focal length, distortion) of the camera(s) used to shoot the images and calculate the 3D coordinates of the object. You define the features by placing markers on images.

Calibration means retrieving the camera parameters of the cameras that took the shots:

- 3D positions and orientation of the cameras
- Camera dependant parameters, such as focal length and radial distortion (see "About cameras" on page 68).

Once you have loaded shots and assigned them to workspaces, you can start to (see "Loading images and panoramas" on page 24 and "Working in the 3D Workspace" on page 29) calibrate your project.

Enter **Calibration** mode by clicking the workflow tab to show the toolbar. For more information about the toolbar, see "Working with the ImageModeler tools" on page 19.

When entering markers across several shots, the calibration toolbar will have these tools:
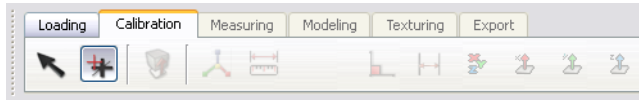
1 **Set camera device parameters** (see "Creating and modifying camera devices" on page 69).

2 **Create markers on 2D images to specify 3D locators** (see either "Creating Locators for Calibration in a Multi-Image Project" on page 43 or "Defining world space across multiple shots" on page 48). This process involves choosing which features to mark, and adding markers to each image that correspond to the same locator (point in space) in each image. You need to add at least 8 markers.

3 **Create a coordinate system** (see "Defining world space across multiple shots" on page 48). Define the world space for your model by specifying width, height, depth and direction of your modeling space.

4 **Improve the calibration** by adjusting markers, or adding more markers or constraints, and manual calibration (see "Improving the calibration" on page 65).

Single image calibration workflow

For **Single Image Projects**, calibration is based on the **Perspective Calibration Triedron**. For ImageModeler to calculate the 3D space from a single image, it must evaluate the perspective plane of the image instead of feature-matching from different angles in multiple shots. For detailed information about each step in the calibration of a single-image project, refer to the next chapter, "Calibrating Cameras in Single-Image Projects" on page 77.

When calibrating a single shot, the calibration toolbar contains the **Triedron Tool**:
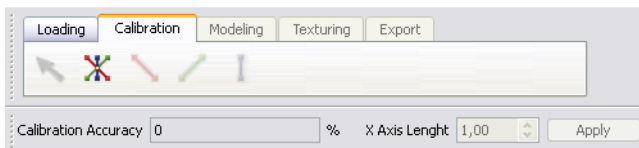
1 **Place the triedron inside the image to calibrate the 3D space** (see "Calibrating a Single Image Project" on page 79). This process involves setting a point of origin from which to place X, Y and Z axes. Mark the point of origin in a place from where you can precisely set the three planes (preferably along clearly identifiable straight "edges").

2 **Improve the calibration** by:

- Adding an X helper axe to complete the calibration. Then you can add other helper aces to further improve the calibration.

- In calibrating a single, normal shot (panoramas do not have distortion or consistent focal length values), use the focal length and distortion sliders to manually adjust the values to get a more precise, undistorted image and accurate calibration.

Creating Locators for Calibration in a Multi-Image Project

After you have assigned your images to their respective viewports, you can start placing the markers that will be used as reference points in the camera calibration process. A locator is a feature in the image (door corner, window corner, …) that is seen and easily identified in several shots.

Where do you place markers?

- **Identify target points on more than one image and preferably in all images**. Markers should be placed on locations that are easily identified in more than one image (preferably in all of the images in the project). Some objects have features that represent better targets than others. Buildings, for example, normally offer many good reference points: corners, intersection of elements, and so on.

  Look for areas where there is a clear color contrast between image elements, for example, at the intersection of a foreground and background element.

- **Place markers only if you are sure to see the same point in the other images**. If you have to guess a point in one of the images, ImageModeler may not be able to complete calibration.

- **Place markers over as much of the image as possible**. Avoid putting many markers in just one area of an image. Doing this may not provide sufficient information to accurately calibrate the cameras.

- **Place markers in the space surrounding the subject**. Using the space surrounding the subject to place markers can aid in the calibration and modeling processes. You don't need to place markers just on the object that you want to model.
- **Ensure that markers cover as many different depths and planes as possible.** Do not place them all on a single plane (such as a wall), as doing so will not provide sufficient 3D information.

In the example of a building (see image below), markers are evenly distributed on all "planes" of the object that will be modeled. The building's corners and the intersections between objects are generally excellent candidates for calibration features and give good 3D information. Some additional markers on the surrounding scene, for example, in the car park, provide important information to help the calibration process.

How many markers to place?

This depends on the size of your project. Small projects are easier to construct, the complexity of the scene to reconstruct, and accessible points in all or several shots.

There is no clear rule stating how many markers you should place, but ImageModeler will not complete the calibration with less than eight common locators on 2 images and at least 4 locators on the rest of the images. Optimally, seven to 12 targets in each

image can be enough. However, you may have to add more points, depending on several factors, such as number of input images, overlap of these images, sparseness of targets in 3D space, and so on.

Adding less than eight locators provides too little information to accurately define 3D locators. The quality and success of the camera calibration is measured according to the residual value. An understanding of the residual value can help you place markers more strategically (see "Evaluating the calibration in multi-image projects" on page 63).

Placing markers on 2D images

When you place markers (2D points) on images, they are transformed into locators (3D points) by the calibration process. You should try to place all markers in all images in the project.

To place markers on images:

1 Ensure the first image you want to mark is in a viewport (see "Working in the 3D Workspace" on page 29).

2 Do one of the following:

- Select **Marker > Place Marker Tool**.

- Click the **Place Marker** tool icon in the **Calibration** toolbar.

The pointer shape changes:

Action	Pointer
Create new locator	⊛
Add marker to selected locator	⊛
Current viewport already has a marker for selected locator	✳

3 Create a new marker in the first image by pressing **Ctrl + click** (Windows) or **Command + click** (Mac). By default, the **Magnifier** window appears, helping you to place markers more accurately:

TIP When placing a second or third marker for the same position on an object across different shots, the magnifier will display a second, smaller view of the last marker placed. This helps you to more accurately place your markers for a specific position on an object across shots. Turn the magnifier on or off and set the zoom factor in **Edit > Preferences > Magnifier** (Windows) or **ImageModeler > Preferences > Magnifier** (Mac).

4 Place the corresponding markers in the other images of the project by clicking the corresponding locations for the same object in the other shots.

5 Create new locators by repeating steps 1 to 4.

NOTE You must either reselect the **Place Marker** tool or press **Ctrl** (Windows) or **Command** (Mac) to create a new locator. To remove a marker from a single 2D image, press **Backspace**. To remove a locator from all images, press **Delete**.

By default, once you have placed at least eight markers in at least two images, you can get a first calibration result. The calibration process runs automatically in the background as you place markers on images, unless **Use Progressive Calibration** is turned off in the **Calibration** page of the **Preferences** panel (see "Running the calibration manually" on page 67).

Locators are added to the **Calibration** folder in the **Locators** directory in the **Scene Browser**.

Define a coordinate system

This section applies to projects containing multiple shots. For a project with only a single shot, you would calibrate using the **Set Triedron** tool and have set up helper axes.

Defining world space across multiple shots

After calibration, you can define the 3D space, or "world space" in which you will create, evaluate, and modify your models. World space orientation is defined by the X-, Y-, and Z-axis of the **XYZ Indicator** in the lower left corner of a viewport:

In addition to width, height, and depth, the XYZ axes also indicate direction (right, left, up, down, higher, lower) and provide a reference point for measuring the size and precise location of an object in the world space.

Most 3D packages, including ImageModeler, assign an arbitrary point in space as the point of origin of the X-, Y-, and Z-axes. This point of origin has a coordinate value of (0, 0, 0): the exact point at which the three axes meet.

About the World Space Tool

World Space Tool is used to define the origin and the main axis (X, Y, Z) of the coordinate system of your scene. The tool is composed of a direct trihedron (three orthogonal axes):
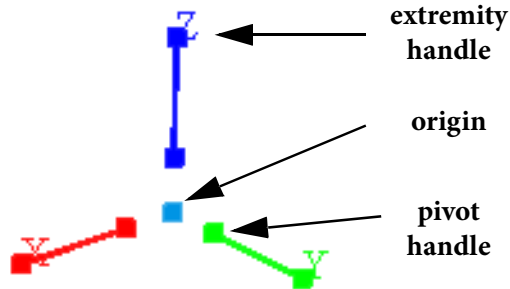
- The **origin** represents the point in the 3D space from where all coordinates will be calculated.
- The **pivot handles** near the origin of the tool allow you to separate the definition of the axis from the origin point. This is useful when you cannot or do not want to place all axis starting from one unique origin.
- The **extremity handles** allow you to define the world coordinate system. To set the origin and the axes of the world space, choose characteristic points in the images that define a trihedron (almost right angles between each edge) and create 3D locators from these 2D points.

NOTE You can change the color of the axes of the **World Space Tool** in the **Colors** page in the **Preferences** dialog.

Setting the world space

1 Do one of the following:

- Select **Scene > Define World Space**.

- Click ![icon] (**Define World Space Tool)** in the **Calibration** toolbar.

The **World Space Tool** appears in the viewport.

2 Drag the point of origin (the point at which all three axes meet) toward the locator to which you want it to snap. The **Snap** tool is automatically enabled, allowing you to snap to locators created from 2D markers. When the pointer changes to a magnet, release. In the following example, the origin is snapped to "Locator_7" the point of origin is locked in place:
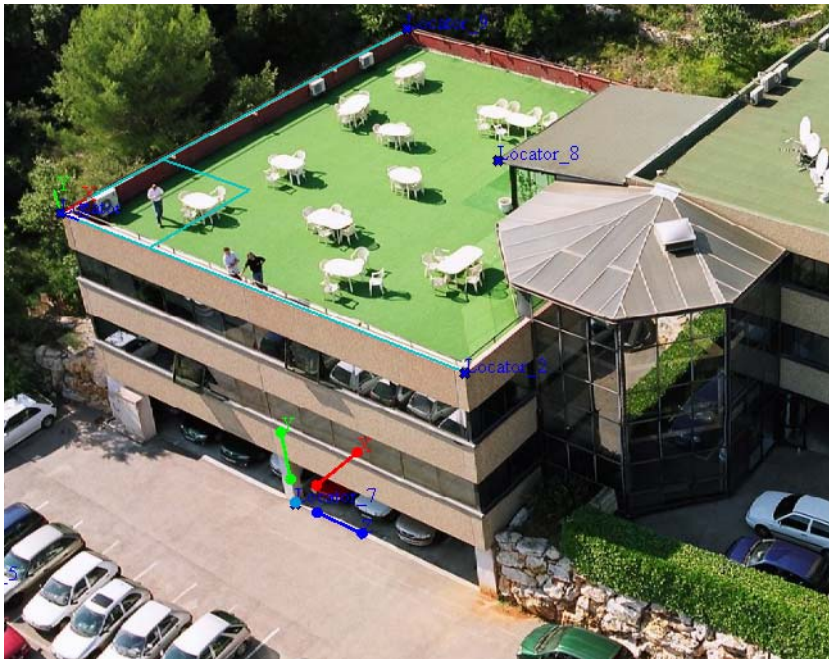
3 Drag one axis handle (X, Y, or Z) toward the locator to which you want it to snap. When the pointer changes to a magnet, release. The first handle is locked in place. In the following example, the X handle is snapped to "Locator":

4 Drag the second handle of the axis toward the locator to which you want it to snap. When the pointer changes to a magnet, release. The handle is locked in place, **lock 1** appears, and all three axes are set. In the following example, the X handle is snapped to "Locator_9".

5 Drag another axis handle toward the locator to which you want it to snap. When the pointer changes to a magnet, release. The second handle is locked in place, **lock 2** appears, and all three axes are set. In the following example, the Z handle is snapped from "Locator" to "Locator_2".

The world coordinate system is now set. The position of the remaining axis that you have not set is imposed by the coordinates of the first two axes and the origin. In the above example, the Y-axis is determined by the position of the X- and the Z-axes and the origin.

The settings are stored in the RZI project file.

NOTE Click **Apply** to validate the coordinate system you have created before choosing another tool. If you switch to another tool or select something else, the **World Space Tool** disappears.

Defining the reference distance

The scale of your calibrated 3D scene is set using the **Reference Distance** tool, composed of a simple ruler defined by two extremities and a line:

To define the scene scale:

1 When taking your photographs, measure the distance between two well-defined points in the scene.
2 In ImageModeler, create locators where you measured the distance.
3 Do one of the following:

-   Select **Scene > Define Reference Tool**.

-   Click (**Define Reference Tool)** in the **Calibration** toolbar.

The **Reference Distance Tool** appears in the viewport.

4 Drag the first ruler handle toward the locator to which you want to snap it. When the pointer changes to a magnet, release. The first ruler handle is locked. There is no constraint; the locator can be one of the previously mentioned locators. In the following example, the first ruler handle is snapped to "Locator_2".
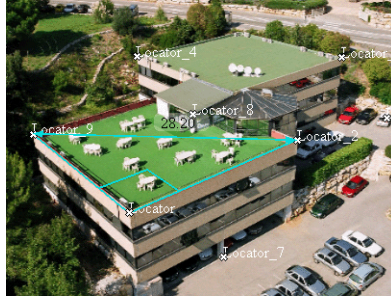
5 Drag the second ruler handle toward the locator to which you want to snap it. When the pointer changes to a magnet, release. The second ruler handle is locked (the locator must be different from the locator used in step 4). In the following example, the second ruler handle is snapped to "Locator".

6 In the tool properties, type the distance in the **Reference Distance** field and click on **Apply** to validate it. If the origin or the axes of the **World Space Tool** are not set, the **Apply** button will not be available to validate the world space.

TIP The settings are stored in the RZI project file. After defining the world space axes and the reference distance, you can use the ruler tools to you can make virtual measurements of any length in a scene (see "Creating a new ruler to measure angles" on page 100).

Resetting the axes

At any time you can drag the point or origin or **lock 1** or **lock 2** to reset them. If you move the point of origin after it is snapped, **lock 1** and **lock 2** (if set) are unlocked. If you move **lock 1** after it is snapped, **lock 2** (if set) is unlocked. Click **Reset** to switch back to the last applied setting.

Setting the up axis

You can define the up axis of the default coordinate system. This determines the axis around which you want the model to orbit.

To set the up axis:

1   Select **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac).
2   From the **Up-Axis** drop-down list in the **General** page, select either **X**, **Y**, **Z**, **-X**, **-Y**, or **-Z** as the default up axis.

Constraining the calibration

ImageModeler handles four types of constraints that can help make the calibration more accurate:

- The **Corner constraint** allows you to tell the solver that three points define a right angle.
- The **Planar constraint** tells the ImageModeler solver that a set of locators are in a same plane by fixing one of the XYZ coordinates.
- The **Survey point constraint** allows you to define the 3D coordinates of some points of the scene that will be used for calibration.
- The **Distance constraint** allows you to define the precise distance between two locators in the 3D space.

NOTE The above constraints provide strong information for the calibration process, which will be useful if they have been verified in the real world, but can produce a bad calibration if they have not.

The table below explains if the constraint sets a coordinate system or requires a predefined one:

Constraint	Constraint sets a coordinate system	Requires a predefined a coordinate system
Corner	No	No
Planar	No	Yes
Survey point	Yes	No
Distance	No	No

Placing a corner constraint

If objects in your images contain right angles, you can speed up the calibration process by constraining the placement of markers on three consecutive locators of the object. Using the **Place Corner** tool, you can help the calibration solver converge and improve the accuracy of the calibration results.

To create a corner, you have to select three locators that form a right angle in the 3D space:

1 Click ![icon](place corner icon) (**Place Corner)** in the **Calibration** toolbar (or select **Marker > Place Corner Tool**). The pointer changes shape.
2 Place the center point of the corner constraint on an existing locator.
3 Place the first branch of the tool on an existing locator that is different from previous one.
4 Place the second branch of the tool on an existing locator that is different from the previous two locators.

The corner is displayed in all viewports and it is added to the **Calibration Constraints** folder in the **Scene Browser** with generic name "Right Angle".
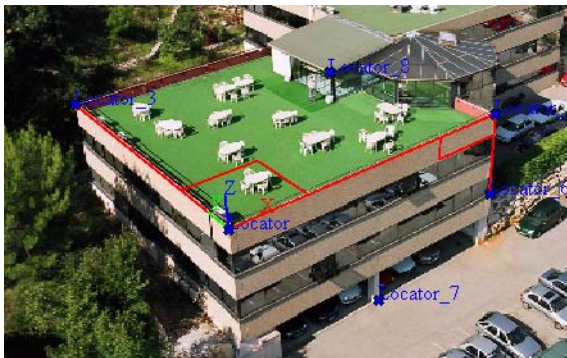
NOTE You can change the color of markers (2D points) and locators (3D points) in the
Colors page in **Preferences**.

Adding distance constraints

Use this constraint to define a distance between two locators. Several distance
constraints can be used in a project to help calibrate.

1 Select two locators between which you will define a distance.

2 Click ![icon] (**Distance constraint)** in the **Calibration** toolbar (or select **Marker >
Define Distance Constraint**). The pointer changes shape.

3 Enter the **Reference Distance** in the **Properties Toolbar**.

4 Click **OK** to validate.

NOTE Distance constraints are added to the **Constraints** folder in the **Scene Browser**.

Adding planar constraints

The planar constraint tells ImageModeler's calibration solver that a set of locators are
in a same 3D plane by fixing one of the coordinates, either X, Y, or Z.

The constraint is dependent on the project coordinates and it must be compatible with
the world space coordinate system.

To set a planar constraint:

1 Select at least two locators.

2 Select the type of planar constraint: **Normal to X**, **Normal to Y**, or **Normal to Z**.
(Oxy=shareZ, Oxz=shareY, Oyz=shareX). For example, Normal to X means that all
selected locators L(x,y,z) are in the same plane and share the same X coordinate. If

Z is the up axis of your scene, all locators on the ground are probably "Normal to Z".

ImageModeler calculates the values of the planar constraint. The constrained locators are added to the **Planar Constraints** folder in the **Scene Browser**. An arrow is drawn on locators in the 3D workspace to represent a planar constraint applied to them. The direction of the arrow depends on the shared axis. The image below shows the **Normal to Z** planar constraint.
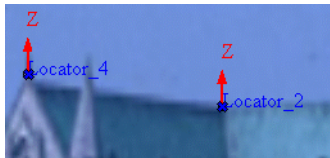
Adding survey point constraints

If you know some of the properties of a scene, for example, GPS information, measurements taken onsite, or measurements deduced from CAD maps, you may know the 3D coordinates of some points of the scene.

Instead of letting ImageModeler compute their 3D coordinates, you can set them before the computation. This is a way to use this information as an input to calibration.

Setting 3D survey points has several advantages:

- The points help ImageModeler automatically finding the appropriate coordinate system that matches your measurements of the scene.
- The calibration will be more robust, as all the survey points will help ImageModeler to find other points in the scene.

NOTE ImageModeler will set a default coordinate system based on three unaligned survey points. However, if you have already set a coordinate system using the **Worldspace tool** and you then want to add survey points, the survey points should be set relative to the same coordinate system. If you use survey points, it is preferable to let ImageModeler set the coordinate system for you.

To set a survey point constraint:

1 Select a locator.

2 Click ![icon] (**Define Survey Point** icon) in the **Calibration** toolbar (or select **Marker > Define Survey Point**).
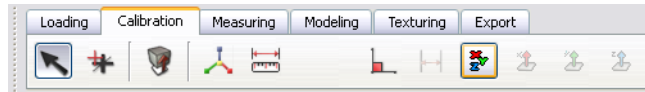
3 Set the known position of the locator in 3D.
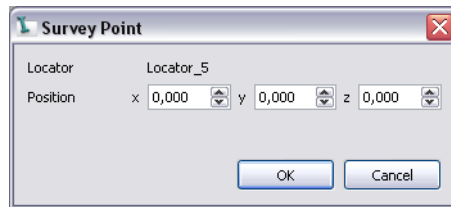
4 Click **OK** to validate the constraint.

The survey locators are added to the **Calibration Constraints** folder in the **Scene Browser**. A blue cube around a locator represents a survey point constraint in the **Workspace**.

Deleting a constraint

Delete a constraint by selecting it in the **Calibration Constraints** folder in the **Scene Browser** and either right-click and select **Delete** from the contextual menu or press **Del** on the keyboard.

Modifying the Magnifier window

You can turn the **Magnifier** window off and you can change its size and level of magnification. By default, magnification is set to 4 × and the size of the window is 256 × 256 pixels.

To set the **Magnifier** window properties:

1 Select **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac).
2 In the **Magnifier** tab, do the following:

- To change the size of the window, type the new size in the **Size** field.

- To change the level of magnification, type the new value in the **Zoom** field.

- Toggle the **Magnifier** display checking the **Use Magnifier** option.

Evaluating the calibration in multi-image projects

To ensure cameras are calibrated properly, you can analyze the color of the icons of the camera shots in the **Cameras** folder and locators in the **Calibration** folder in the **Scene Browser** as the calibration process runs.

Colored icons represent the residual value in pixels between the markers you place on the 2D images (see "Understanding the residual value" on page 64) and the associated 3D locators.

- Green icons indicate successfully created locators.
- Yellow icons indicate moderately successfully created locators.
- Red icons indicate poorly created locators.

Locator icons represent the average residual value of the locator in all the shots. Colored camera shots icons represent the average residual value of all locators in that shot.

If the calibration is poor, a circle appears around the badly positioned locator, indicating that the residual is above the "good" value for the quality threshold and the locator is not well calibrated (see "Changing the Quality Threshold" on page 66 for more details on the quality threshold). The circle's radius is proportional to the residual value, so you need to minimize the size of all the circles in the view by relocating the corresponding marker. If a locator's residual is below the good threshold, no special symbol is displayed.

Understanding the residual value

The residual value is the distance in pixels between the 2D marker placed in the image and the 3D locator constructed by ImageModeler and reprojected onto the image.

For example, a residual of one pixel means that the locator is one pixel away from the corresponding marker that was placed on that image. This error value is directly related to how precisely you placed the marker; the more carefully you place markers, the better the chances of good calibration.

Residual value is also related to size of your images. For example a residual value of 2-pixels on a 500 × 500 image represents less precision than that on a 1,000 × 1,000 image.

To view the residual value of a locator:

1 Select a locator by clicking on it.
2 Click the **General** tab in the **Property Box**.
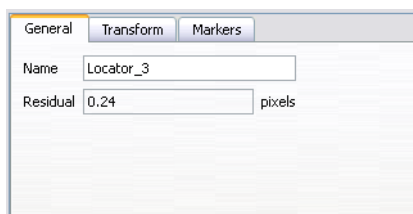
Filtering and Sorting Locators in the Scene Browser

Locator markers can be sorted in the Scene Browser according to their residual. They are sorted according to their creation ID by default.
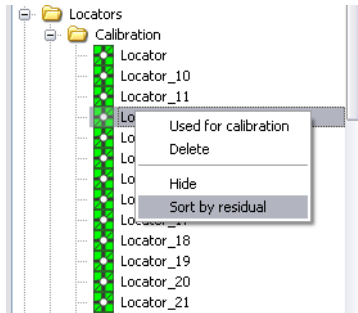
- Right-click a locator and select **Sort by residual** to change the order of the locators.

Improving the calibration

What do you do if the calibration is poor?

Ideally, you want all icons to turn green. If calibration results return too many red or yellow icons, the 3D space construction is not precise. Try

- Adding constraints to the calibration process (see "Constraining the calibration" on page 57).
- Checking the existing constraints consistency with the coordinate system (Worldspace) that was set (see "Setting the world space" on page 50).
- Check that the information in the camera device(s) are correct (see "Creating and modifying camera devices" on page 69).
- Adding more markers (see "Placing markers on 2D images" on page 45) and constraints (see "Constraining the calibration" on page 57).

- Adjusting the position of the markers you have placed to reduce the residual value (see "Adjusting the position of markers" on page 66).
- Change the level of precision (pixels) that ImageModeler uses to determine the residual value (see "Changing the Quality Threshold" on page 66).

As ImageModeler calculates the position and characteristics of the camera (or cameras) used to take the images by matching the points you have placed in the images, one badly placed marker may render not only its corresponding locator red, but also the neighboring locators. Try locating and changing the badly placed marker.

If your images are large, try changing the quality threshold to change the level of precision (pixels) that ImageModeler uses to determine the residual value (see "Changing the Quality Threshold" on page 66).

Adjusting the position of markers

By fine-tuning the position of the various markers, you can improve the positional quality of the markers. The corresponding locator icons change to green when good positional quality is achieved.

To adjust the position of markers:

1 Click a marker that you want to move. By default, the **Magnifier** window appears, helping you to place markers more accurately.

2 Adjust the position of the marker.

NOTE Locators can be checked or unchecked for calibration by clicking on a locator and selecting **Marker > Used for Calibration** or right-clicking on a locator and selecting **Used for Calibration** from the contextual menu.

Changing the Quality Threshold

Although changing the **Quality Threshold** does not change the actual accuracy of the calibration, you can change the level of precision (pixels) that ImageModeler uses to determine the residual value.

The default setting for **Quality Threshold** is optimized for six mega pixel shots. If you find that all the helpers are consistently red, consider changing the quality threshold to a lower value.

If you work with large images, consider changing the **Quality Threshold** to a higher value than the default value. Because the threshold value is measured in pixels, high-resolution shots tolerate higher threshold values. Low-resolution shots require lower threshold values to maintain accuracy.

To change the default residual setting:

1 Select **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac). The **Preferences** dialog opens in the **Calibration** page.

2 In the **Min Residual** and **Max Residual** fields, type the number of pixels that represent good and poor calibration.

A shot or locator with a residual higher than the poor value has a red icon in the **Scene Browser**. Shots or locators with a residual lower than the good value have a green icon in the **Scene Browser**. Shots or locators with a residual between the good and the poor value have yellow icons in the **Scene Browser**.

Running the calibration manually

The **Use Progressive Calibration** option in the **Calibration** page of the **Preferences** dialog determines whether or not cameras are automatically calibrated as you create or edit locators. If the option is turned off, you must run the calibration process manually.

To run the calibration process manually, do one of the following:

- Select **Camera > Calibrate** (or press "**F9**").

- Click (**Calibrate)** in the toolbar.

About cameras

Cameras represent the different devices used to capture the images. By default, when an image is loaded, ImageModeler creates a camera and the image is assigned to it. A camera is characterized by its internal parameters. the principal point, the focal length, the pixel aspect ratio, and the non-linear distortion.

If you already have information concerning the camera, for example, you know that it is a 24 by 36 mm film back camera with a 35 mm lens, you can provide ImageModeler with this information before launching the camera calibration process.
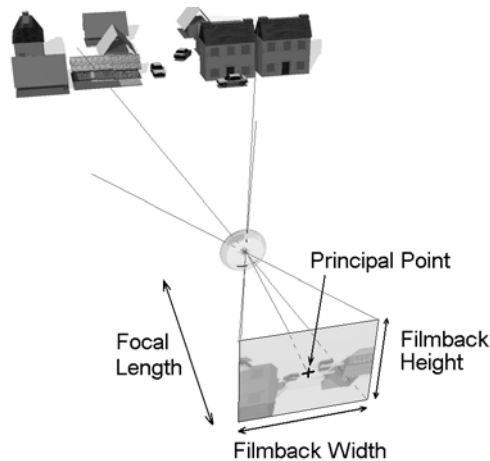
The focal length is the distance between the film and the optical center of the lens when the lens is focused on infinity. The principal point represents the projection of the optical center onto the film back, perpendicular to the film back plane. The film back values represent the size of your film and is proportional to the pixel aspect ratio.

Each camera parameter has a value that you can provide or you can allow ImageModeler to calculate it. The camera parameters—focal length, principal point, pixel aspect ratio, and non-linear distortion—vary or remain constant throughout the images and are either known or unknown.

Non-linear distortion

Mathematical models of a perfect camera imply that the image of a straight line is always a straight line. However, real lenses are not always perfect and may introduce distortion into your footage. The effect of distortion is that straight lines become curved as shown in the following image.
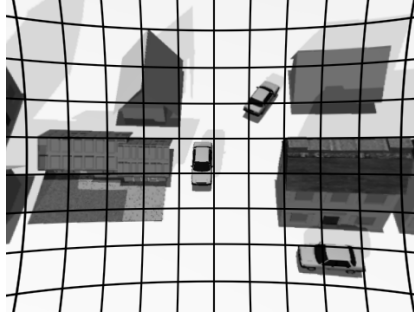
ImageModeler lets you input the radial distortion of your cameras if you know it, or will calculate it if you don't.

Creating and modifying camera devices

Different lenses and camera settings produce different effects in photographs, such as lines that appear slightly curved or wider angles of view. When you load images into a new project, ImageModeler estimates the properties of the cameras that were used to take the shots and creates a new camera device for the loaded shots (see "Loading images and panoramas" on page 24).

If you are an advanced user, you can control the information used to calibrate the cameras by adding a new camera device or changing an existing camera device's properties.

For example:

- If all the shots were taken with the same zoom., the focal length and distortion should be set to "constant". The option should already be set if you selected "zoom

constant" in the Load Image Wizard. This is the best case for calibration, as it is more constrained.

- If all the shots were taken with different zoom or you don't remember how you shot them, the focal and distortion should be set to "variable".

- If image1, image2, and image3 were taken with the same zoom and image4 and image5 were taken from further away, you need to zoom in the latter two images. You can create one device for image1, image2, and image3 with "constant" parameters, and another device for image4 and image5 with "variable" parameters.

You may want to modify a camera device if you captured the shots with the same camera and/or lens, but different zoom settings. You can change the focal length (see "Specifying the focal length" on page 71). Similarly, if shots have different lens distortion, you can change the camera device's distortion value. However, if you captured some shots with different lenses or cameras, you must create a new camera device for each lens, and then specify which shots were captured with the device.

If you know another camera was used to take some of your shots, but you do not know the values of it (for example, focal length), again you must create a new device with the default settings. If you're not sure if the shots were captured with the same device, use the default camera device.

Creating a new camera device

You can create a new camera device when you load images (see "Loading images and panoramas" on page 24), but you can also add a camera device just before calibrating the cameras.

To add a new camera device, select **Camera > New Camera Device**. The new device is listed in the **Camera Device** folder in the **Scene Browser**.

TIP Right-click in the **Scene Browser** and select **Add Camera Device** from the contextual menu to add a new camera device.

Assigning a camera device to a shot

If you created a new camera device, you must assign the device to the shot(s) that were taken with the device.

To assign a camera device to a shot:

1 In the **Camera** folder in the **Scene Browser**, select the camera shot you want to modify.
2 Select the **General** tab in the **Property Box**.
3 Select a new camera device from the **Device** drop-down list.

Modifying a camera device

When you modify a camera device, you can specify the focal length, the lens distortion, the film back value, the aspect ratio and the principal point according to your camera's settings.

Specifying the focal length

If you captured the shots with the same camera and/or lens, but different focal lengths, you can change the camera device's focal length. Images with the same focal length help to constrain the calibration, but it is not a necessary criteria. The focal length is the distance between the front of the lens and the film back (the plate where the film is exposed).

The default camera device is 35 mm with a film back value of 32×24 for a typical digital camera, which most closely resembles how the human eye perceives the objects it sees. Focal lengths greater than 35 mm create a narrower angle of view; focal lengths less than 35 mm create a wider angle of view.

To change the focal length of a camera device:

1 In the **Scene Browser**, from the **Camera Devices** folder, select the camera device you want to modify.
2 Select the **Device** tab in the **Property Box**.

3 In the **Focal (mm)** field, select either:

- **Known** if you know exactly the value and you do not want ImageModeler to recompute it. Type the approximate value in the **Focal (mm)** text field.

- **Constant** if you do not know the exact value, but can approximate it, and know that the parameter does not change. Typically, the default setting is adequate.

- **Variable** when the shots were taken with the same camera but with different focal length zoom.

Specifying the lens distortion

(Radial) distortion is a lens effect that causes straight lines close to the edge of a photograph to appear curved. If all the images were taken with the same camera, lens, and zoom settings, the images will have the same distortion:

To specify the lens distortion of a camera device:

1 In the **Scene Browser**, from the **Camera Devices** folder, select a camera device.

2 Select the **Device** tab in the **Property Box**.

3 From the **Distortion Status** list, select either:

- **Known** if you know exactly the value and you do not want ImageModeler to recompute it. Type the value in the **Distortion** text field.

- **Constant** if you do not know the exact value, but can approximate it, and know that the parameter does not change. If the value you type is very different from the real one you may get unsatisfactory results. Typically, the default setting is adequate.

- **Variable** for shots taken with the same camera but with different focal lengths.

4 From the Distortion Type list, choose either:

- Disto 3 (3i)—this is the default distortion type and it works in almost all cases.

- Disto 3 5 (-3i 5i)—this is a specific distortion type to be used when you're sure that either -3i 5i applies.

TIP You can also undistort your photographs with dedicated software or recreate wide-angle photographs with ImageModeler using several photographs stitched together.

Advanced Specification—setting the principal point

NOTE The following settings are recommended only to advanced users. Changes you make to these settings could adversely affect your calibration.

1   In the **Scene Browser**, from the **Camera Devices** folder, select a camera device.
2   Select the **Advanced** tab in the **Property Box**.
3   Choose **Known**, **Constant** or **Variable** from the **Principal Point** list.
4   Enter the **X** and **Y** coordinates of the point.

NOTE Previously saved camera parameters (*.lens files) can be loaded—either from Autodesk Stitcher or from other ImageModeler projects.

Specifying the film back size

The film back is the rectangular plate where the film is exposed. Still shots usually do not need any change to the default values; the film back size of a typical SLR camera is 24×36 mm.

To specify the film back size:

1   In the **Scene Browser**, from the **Camera Devices** folder, select the camera device you want to modify.
2   Select the **Advanced** tab in the **Property Box**.
3   In the **Size** fields, specify the width and height of the film back.

Specifying the film back aspect ratio

The aspect ratio is the height to width ratio of an image. All the images that are associated with the same camera must have the same aspect ratio. You need only to change this setting for video images because the film back aspect ratio is the same as the image aspect ratio for still shots.

To specify the film back aspect ratio:

1 In the **Camera Devices** folder, select the camera device you want to modify.
2 Select the **Advanced** tab in the **Property Box**.
3 In the **Aspect Ratio** field, type the value of the aspect ratio.
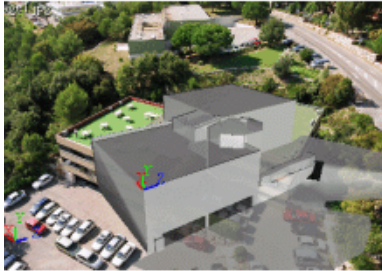
Navigating in 3D space

Before calibration, your view of the scene matches the angle and position of the camera that was used to take the shot (an image must be in the viewport) and the view is locked.

Interactive shot matching

While locked on a shot, you orbit in the 3D space using **Alt**+right-click. As you move the pointer, the 3D scene orbits and the viewport snaps to the nearest camera. This function is particularly useful to orient an object to add markers or when modeling.

Select a 3D object by clicking on it or selecting it from the **Scene Browser**

Press **Alt**+right-click and drag the pointer to orbit the object

Release the mouse button and the camera snaps to the nearest viewpoint

TIP Use the **Lock at Nearest Camera** option in **Edit > Preferences > General Settings** (Windows) or **ImageModeler > Preferences > General Settings** (Mac) to force the active viewport to use a specific camera angle.

Locking and unlocking a view

When you lock a view, your view of the scene matches the angle and position of the camera that was used to take the shot (an image must be in the viewport).

- Select **View > Lock View** or right-click and select **Lock View** (this action is independent of the **General Settings** option: **Lock View to Nearest Camera**).
- To toggle the camera display in the unlocked view, click on the **View Cameras** icon

  in the **Display** toolbar.

NOTE You can change the color of the cameras in the **Colors** page in the **Preferences** dialog.

Framing the viewport contents

ImageModeler allows you to frame the contents of your scene by selecting **View** and one of the following options.

- The **Fit to View** option changes the zoom to frame the content of your scene (in the vertical plane) in the viewport.
- The **Look at Selected** option centers the selected content of your scene (locators or objects) in the viewport.
- The **Frame Selected** option changes the zoom to frame the selected content of your scene (in the vertical and the horizontal planes) in the viewport.
- The **Frame All** option changes the zoom to frame all of the content of your scene (in the vertical and horizontal planes) in the viewport.

TIP You can access these options from the contextual menu that appears when you right-click anywhere in the **3D Workspace**.

4

Calibrating Cameras in Single-Image Projects

Calibrating a Single Image Project

Images suitable for the single-image calibration workflow are:

- A still image, where the camera parameters are either known or unknown. If camera information is available, ImageModeler will initialize the focal length value for each new project. If no EXIF information is available, you can edit the default values in ImageModeler.
- A fully closed, 360-degree panorama that represents the entire 3D space of the scene, where the distortion and focal length values are known values. For example, Stitcher® can be used to create high-quality panoramas for the Web, film, print, and 3D. Partial panoramas, e.g., panoramas with a FOV of less than 360 degrees, are not supported. The procedure for calibration is the same as for a still image except that you do not need to supply camera information (see "Calibrating an image" on page 87).

NOTE In certain cases, you can calibrate paintings and drawings, but satisfactory results are not guaranteed. ImageModeler relies on geometrically rigorous images and bases calibration on parallel lines representing the perspective of a scene. The perspective in paintings and drawings is drawn and may therefore be false.

About the calibration features

Once you have loaded a shot or a panorama into the 3D Workspace, you are ready to calibrate your project. Calibration is the most important step in ImageModeler; it helps to define the 3D space, or "world space" in which you will create, evaluate, and modify your models.

The Calibration Triedron and at least one Helper Axis are used to define the origin and the main axes (X, Y, Z) of the coordinate system of your scene.

The Calibration Triedron is composed of a direct triedron (three orthogonal axes).
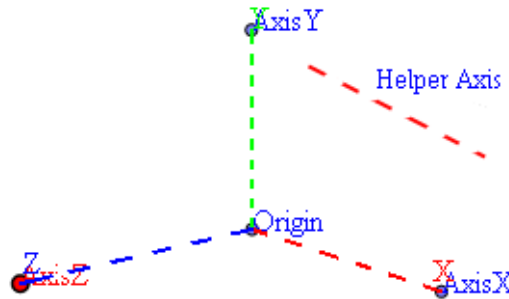
The handles allow you to define the world coordinate system. To set the origin and the axes of the world space, choose characteristic points in the images that define a triedron (right angles between each edge), like a room's corner or the corner of a building.

NOTE You can change the color of the axes of the **Calibration Triedron** in the **Colors** page in **Preferences**.

When the Calibration Triedron is placed satisfactorily, ImageModeler requires you to place an additional edge, called a Helper Axis, in the scene that is parallel to either the X-, Y-, or Z-axis. By placing more Helper Axes, the calibration refines to fulfill all the features placed.

Calibrating a panorama

To calibrate a panorama:

1. Do one of the following:

- Select Calibration > Set Triedron.
- Select the Calibration Triedron in the Calibration workflow tab:

The Calibration Triedron appears when you move the pointer into the 3D Workspace:

2. Place the point of origin (the point at which all three axes meet) to where you want to place it, for example, in the corner of a room:

TIP Press the Z button to open the Quick Zoom view and place the triedron more accurately.

3. Place one axis (X, Y, or Z) along the longest feature in the scene, e.g., a wall or a doorframe and click to place the axis.

The example below shows the placement of the X-axis along the floor/wall intersection:

4. Place the second axis along a second visual axis that is 90 degrees to the first axis and click to place the axis. The example below, the Y-axis is placed at a right angle to the X-axis where the two walls intersect:

5. You can use the navigation options to move around in the scene until you find the best view for placing the axis. Place the last axis perpendicular to the other axes and click to place it as accurately as possible:

In the example, the Z-axis is determined by the position of the X- and the Z-axes and the origin. The example below shows the placement of the Z-axis along the floor/wall intersection.

If one of the axes is not visible in the image, you should:

- Place it approximately as a first step (see Z-axis placement in the previous image)
- You can refine its position later once additional helper axes are placed

6. To calibrate the scene, you must at least place another Helper Axis (X-Helper Axis), which is parallel to the corresponding Calibration Triedron axis.

Place an X-Helper Axis by either:

- Selecting Calibration > Add X edge.
- Pressing the respective icons, or in the Calibration Toolbar:

7. Place the helper axis along the longest feature in the scene. The example below shows the placement of an X-Helper Axis at the wall ceiling intersection:

8. Increase the accuracy of the calibration by continuing to place X-, Y-, or a Z-Helper Axes in the scene. Two or three well-placed Helper Axes are sufficient.

NOTE If you switch to another tool or select something else, the **Calibration Triedron** disappears.

Calibrating an image

Calibrating an image is exactly the same process as calibrating a panorama except that the focal length and the distortion of the shot might be unknown, and ImageModeler requires you to set those values, or a good estimation of them (see"Setting the camera parameters" on page 87).

However, if the focal length is present in the EXIF header, it will be read and set automatically, giving a good initialization for the calibration process. You can always edit this value to improve the calibration accuracy value.

Setting the camera parameters

When you load an image, you can specify the focal length and the lens distortion according to your camera's settings before placing calibration elements. If camera information is available for the images in the panorama, you can select the Read EXIF Header checkbox in the General page of the Preferences dialog and ImageModeler will initialize the focal length value for each new project.

If no EXIF information is available, enter the focal length and distortion of your camera in the corresponding fields in the Tool Properties.

Deleting an axis

To delete an axis, click on it to select it and press **Delete**.

Resetting the Calibration Triedron

To reset the Calibration Triedron, select **Calibration** > **Reset Tool**.

Refining the calibration

The world coordinate system is now set and the project is calibrated. By checking the position of the reconstructed axes and adjusting the Calibration Triedron and the Helper Axes to match it and checking the Calibration Accuracy value, you can refine the calibration. Check the Calibration Accuracy value in the Tool Properties, which should be close to 100%. A value above 95% constitutes a satisfactory calibration:

Calibration Accuracy 39.277   %
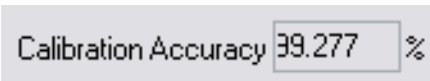
If the value is unsatisfactory and the axes do not correspond with the guidelines, you can:

- Adjust the camera parameters for still images only (see "Adjusting the camera parameters" on page 89)
- Adjust the position of the estimated axes (see "Editing the Calibration Triedron and Helper" on page 89)
- Add Helper Axes to improve calibration (see "Adding more Helper Axes" on page 90)
- Check the perspective (see "Checking the perspective" on page 90)

Adjusting the camera parameters

For images, adjusting the focal length may improve the calibration. If your images are highly distorted, for example, if you have used a wide-angle lens to take your shots, you should increase the Distortion value. You can also undistort your photographs with dedicated software or recreate wide-angle photographs with Stitcher® using several photographs stitched together.

Editing the Calibration Triedron and Helper

Axes

You can edit each axis and the origin of the Calibration Triedron and the Helper Axes by selecting the Selection icon in the Calibration Toolbar or selecting **Calibration > Select/Edit** and dragging the origin or an axis extremity. Try to match the axes with the reconstructed ones to improve the calibration. Do not adjust the axes placed correctly; only edit the axes that have been placed approximately. For example, in the image below, you can clearly see the wall/wall intersection where the Y-axis is placed and the wall/floor intersection where the X-axis is placed. However, the table hides the wall-floor intersection along which the Z-axis should be placed.

You should adjust the position of the Z-axis using the reconstructed axes for guidance:

Adding more Helper Axes

You can improve calibration by adding more Helper Axes. Remember to distribute the Helper Axes appropriately by placing them on different areas of the scene. Refer to "Guidelines for placing calibration features" on page 92.

Checking the perspective

You can verify the calibration by checking the 3D perspective using a 3D object.

1. Do one of the following:

- Select **Calibration > Set Triedron**.
- Click the **Modeling** tab to display the **Modeling Toolbar** and click **Add Primitive**. By default, a plane appears in the 3D Workspace.

2. Click **Cube**:
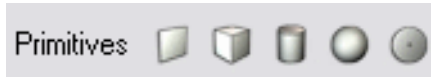
3. Create a box from the origin of the Calibration Triedron to each corner of the room. Use the navigation tools (see "To change the field of view in a 2D image" on page 35) to move around in the scene:

For more information on placing a primitive in a scene, see "Modeling and the workflow" on page 107.

Defining the reference distance

The scale of your calibrated 3D scene is set using the value set in the X Edge Length field: The value corresponds to the length of the X-axis of the Calibration Triedron and allows you define a reference distance and to measure the 3D space in a scene from a

simple photograph: objects of any size, buildings, landscapes, far distances, inaccessible areas, crime scenes, etc.

The default value is set to 1.000. Use the arrow buttons to change the value and click on Apply to validate it. If the origin or the axes of the Calibration Triedron are not set, the Apply button will not be available to validate the world space.

Setting the up axis

You can define the up axis of the default coordinate system. This determines the axis around which you want the model to orbit.

To set the up axis:

1. Select **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac).

2. From the Up-Axis drop-down list in the General page, select either X, Y, or Z as the default up axis.

Guidelines for placing calibration features

You should remember the following guidelines when placing the Calibration Triedron and the Helper Axes.

1. Place the first axis where you see the perspective is the strongest. Generally, this is not the up axis. In the image below, the X-Helper Axis is placed on the left wall, which displays the most perspective:
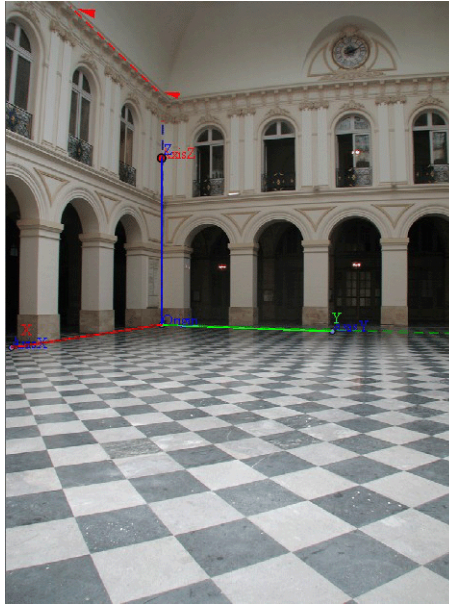
- Placing one to three Helper Axes is sufficient to achieve a good calibration. You must place a minimum of one Helper Axis. More than three Helper Axes tends not to be beneficial.
- Place the Helper Axes on the longest element in the scene.
- Parallel axes should not be placed too close in the image.
- Do not place two Helper Axes in the same latitude. For example, do not place axes along the same wall/floor intersection, but preferably place them on opposite wall/ floor intersections.

If you need to adjust the axes, do not adjust the axes placed where you can see the element you are aligning with. Only edit the axes that have been placed approximately.

5

Measuring Distances and Angles

About measuring distances

When shooting your images, measurement of any object in the real world must be taken to standardize the virtual coordinate system used by ImageModeler. To initialize the scale of a scene, you should capture a standard while shooting the images. The standard measurement can be, for example, a door's or window's width or height.

Using the **Distance Ruler** and **Angle Ruler** tools, you can make virtual measurements of any length or angle in a scene without requiring complete scene modeling. Using the ruler tools, measuring objects that are difficult to access, for example, the height or angle of a building, becomes easy. You can add more than one ruler to a scene and change the units of measurements for those rulers.

Before you can use rulers, you must define the world coordinate system correctly to define the 3D space in which you will create, evaluate, and modify your models. In doing so, you define the ratio between the real world and the virtual scene (see "Defining the reference distance" on page 54).

NOTE You can change the color of the rulers in the **Colors** page in the **Preferences** dialog.

## Creating a new ruler to measure distances

To create a distance ruler:

1 Select the **Measuring** tab in the workflow toolbar:
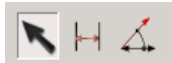
2 Do one of the following:

- Select **Ruler > Distance Ruler Tool**.

- Click (**Add Distance Ruler)** in the toolbar.

The ruler appears with the default measurement setting:
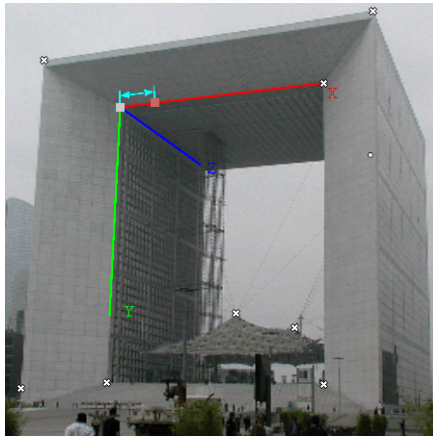
Each ruler has a start point, an end point, and a line joining the points. The ruler is added to the **Measures** folder of the **Scene Browser**.

NOTE To change default settings, see "Changing the ruler units of measurements" on page 103).

3 Click the start point of the ruler you want to measure:
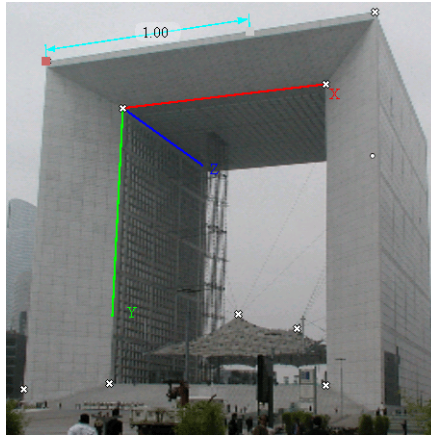

To attach rulers to points on an object with precise measurements, snap the ruler points to a vertex, an edge, or a face of an existing object, to a locator, or the axes of the world space, see "Setting the world space" on page 50. You can also position the start point anywhere in the 3D space.

4 Click and drag the other end point of the ruler to position it:
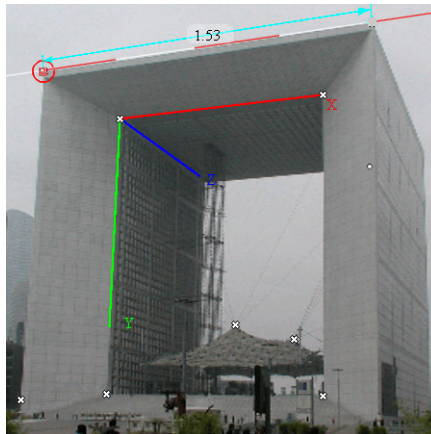
The measurement appears in the **3D Workspace** and in the tool properties.

5 Press **Enter** to validate the ruler. The ruler is added to the **Measures** folder of the **Scene Browser**.

Creating a new ruler to measure angles

To create an angle ruler:

1 Select the **Measuring** tab in the workflow toolbar:
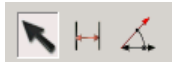
2 Do one of the following:

- Select **Ruler > Angle Ruler Tool**.

- Click on the **Add Angle Ruler** tool icon in the toolbar.

The ruler appears with the default measurement setting:
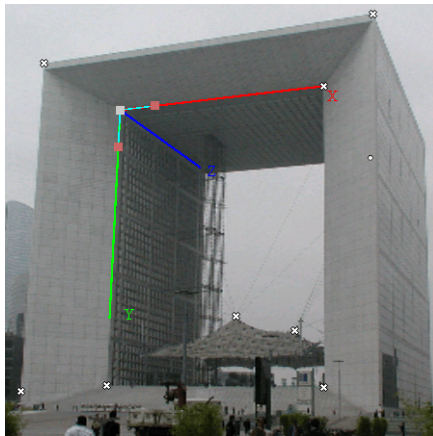
Each ruler has a start point, an end point, and a line joining the points to a center point. The ruler is added to the **Measures** folder of the **Scene Browser**.

NOTE To modify default settings, see "Changing the ruler units of measurements" on page 103).

3 Drag the origin of the ruler to where you want to position it:
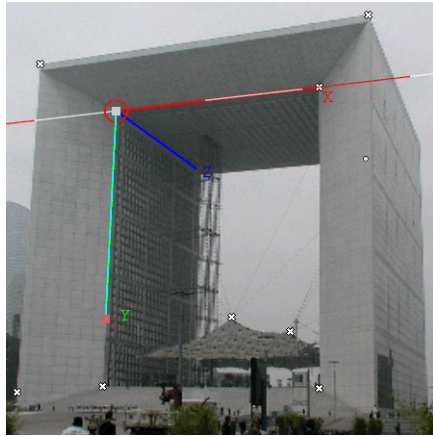
Snap the ruler points to a vertex, an edge, or a face of an existing object, to a locator, or the axes of the world space to measure with precision (see "Setting the world space" on page 50). You can also position the origin anywhere in the 3D space.

4 Click and drag the first axis of the **Angle Ruler** tool and drag it to where you want to place it:
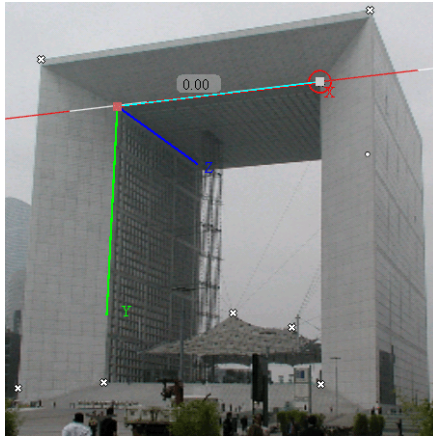
5 Click and drag the second axis of the **Angle Ruler** tool and drag it to where you want to place it:
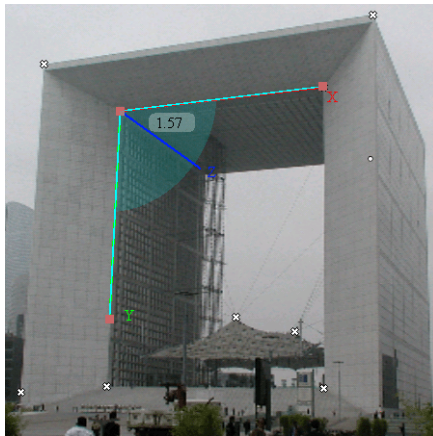
The measurement appears in the **3D Workspace** and in the tool properties.

6 Press **Enter** to validate the ruler. The ruler is added to the **Measures** folder of the **Scene Browser**.

Changing the ruler units of measurements

By default, the ImageModeler rulers are set to meters with a decimal digit of 2. You can change a distance ruler's unit of measurement to mm, cm, m, km, inches, feet, or miles, an angle ruler's unit of measurement to degrees, radians, or grads, or the decimal digit from 1 to 5.

To change the ruler units of measurement:

- Click **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac) and click the **Measurements** tab. Do one of the following:
  - Select an option from the **Distance Units** or **Angle Units** drop-down lists.
  - Select an option from the **Number of Digits** drop-down list.

NOTE the **Number of Digits** setting will not affect the precision of the values in the property box.

6

Modeling

Modeling and the workflow

Computer modeling is the process of creating shapes and forms onscreen using one or more types of geometry. In 3D packages, the mathematics behind the geometry is usually well hidden so that you can mould or expand your model with tools, just like you would in the real world; the computer does the necessary mathematical calculations. In ImageModeler, you model polygon objects like a sculptor using various tools in a 3D scene.

What are polygons and polygon meshes?

A polygon consists of three or more points connected by lines that create a shape. A polygon can be three-sided (triangle), four-sided (quadrangles, or quads), or many sided (n-gon).

Connected polygons comprise a polygon mesh. Polygon meshes are usually called polygon objects, and objects are made up of vertices, edges, and faces, which are the points, lines, and shapes of the connected polygons. The figure below shows a simple (left) and more complex (right) polygon mesh:
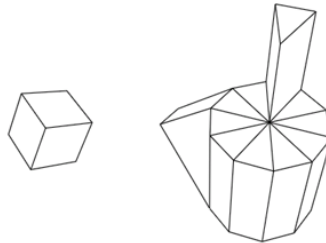
Which modeling methods are available?

Which modeling methods and tools you use and in what order depends on factors such as the complexity of the model, how far into the modeling process you have progressed, and your personal working style. Modeling options are available in the **Modeling** toolbar and through menu commands.

Click the **Modeling** tab to access the toolbar:

The toolbar provides access to the modeling tools. You can create objects, change the position and shape of components in the 3D space, add and edit markers in the scene, and make complex edits to an object.

The modeling tools handle operations that need interactivity and tuning using several parameters. Only one tool is activated at time and almost all tools have their own tool properties that appear in the toolbar when you select a tool. In addition, several tools work on object components that require you to select them first.

Menu commands perform instant operations for making complex edits to an object. These actions do not have properties, they apply to the selected component, and can be called at anytime, even when you are using a tool.

The modeling workflow

A basic modeling workflow:

1   **Create an object**. You can create a primitive, create faces, create a point cloud mesh, or import an object on which you can lay down an initial polygon mesh and start your model (see "Step 1: Creating objects").
2   **Make basic edits to the object**. After creating a polygon mesh, you can manipulate selected objects to match the objects in the 3D scene by moving, scaling, and rotating them using interactive manipulators. You can also snap objects and components to existing ones (see "Step 2: Making basic edits to objects" on page 131).
3   **Make complex edits to the object**. You can make complex edits to a model to add detail. You can merge, subdivide, or triangulate objects and components, split or extrude faces, and glue vertices (see "Step 3: Making complex edits to objects" on page 148).

Before you begin to model...

- Ensure that cameras are successfully calibrated (see "Evaluating the calibration in multi-image projects" on page 63 and "Improving the calibration" on page 65).
- Place images into viewports to give you a better perspective of the objects you need to model (see "Working in the 3D Workspace" on page 29).
- Define the world space if necessary (see "Defining the reference distance" on page 54).
- Set the direction of the up axis (see "Setting the up axis" on page 56).
- Make sure you understand how to navigate 3D space for modeling (see "Navigating in 3D space" on page 74).

Step 1: Creating objects

To create an object, you can do one or more of the following:

- **Add a primitive**. The ImageModeler primitives are basic shapes that you can add to a scene to lay down an initial polygon mesh and start your model. You snap the primitive to existing locators, or any mesh components or by using the snapping constraints. Use a primitive to model an object with a simple or strong geometric shape, such as a wheel or a metal can.
- **Create a face or add faces to an existing object**. You can add individual faces to a scene by marking 3D points anywhere in the 3D space drawing them directly on the image plane, which is the angle perpendicular to your view of the scene at any given time. You can add a new face using locators as reference points (and add new ones if necessary) or use existing object's locators, vertices, edges, or faces. Create a face on strong geometric shapes.
- **Create a point cloud mesh**. A point cloud is a collection of points in space (locators) around which you can wrap a mesh. The points in space become the vertices. ImageModeler automatically creates the edges and faces of the mesh. Use a point cloud mesh to model an organic or complex object, such as a human face or a crumpled metal can.

- **Import an object**. Typically you import a 3D object, make any edits you require and texture it from the calibrated images.

Adding a primitive

ImageModeler allows you to add a primitive mesh, a plane, a cube, a cylinder, a sphere, or a disk to your project:
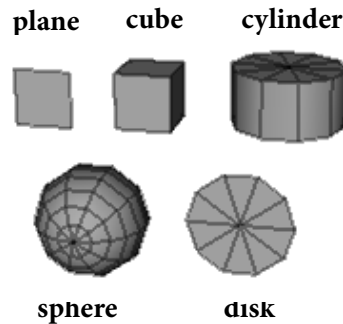
Before adding a primitive...

- If necessary, you can place a new locator(s) as a reference point to which you can snap the primitive's vertex, see "Adding more locators for modeling" on page 122.
- You may want to change the working support to better position your object in the 3D space according to the world space or existing objects (see "Setting the world space" on page 50).
- The **Free Scale** tool is activated by default, allowing you to change both the size and the shape of the primitive. To constrain the primitive's dimensions, see "Applying constrained scaling" on page 115.

Adding a 3D primitive

To add a primitive:

1 Do one of the following:

- Select **Scene > Create Primitive Tool**.

- Click ![Add Primitive icon] (**Add Primitive** icon).

Select a primitive from the tool properties:

Click...	To...
![plane icon]	Add a plane to your scene
![cube icon]	Add a cube to your scene
![cylinder icon]	Add a cylinder to your scene
![sphere icon]	Add a sphere to your scene
![disk icon]	Add a disk to your scene

TIP Right-click in the **Scene Browser**, select **Add Object** from the contextual menu, and select a primitive from the list.

TIP While placing a primitive, press the "+" key to increase the main subdivision of the primitive and press the "-" key to decrease the main subdivision of the primitive. This is particularly useful when placing circle-based primitives like disks, cylinders, and spheres that do not have corners.

The primitive shape is added to the scene, ready for you to place it. The **Create Primitive** tool activates the first vertex of the primitive:
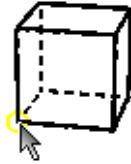
The **Create Primitive** tool allows you to define the position of the new primitives, assisted by the snapping on vertex, edge, face, locator and axes constraints.

NOTE Change the **Tool** color in the **Colors** page in the **Preferences** dialog to change the color of the **Create Primitive** tool.

2 Drag the first vertex of the primitive and snap it to a vertex, an edge, a face of an existing object, a locator, or the axes that define the world space (see "Setting the world space" on page 50) or indeed anywhere in the 3D space.
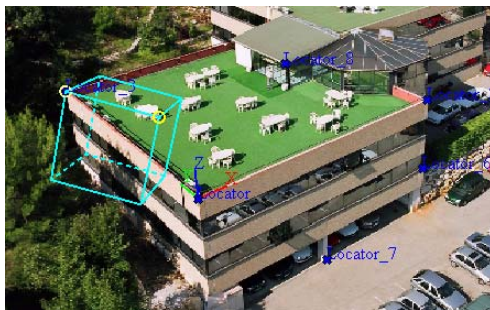
If you are satisfied with the placement of the first vertex, proceed to step 2; otherwise, press **Backspace** to undo the last step.

TIP If a locator or a locator label hides the component to which you want to snap a vertex, hide it by clicking on the following icons in the **Display** toolbar:

- The **View Locators** icon .

- The **Locator Labels** icon (the option is disabled if the locators are hidden).

You can also show/hide locators by selecting a locator(s) in the **Scene Browser** and then selecting **Edit > Show** or **Hide** or right-click on a locator in the **Scene Browser** and select **Hide** from the contextual menu. Select **Show only** to hide every non selected locator or object.

3 The second vertex is now activated. Snap it to a component, a locator, or anywhere in the 3D space:
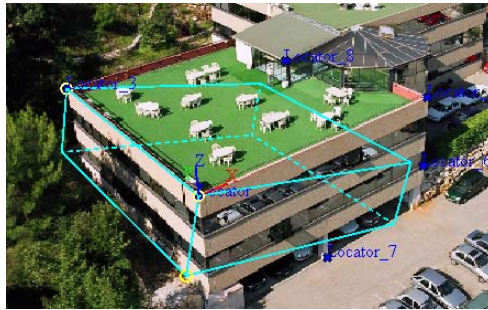
4 The third vertex is activated. The position of the vertex is constrained around the axis created by the first two vertices. Snap it to a component, a locator, or anywhere in the 3D space:
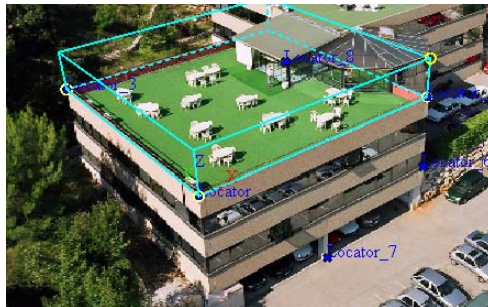
5 If the primitive is a 3D shape, the final vertex determines the height of the primitive. Snap it to a component, a locator, or anywhere in the 3D space:
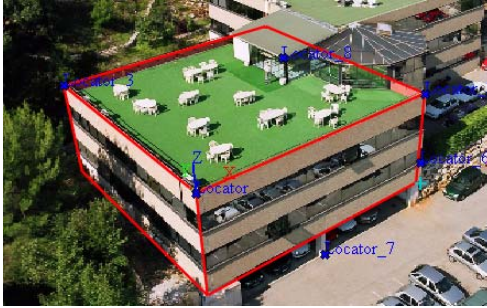
The creation is validated automatically. However, the validation option is available at each step by pressing the **Enter** key or double-clicking the mouse button.

After you add a primitive to your scene, you can:

- Add more faces to the object (see "Creating and adding faces" on page 126).
- Change its position or shape (see "Step 2: Making basic edits to objects" on page 131).
- Apply more complex transformations that change the basic structure of the primitive (see "Step 3: Making complex edits to objects" on page 148).
- Add more than one primitive, and then merge them to create one object (see "Merging objects and components" on page 148).

Applying constrained scaling

When you select the **Create Primitive** tool, you can scale and change the default shape and size of the primitive to define it in the 3D space. However, ImageModeler allows you to constrain the size and shape of the primitive using the **Scaling** options in the tool properties:

From left to right, the scaling options are:

- **No Scale** - You cannot change the size or the shape of the primitive. Snap the first vertex of the primitive to a project component or anywhere in the 3D space; thereafter, placement of the subsequent vertices is constrained by the primitive's default size and shape.
- **Uniform Scale** - You cannot change the shape of the primitive. Snap the first and second vertex of the primitive to a project component or anywhere in the 3D space; thereafter, placement of the subsequent vertices is constrained by the primitive's default shape.
- **Free Scale** - This is the default mode. You can change the size and the shape of the primitive by snapping to any vertex, edge, or face of an existing object, or to a locator. You can also snap the vertex to the axes that define the world space or indeed anywhere in the 3D space.

Applying the snapping filters

The snapping filters appear in the tool properties when you select the **Create Primitive**, **Create Face**, or **Snap** tools and allow you to constrain to which elements you can snap:

Everything existing in the 3D space as locators or any part of a mesh can be the origin of a snapping and constraint action. You can snap to:

- A vertex, or up to a vertex
- An edge, or along an edge, or parallel to an edge
- A face, or normal to the face, or up to any point inside the face
- A locator, or up to a locator
- The axes that define the world space (the world space axes appear on the **3D Workspace** when you manipulate the primitive)
- Normal to a plane defined by the world space
- Along an axe defined by the local object transformation
- Normal to an axe defined by local object transformation
- The distance values in the **Create Primitive** and **Create Face** tools. Entering a value in the text field snaps to multiples of that distance. For example, if you enter the value 2.0, the tool snaps to distances equivalent to multiples of 2: -4, -2, 0, 2, 4, etc.

If you click on an icon to deselect the filter, you cannot snap to that component of the selected object.

Constraint shortcuts

Shortcut	Function
V	Activate the constraint selector
Esc	Unlock locked constraint
Shift	Lock activated constraint
Ctrl (Windows) Command (Mac)	Avoid intersection with scene elements while locked
Tab	Switch between possible constraints

The activated filters depend on the selected tool. If activated, the object components are highlighted and the pointer snaps to them. A red, green, or blue dotted line constraints represents that two consecutive points are snapped to the X-, Y-, or Z-axis, respectively.

For example, the first point of your primitive is used as reference point (left figure below):
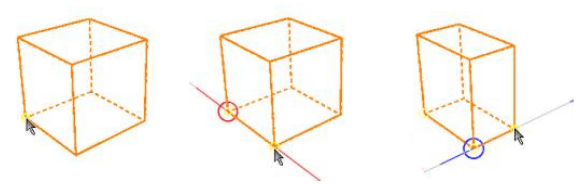
The line constraint defined by the reference point and the second point is aligned with the X-axis: a red dotted line is shown, and reference point is circled (center figure). The second point now becomes the reference point. The third point is aligned with the Z-axis: blue dotted line is shown, and reference point is circled (right figure).

Locking the last snapped component

Press **Shift** to stay locked on the last snapped component.

- To snap on faces, highlight a face (see Selecting objects and components) and press **Shift**. A grid plane passing through the highlighted face appears.
- Snapping is constrained to the face plane:
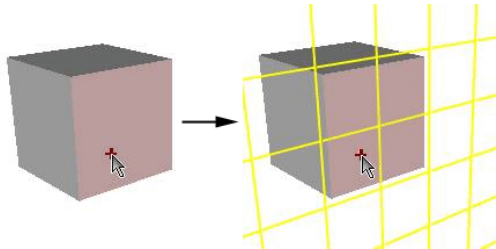
- To snap on edges, highlight an edge and press **Shift**. Snapping is constrained to the edge line:
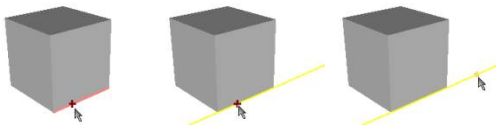
- When an axis is displayed, snap on it by highlighting a face and pressing **Shift**. Snapping is constrained to the axis:
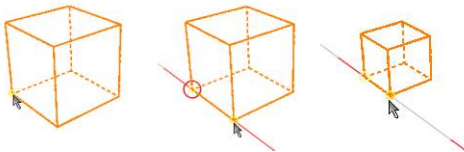
   Tip: Press **Shift** to keep locked on an axis.

Switching between line constraints

When a line constraint is activated or locked, you can switch to other axis constraints by pressing **Tab** key. By doing so, you can access points in 3D where there may be no locators, or any 3D model already created.

If you press the **Shift** key, you lock the constraint, allowing you to make camera movements, zoom, rotation, change a shot. To unlock the constraint, press the **R** key. or press **Shift** over an empty space where nothing is activated.

For example, if the X-axis is activated, switch to the Y-axis by pressing the **Tab** key:
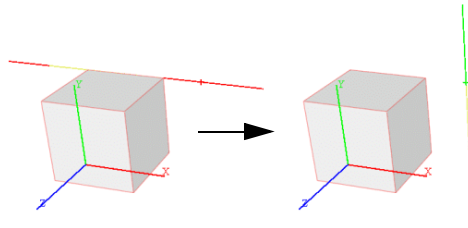
Press the **Tab** key again to switch to the Z-axis

and press the **Tab** key again to switch back to the X-axis.
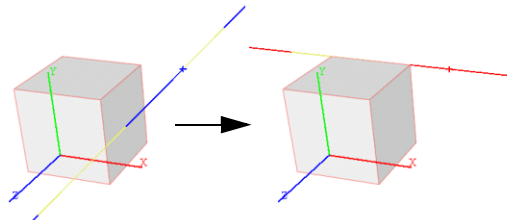
While a constraint is activated or locked, you can activate the dual constraint by pressing **Ctrl + Tab** (Windows) or **Command + Tab** (Mac).

- The dual of a line is the plane normal to this line passing through the snapped point:
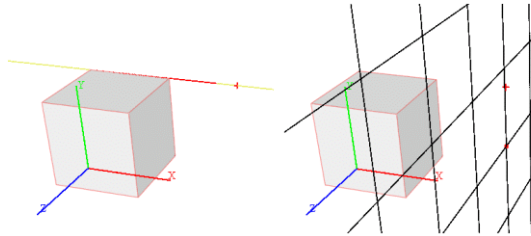
- The dual of a plane is the line normal to the plane passing through the snapped point:
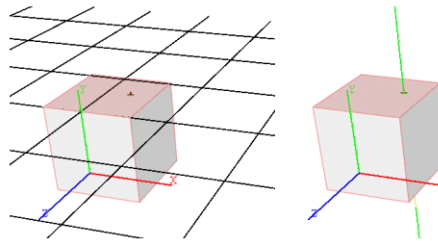
Snapping and Constraints on axes or on planes

When you are creating faces, placing primitives or splitting faces, ImageModeler has powerful snapping and constraints features to help you better position your object in the 3D space according to the world space or existing locators and objects.

The constraints you can use are:

- X, Y or Z axes
- XY, XZ or YZ planes

1 When creating a primitive or a face, select the constraint origin by moving the mouse over a vertex, an edge, a face or the origin of the scene.

2 Press **V** to activate the cosntraint selector.

3 Move the mouse over the selector to activate the different constraints available.
4 Left-click the constraint you want and the tool element will lock on this contraint.

TIP Press **ESC** (or **V**) to quit the selector without making a choice. Change the **Constraints** colors in **Edit > Preferences > Colors** (Windows) or **ImageModeler > Preferences > Colors** (Mac) to change the color of the plane grid.

TIP When you move the cursor in the 3D view, tool tips appear (the tool tips are displayed with some transparency to keep the shot clearly visible underneath) displaying information or guides. Depending on the constraint or the snapping rules that have been defined, the information displayed will be **[locator] [vertex] [edge]** or **[face] [aligned to ...] [locked on ...]** which corresponds to the element intesected or the active constraint.

Adding more locators for modeling

Because camera calibration creates a 3D environment from the 2D images, you can add locators directly to a scene after calibration is complete.

You may want to add a locator:

- To use as a point to which you can snap an object to rotate the object with precision (see "Snapping objects and components" on page 145).

- To create points in space to create a face (see "Creating and adding faces" on page 126).
- To create points for point cloud meshes to build an organic shape (see "Creating a point cloud mesh" on page 129).

Adding markers

You can use **Guiding Lines**, which represent the camera views, originating from the camera position and passing through the selected point, to help you place a marker where you could not do so before the calibration (for example, on borders that are not sharp lines). Ideally, all the **Guiding Lines** intersect at a single point. In practice, a small error is often visible with respect to the calibration quality.

Note: Change the color of the **Guiding Lines** in the **Colors** page of the **Preferences** dialog.

To add markers:

1 Ensure the first image you want to mark is in a viewport (see "Working in the 3D Workspace" on page 29).

2 Create a marker in the first image. By default, the **Magnifier** window appears as you place markers, helping you to place markers more accurately:

The **Guiding Lines** are displayed in the other shots in the viewport:
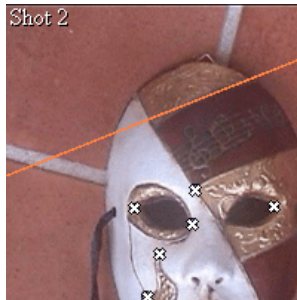
If the **Guiding Lines** are not visible, click on the **View Guiding Lines** icon ⬦ in the **Display** toolbar.

3 In another shot, snap the marker to the nearest **Guiding Line** by pressing the **Shift** key. The pointer changes from cross hairs to a square:
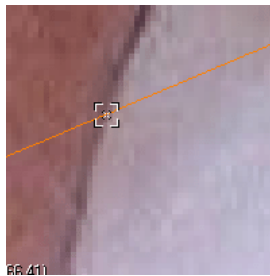
4 Slide the pointer along the **Guiding Line** until you reach the position where you want to place the marker and release the pointer:
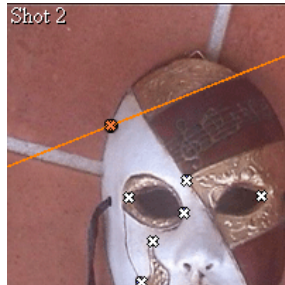
The 3D locators generated from the markers are added to the **Modeling** folder in the **Scene Browser** and they are not used in the calibration process.

Adjusting the position of markers

To adjust the position of markers:

1 Ensure the first image you want to mark is in a viewport (see "Working in the 3D Workspace" on page 29).

2 Select the **Place Marker** tool.

3 Select the marker you want to move. By default, the **Magnifier** window appears as you place markers, helping you to place markers more accurately.

4 Move the marker to the where you want it.

Toggling the display of objects

To show/hide an object:

1 Select the object that you want to hide (see "Selecting objects and components" on page 131).

2 Select **Edit** > **Show** or **Hide** (**Ctrl + H** (Windows) or **Command + H** (Mac)).

TIP Right-click on an object in the **Scene Browser** and select **Hide** from the contextual menu.

Creating and adding faces

You can add an individual face to a scene by marking 3D points anywhere in the 3D space by drawing them directly on the image plane or attaching it to an existing object's vertex, edge, or face.

When you create a face, you draw the edges of the face in the direction facing the camera (or viewport). When you add a face to an existing object, the direction of the face normals for the object face determines the direction of the face (see "Understanding face normals" on page 128).

Before creating a new face...

- You can define the vertices of a new face using existing locators, or if necessary, you can place a new locator as a reference point to which you can snap the new face (see "Adding a primitive" on page 110).
- You can create a face by marking 3D points anywhere in the 3D space. However, you may want to define the working support to better position your object in the 3D space according (see "Setting the world space" on page 50).

Creating a face or adding a face to an object

1 Do one of the following:

- Select **Scene** > **Create Face Tool**.

- Click on the **Create Face** icon in the **Modeling** toolbar.

The pointer changes shape.

2 Position the pointer either:

- In the 3D space where you want to start the new face. You can snap to a locator or an axis (see "Creating and adding faces" on page 126).

- On the existing object's vertex, edge, or face (see "Selecting objects and components" on page 131). If you want to add a face to an existing object, please make sure this object is selected. If not, ImageModeler will create a new object with the face. Starting a face from an existing object's edge is recommended because it creates directly an edge of the new face with the correct orientation.

   Tip: If a component to which you want to snap a vertex is hidden by a locator or a

   locator label, click on the **View Locators** or **Locator Labels** icon in the **Display** toolbar (the latter option is disabled if you have already hidden the locators).

If you are satisfied with the placement of the first vertex, proceed to step 2; otherwise, press **Backspace** to undo the last step.

3 Position the pointer where you want to add the second point and click the second point.

4 Position the pointer where you want to place the third point. If you are creating a triangle, click and press **Enter** or double-click to validate the face. Repeat the last two steps for a quad or n-gon face.

ImageModeler creates a face that is defined by the points you have placed.

When you have created three vertices, the face plane is defined. All subsequent "free" points are added on this same plane, except if you snap the face to locator that is not on the same plane.

Understanding face normals

Face normals indicate the direction of the faces of a polygon. By default, ImageModeler displays face normals outward and you model an object on the outside of the faces.

To verify which way normals are facing, click on the **View Normals** icon in the **Display** toolbar (see "The ImageModeler interface" on page 15).

Markers facing outward or inward indicate which way the faces of a polygon face.
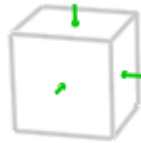
normals   normals
facing outward facing inward

NOTE When creating a primitive, if the current camera is inside the primitive's volume, the direction of the primitive's normals will follow the camera's direction (inward). However, if the camera is not included in the primitive's volume, the direction of the primitive's normals will be outward.

Inverting face normals

Typically, you work with objects with the default normals setting, but you may need to invert normals, if for example, if you want to model a room. Inverting normals is like turning the object inside out, so you can see the surface of the normals on the outside of the object.

To invert face normals:

1 Select the object. To find out how to select, see "Selecting objects and components" on page 131.

2 Click **Scene** > **Invert Face Normals**.

NOTE When you set face normals, you set them for the entire selected object, not just for a face or group.

Creating a point cloud mesh

By the time you are ready to create a point cloud mesh in the ImageModeler workflow, some of the locators (a collection of markers) will have already been created during the camera calibration process.

**point cloud and
wrapped mesh**

Because the calibration process does not provide enough locators to produce a quality point cloud mesh, you must place more markers before you can wrap a mesh around them.

Using the ImageModeler automatching feature to reduce the amount of time and effort you spend adding markers to create locators. You place one marker, and ImageModeler determines where to place the corresponding markers in images in viewports.

NOTE Automatching results depend on high calibration quality.

Consider the following when placing markers:

- Add markers to distinguishable features in the images, not bare blue sky, for example.
- The more markers you add, the more accurate and better quality the model but the larger the file size. Keep the model simple for Web applications.

Refer also to "Where do you place markers?" on page 43.

Creating a point cloud mesh

1 Make sure you have placed images that show the feature you want to mark in at least two viewports. Each image must show the same feature to mark (see "Working in the 3D Workspace" on page 29).

   TIP For an easier selection of the locators, uncheck **Object Display** in the display properties.

2 Select the **Place Marker** tool ✳ in the **Modeling** toolbar. The pointer changes shape.

3 Check the **Automatching** option in the **Properties** toolbar to activate it.

4 Click and hold the pointer over the part of the feature you want to mark. The **Magnifier** window appears to help you locate the feature more precisely.

5 Release the pointer. ImageModeler creates new marker, determines automatically the corresponding point in the other images in the viewports, and adds the new locator to the **Modeling** folder in the **Scene Browser**.

6 Repeat the previous three steps for each marker you want to add.

7 Select **Scene > Create Mesh**.

ImageModeler creates a point cloud mesh.

Relabeling project items

Use the **Property Box** to relabel a camera shot, camera device, locator, object, material, or ruler to something more meaningful.

To rename a project item:

1 In the **Scene Browser**, select one or more primitives or meshes you want to rename.

2 Click the **General** tab.

3 Type the new name in the **Label** field.

4 Press **Enter**.

Step 2: Making basic edits to objects

You can make basic edits to objects before you use some of the tools to make more complex edits, such as splitting or extruding faces. Now that you have added 3D objects to your project, you may need to reposition them to match the objects in the 3D scene. You can move and/or rotate objects and components using interactive manipulators. You can also snap objects and components to other ones. To do so, you must firstly select the required components or objects, and then apply the appropriate editing tool.

Selecting objects and components

Before you can position objects, or otherwise modify objects and components in your scene, you must select them. You can select objects, faces, edges, vertices, and pivot points, and locators.

To select objects and components using the **Selection** tool:

1 Do one of the following:

- Select **Edit > Selection Tool**.

- Click on the **Select** tool ![select icon] in the **Modeling** toolbar.

The selection options appear in the tool properties.

NOTE You can change the default color and the color of selected items in the **Colors** page in the **Preferences** dialog.

2 Click any of the following selection icons to activate the tool:

Tool	Function
	Select objects
	Select faces
	Select edges
	Select vertices

3 Do one of the following:

- To select one object or component, hover the pointer over the object, edge, vertex, or face that you want to select. ImageModeler highlights the object. Click to select it.
- To select more than one object or component, drag diagonally to marquee select them. A box appears as you drag, and the objects or components are highlighted.
- To add an object or component to the selection, press **Shift**, then click another object or component, or drag diagonally across it.

- To remove an object or component, press **Ctrl** (Windows) or **Command** (Mac), and then click another object or component or drag diagonally across it.
- To select all objects or components, select **Edit > Select All**.
- To unselect all objects or components, select **Edit > Unselect All**.

If you unintentionally select components that face away from you, turn on backface culling (see "Hiding back-facing polygons" on page 163).

Increasing face selection

You can increase or decrease the current face selection by adding or removing, respectively, faces that have the same normal.

Click **Edit > Face Selection > Increase (Shift + Up)** to add faces to the selection or **Decrease (Shift + Down)** to remove faces from the selection.

Selecting edges

By selecting one edge and using the **Edge Loop** command, you can simultaneously select all edges of an object in one plane and then manipulate the size and shape of the object around that plane:
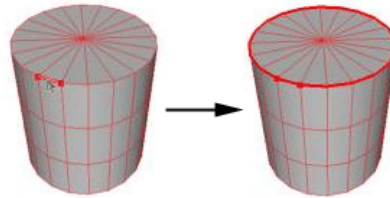
selection around the horizontal
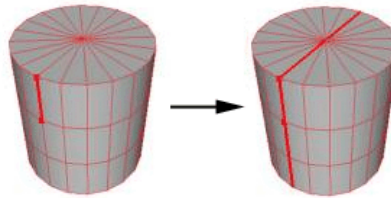
selection around the vertical axis

For example, you may want to intent an object proportionally around the object's circumference, or scale up along one plane of an object while keeping the object in proportion.

To select all edges on the same plane:

1 Click on an object's edge. The object or component is highlighted.

2 Select **Selection > Edge Selection > Edge Loop**.

All edges in the same plane as the selected edge are selected.

Defining the selection buffer settings

In the **Display** toolbar, you can toggle the priority for the selections and highlights of scene elements (faces, edges, vertices) and the snapping behavior in the active tool:

By activating or deactivating the option in the locked or unlocked view, you toggle:

- **Normal selection buffer**: The front faces have priority over the back faces. The snapped point is on the front face of the building.
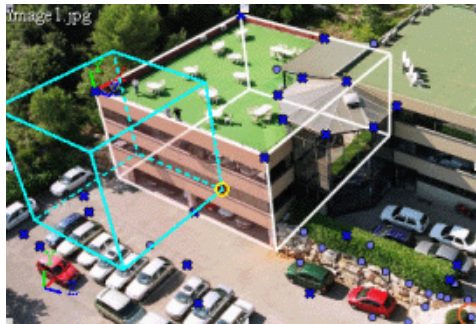
- **Inverse selection buffer**: Back faces have priority over the front faces. The snapped point is now on the bottom of the building. This is useful when you want to create an object in the same plane as the bottom of the building.
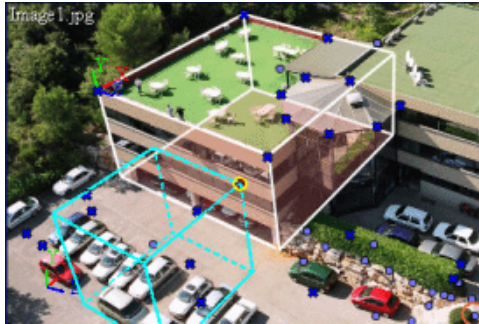
Storing and restoring selections

When you are modeling an object, you can select areas of your model, store the selection, and revert to the selection later on. ImageModeler allows you to store a maximum of five selections by selecting **Edit > Selection Bookmark > Store Selection**.

When required, you can revert to a previously stored selection by selecting **Edit > Selection Bookmark > Restore Selection**.

The Move, Rotate, and Scale manipulators

ImageModeler has three manipulator tools located in the **Modeling** toolbar, from left to right, **Move**, **Rotate**, and **Scale** tools, to move and change the shape of objects and components interactively:

TIP To save time, press **Tab** to cycle among the interactive manipulators.

If you select an entire object and then either the **Move**, **Rotate**, or **Scale** tool, the manipulator appears in the center of the selected object or component:
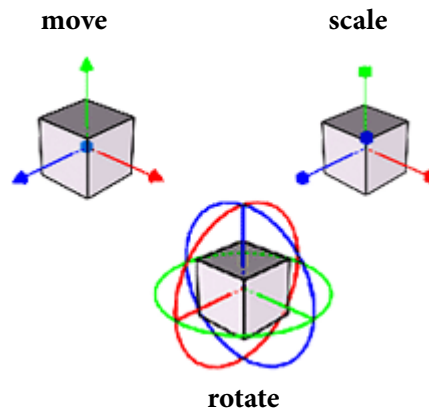
If you select an object's vertex, edge, or face, the manipulator appears at the vertex or in the center of the object's edge or face, respectively. You can also change the position of the pivot point (see "Understanding and moving the manipulator's pivot point" on page 142). Subsequently, you manipulate the object or component around the manipulator's pivot point.

NOTE You can change the color of the axes of the manipulators and the active handle in the **Colors** page in the **Preferences** dialog.

Moving objects and components

Use the **Move** manipulator to move objects and components interactively. When you move entire objects, the objects retain their shape; they just move to another location. When you move vertices, edges, or faces, you pull or push them to change the shape of the object. The resulting change depends on where you move the component(s). For example, you can move an object's face, edge, or vertex as shown below:
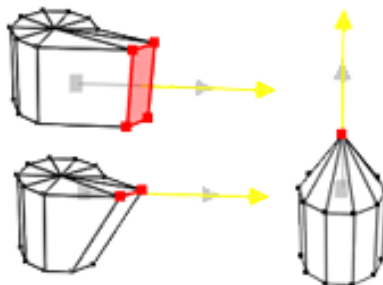
You can also move objects or its components to another point in space by rotating them around their pivot points (see "Rotating objects and components" on page 139).

To move objects or components with the **Move** manipulator:

1   Select an object or component (see "Selecting objects and components" on page 131). The object or component is highlighted.

2 Do one of the following:

- Select **Scene > Move Tool**.

- Click on the **Move** tool icon .

The **Move** manipulator appears in the center of the selected object or component.

3 Before using the manipulator:

- If you want to move the manipulator's pivot point, see "Understanding and moving the manipulator's pivot point" on page 142.

- If you want to orient the manipulator to a coordinate system, see "Aligning the manipulator with a different orientation mode" on page 143.

Otherwise, proceed to step 4.

4 To move the object or component along:

- The X-axis, drag the red arrow.
- The Y-axis, drag the green arrow.
- The Z-axis, drag the blue arrow.

The arrow changes color as you drag.

If you move the entire object, its new position is changed in the **Property Box** (for more details, see "Changing the size and shape of objects numerically" on page 144).

Rotating objects and components

Use the **Rotate** manipulator to rotate objects and components interactively. When you rotate entire objects, the objects retain their shape; they just turn on the axis (or change location in 3D space if you move its pivot point first). When you rotate edges or faces, you twist them to change the shape of the object. The resulting change depends on how far you twist the component(s).

To rotate objects or components with the **Rotate** manipulator:

1 Select an object or component (see "Selecting objects and components" on page 131). The object or component is highlighted.

2 Do one of the following:

- Select **Scene > Rotate Tool**.

- Click on the **Rotate** tool icon .

The **Rotate** manipulator appears in the center of the selected object or component.

3 Before using the manipulator:

- If you want to move the manipulator's pivot point, see "Understanding and moving the manipulator's pivot point" on page 142.

- If you want to orient the manipulator to a coordinate system, see "Aligning the manipulator with a different orientation mode" on page 143.

Otherwise, proceed to step 4.

4 To move the object or component along:

- The X-axis, drag the red ring.
- The Y-axis, drag the green ring.
- The Z-axis, drag the blue ring.

The ring changes color and indicates the angle to which you are rotating.

If you rotate the entire object, its new position is changed in the **Property Box** (for more details, see "Changing the size and shape of objects numerically" on page 144).

Scaling objects and components

Use the **Scale** manipulator to scale objects and components interactively. When you scale entire objects, the objects retain their shape; they just get larger or smaller. When you scale an edge or face, you change the shape of the object. The resulting change depends on how far you scale the component.

To scale objects or components with the **Scale** tool:

1 Select an object or component (see "Selecting objects and components" on page 131). The object or component is highlighted.

2 Do one of the following:

- Select **Scene > Scale Tool**.

- Click (**Scale** tool icon).

The **Scale** manipulator appears in the center of the selected object or component.

3 Before using the manipulator:

- If you want to move the manipulator's pivot point, see "Understanding and moving the manipulator's pivot point" on page 142.

- If you want to orient the manipulator to a coordinate system, see "Aligning the manipulator with a different orientation mode" on page 143.

Otherwise, proceed to step 4.

4 To scale along:

- The X-axis, drag the red handle.

- The Y-axis, drag the green handle.

- The Z-axis, drag the dark blue handle.

- To scale along all three axes (uniform scale), drag the light blue handle.

The handle changes color as you drag.

If you scale the entire object, its new position is changed in the **Property Box** (for more details, see "Changing the size and shape of objects numerically" on page 144).

TIP If you press the **Ctrl** key (or **Command** key on a Mac) while scaling along an axis, you will scale uniformly in the complementary axes. For example, if you press **Ctrl** and scale along the X scale axis, you will scale in the Y and Z directions uniformly, and not in the X direction

Understanding and moving the manipulator's pivot point

In ImageModeler, by default, the pivot point of a manipulator is in the center of an object. This allows you to move, rotate, or scale an object around this central point to turn or resize it, respectively. However, you can move the pivot point to another point in 3D space, anywhere inside the object, at one side of the object (like a door hinge), or outside the object (like a swing).

To move the pivot point:

1 Click on the **Select** tool in the **Modeling** toolbar and select an object or a component (see "Selecting objects and components" on page 131).

2 Select either the **Move**, **Rotate**, or **Scale** tool. The pivot point of the object appears in the center of the selected object or component. The **Pivot Edition** options also appear in the tool properties:

| Edit | Reset | X -1.000 | Y 0.250 | Z 0.500 |

3 Click on the **Edit** button.

   Tip: Alternatively, press **Shift**+click on manipulator to edit the pivot.

4 Drag the pivot point and snap the first point of the face to a vertex to the axes that define the world space (see "Creating and adding faces" on page 126) or anywhere in the 3D space.

5 Click on the **Edit** button to exit the option.

NOTE Changing the X, Y, and Z values changes the position of both the object or the component and the pivot numerically.

Aligning the manipulator with a different orientation mode

You can align the manipulator to either:

world   **object**   **selection**
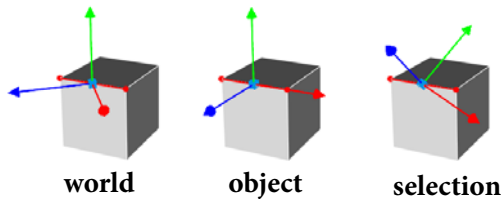
- The **world coordinate system**. The manipulator's axes are aligned to the coordinate system of the scene in which you will create, evaluate, and modify your models.

  For more information about defining the world coordinate system, see "Defining the reference distance" on page 54.
- The **object's coordinate system**. The axes are aligned according to the object's position in space. The coordinate system axes align to the position of the object's pivot point (see "Understanding and moving the manipulator's pivot point" on page 142).
- A **defined selection**. Select a vertex, an edge, a locator, or a face with which you want to align the manipulator. The axes align perpendicular to the normal of the selection.

For example, if you choose to align the manipulator to the face of an object, the axes align perpendicular to the normal of the face. If you select an edge or a vertex, the axes align to the average of the normal of the adjoining faces.

To align the manipulator:

1 Select an object or component to which you want to align the manipulator (see "Selecting objects and components" on page 131). The object or component is highlighted.

2 Select either the **Move**, **Rotate**, or **Scale** tool. The manipulator appears in the selected object or component.

3 Click on one of the **Orientation Mode** radio buttons in the tool properties:

Orientation Mode ○ Auto ○ Object ⦿ World

ImageModeler aligns the manipulator.

Changing the size and shape of objects numerically

Alternatively to changing the size and shape of objects using the manipulators, you can use the **Property Box** to alter a primitive's properties by precise number of units. The available options depend on the primitive or mesh selected.

For example, in the following figure, the objects are divided along the X- (left), the Y- (center), and the Z- (right) axes, respectively.
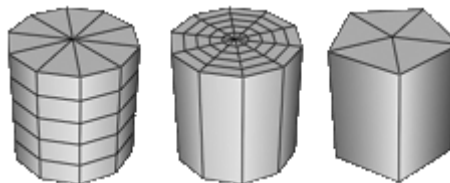
NOTE You can also subdivide an entire object along each axis evenly (see "Increasing the number of faces in an object" on page 152).

To change the size and shape of objects numerically:

1 In the **Scene Browser**, select the primitive or mesh.
2 Click primitive's tab.
3 Do one of the following:
   - To move, rotate, or scale a primitive or a mesh, type the new value in the **Move** field, the **Rotate** field, or the **Scale** field.
   - To resize a plane or a cube type the new value in the **Size** field.

- To change the radius of a cylinder, sphere, or disk, type the new value in the **Radius** field.

- To change the length a cylinder, type the new value in the **Length** field.

- To change the angle of a cylinder, sphere, or disk, type the new value in the **Angle** field.

To subdivide a plane, cube, cylinder, or sphere along an axis to add faces to that axis:

- To subdivide along the X-axis, enter a new value in the **X-Sub** field.

- To subdivide along the Y-axis, enter a new value in the **Y-Sub** field.

- To subdivide along the Z-axis, enter a new value in the **Z-Sub** field.

4 Press **Enter**.

Snapping objects and components

Snap an object or component to attach it to another one in the scene. You can snap objects or components to a face, to a vertex, to local object axes, or world space axes that define the world space or anywhere in the 3D space.

NOTE The original position of a snapped element will be used as a pivot reference for the axis constraints.

For example, you can use the **Snap** tool to do the following:

- Snap a pivot point to a project component with precision to reshape objects (see "Step 2: Making basic edits to objects" on page 131).

- Attach faces to a vertex, an edge, or a face of existing objects or create new faces by snapping to locators as reference points (see "Creating and adding faces" on page 126).

- Align a primitive in the 3D space by snapping its vertices to the axes defined by the **World Space Tool** (see "Adding a primitive" on page 110).

- Split an existing face from a vertex, an edge, or anywhere in the face to create different shaped faces (see "Splitting faces" on page 153).
- Add a ruler to measure the distance between components or objects in the scene (see "Creating a new ruler to measure angles" on page 100).

Snapping one component to another

To snap one item to another item:

1 Select an object or component (see "Selecting objects and components" on page 131). The object or component is highlighted.

2 Do one of the following:

- Select **Scene > Snap Tool**.

- Click ![Snap tool icon] (**Snap** tool icon) in the **Modeling** toolbar.

The pointer changes shape.

3 If you want to constrain to which elements you can snap, click on a snapping filter icon to deselect the option (see "Applying the snapping filters" on page 116).

4 Click any part of the selected item, for example, a vertex, an edge, or a face, drag to the component to which you want to snap, and then release the mouse button.

Setting the snapping tolerance value

By default, you can drag an object or component to within five pixels around the destination point, release the mouse button, and the object or component snaps to it.

1 Click **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac).

2 In the **General** tab, change the value of the **Snapping Tolerance Value**.

Duplicating objects

To duplicate an object:

1   Select the object that you want to duplicate (see "Selecting objects and components" on page 131).
2   Select **Edit** > **Duplicate**.

TIP Right-click on an object in the **Scene Browser** and select **Duplicate** from the contextual menu.

Deleting objects

You can delete 3D objects or their components, cameras, camera devices, or locators from a scene. Deleting a face, an edge, or a vertex, does not remove the object from the scene.

To delete an object or a component from a scene:

1   Select the object or component that you want to delete (see "Selecting objects and components" on page 131).
2   Select **Edit** > **Delete**.

TIP Right-click on an object, camera, camera device, or locator in the **Scene Browser** and select **Delete** from the contextual menu.

Step 3: Making complex edits to objects

ImageModeler allows you to make complex edits to the primitives and meshes in your project. You can create more complex models from simple polygon meshes, or create different shaped models that you can manipulate using a combination of the ImageModeler editing tools.

- **Merge two or more objects or components**. You create more complex objects from simple ones by merging the vertices, faces, or objects.
- **Increase the number of faces in an object**. ImageModeler has two options that allow you to increase the number of faces of an existing object. You can subdivide faces to increase the number of faces and vertices in an object to add more detail to your model and edit the new subdivide mesh by manipulating the object components to smooth the new mesh.
- **Reshape objects**. ImageModeler has two options that allow you to change the shape of existing objects and add more detail to your model.
    - Split faces by adding one or more edges that divide the face to create different shaped faces.
    - Extrude one or more faces by protruding or projecting the face(s) along the image plane, for example, to create depth in a model.

Merging objects and components

Merging objects, or faces or vertices of objects, helps you create more complex objects from simple ones. For example, you can create the legs of a table and the tabletop separately, and then merge them to create one object that you can manipulate.

Merging two or more objects

Merged objects are "grouped" rather than blending objects together to form a new shape. Merged objects maintain their existing shape. For example, the merged cylinder and sphere in the following image maintain their shapes, but they can be moved and manipulated together as one object.

- Select **Scene > Merge Objects** (**Ctrl + M** (Windows) or **Command + M** (Mac)).
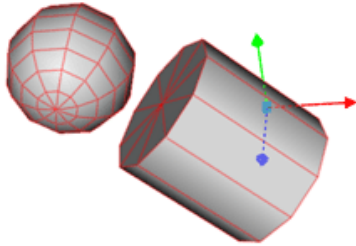
After merging objects, you can close any holes that may exist in the object by creating a new face (see "Creating and adding faces" on page 126).

Merge two or more faces of the same object

By selecting two or several faces of an object, you can merge them to create a new face, for example, if you want to manipulate several faces at the same time.

- Select **Scene > Merge Faces** (or press "**M**").

**merging these   ...results in
faces...   one new face**
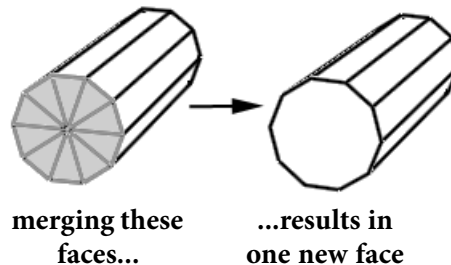
After merging and manipulating faces, you can divide them again using the **Split** tool (see "Splitting faces" on page 153).

Glue two vertices of the same object

You can join, or glue, two vertices that have one missing adjacent face. For example, if you create two simple polygons, you can select a vertex on either one and glue them.

■ Select **Scene > Glue Vertices** (or press "**G**").
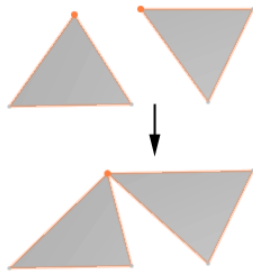
In addition, you can change the shape of objects by deleting faces, selecting adjacent vertices, and "sewing" them together:
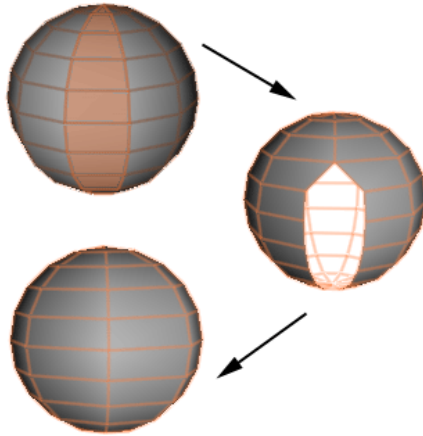
NOTE If you want to glue two vertices of different objects, you must first merge the objects.

Merging objects, faces, or vertices

To merge objects, faces, or vertices:

1   Use the **Move** and **Rotate** tools in the **Modeling** toolbar to position the objects, vertices, or faces that you want to merge (see "Moving objects and components" on page 138 and "Rotating objects and components" on page 139).

   You can align objects and faces with precision before you merge them (see "Snapping objects and components" on page 145).

2   Click **Select** in the **Modeling** toolbar and select all objects that you want to merge (see "Selecting objects and components" on page 131). The objects are highlighted.

3 Check that the normals of the faces to merge are facing the same direction (see "Understanding face normals" on page 128). If not, invert the required faces (see "Inverting face normals" on page 129).

4 Select **Scene** and one of the following:

- **Merge Objects** - ImageModeler merges the objects into a single, new one. The merged objects are listed as one mesh in the **Scene Browser** in the objects folder.
- **Merge Faces** - ImageModeler merges the selected faces of an object to form a single face.
- **Glue Vertices** - ImageModeler merges the selected vertices of an object into a single one. Vertices must have a missing adjacent face before you can glue them.

Increasing the number of faces in an object

In ImageModeler, you can increase the number of faces in an object by subdividing or triangulating faces or using the bevel tool to add more detail to your model.

Subdividing an object

When you subdivide an object, you increase the number of faces in the object, allowing you to add more intricate detail to your model.

You can subdivide a primitive along one plane using the **Property Box** (see "Changing the size and shape of objects numerically" on page 144) or create a more complex model by subdividing an edge or a face of an object, or the entire object.

If you select:

- An **object**, all faces of the selected object are subdivided.
- A **face**, all selected faces are subdivided
- An **edge**, all selected edges are split at midpoint.

To subdivide an object:

1   Select the object you want to subdivide.
    To find out how to select objects, see "Selecting objects and components" on
    page 131.
2   Select **Scene** > **Subdivide** (or press "**S**").

Triangulating an object or a set of faces

You can also triangulate your model to add more faces to a mesh to make more
intricate changes to it. Typically though, you would subdivide a mesh instead.

The following figure shows a regular sphere and a triangulated sphere:
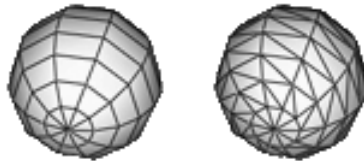
To triangulate an object or face(s):

1   Select the object or a face(s).
    For more information on selecting objects and components, see "Selecting objects
    and components" on page 131.
2   Select **Scene** > **Triangulate** (or press "**T**").

Splitting faces

Split faces create different shaped faces that can add more detail to your model. When
you split a face you add one or more edges that divide the face. You may want split a
face to modify the shape or part of it. You can split the face starting from an edge, a
vertex, or from the inside of a face and then make basic edits to modify shape of the
new faces (see "Step 2: Making basic edits to objects" on page 131).

You can also make more complex face splits starting from the inside of a face. You may want to create a hole in a face to create, for example, a window or a door. You can split a face from the inside and either create a hole in the face or extrude it to add depth to the model.

To split a face:

1 Do one of the following:

- Select **Scene > Split Face Tool**.

- Select the **Split Face** tool . The pointer changes shape.

2 Position the pointer either on the face, at a vertex or on an edge, and place points by clicking the pointer to create a new face.

You can snap the first point of the face to a vertex, an edge, or the inside of a face, depending on what you want to do:

Splitting faces starting from an edge

If the first click is point on an edge, then the end point must be either a vertex or a point on an edge on the same face.

You can add intermediate points are allowed inside the face. For example:
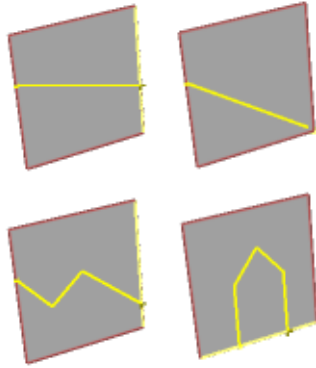
Splitting faces starting from a vertex

If the first click is on a vertex, then the end point must be a vertex or a point on an edge of the same face. You can add intermediate points are allowed inside the face.

For example:
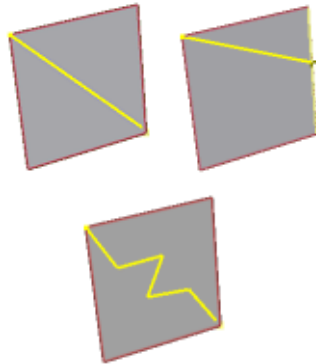
Splitting faces starting from the inside of a face

If the first click is a point inside a face, then the end point must be the same point. ImageModeler does not support faces with holes; when you validate the face, you create two new faces:
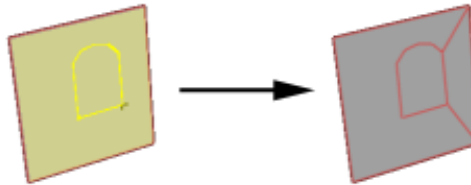
If you are creating a face starting from the inside of a face, position the pointer where you want to place the last point. Click and press **Enter** or double-click to validate the face.

NOTE If the **Auto Repeat** option is checked in the tool properties, when you finish splitting the face, you can continue to split the face from the last point or press **Enter** to validate the face. Otherwise, you must reselect the **Split Face** tool.

Creating a Round Mesh with the Bevel Tool

The bevel tool allows you to subdivide an edge and transform it into to a round mesh. The bevel size and the subdivision can be adjusted interactively.

1   Select the edge that you want bevel
2   Click the **Bevel Tool** and do the following:
    - Drag the mouse to change the size of the bevel
    - Use the "+" and "-" to add more subdivisions

TIP The bevel values can be set manually in the properties toolbar.

Before beveling the front edge

After adding bevels to the mesh.

Snapping to an object's center points

If the **Center Snap** option is checked in the tool properties, points appear in the object, defining the midpoint of the edges and faces. You can snap to these points:
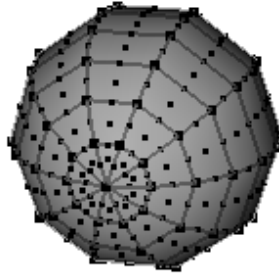
Snapping to an object's coordinate system

Activating the axis snapping allows you to create well-orientated splits that are parallel to the object coordinate system (see "Setting the world space" on page 50).

For example, when creating doors or windows on a building, you can align them accurately with the general orientations (horizontal and vertical) of the building.
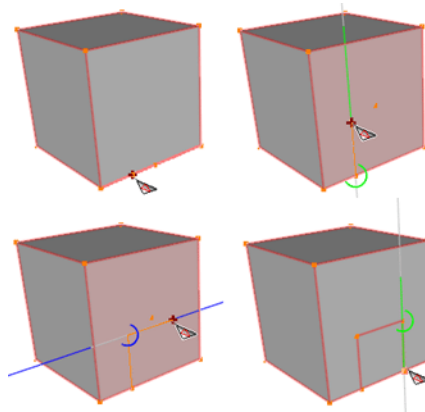
NOTE Change the **Tool** color in the **Colors** page in the **Preferences** dialog to change the color of the points.

Extruding faces

Extruding one or more faces by protruding or projecting the face(s) along the image plane creates depth and perspective in a model. You can extrude a face inside an object or outside an object.

To extrude one or more faces:

1 Do one of the following:

- Select **Scene > Extrude Tool**.

- Click the **Extrude face** tool .

2 Click the face(s) you want to extrude (they become highlighted).
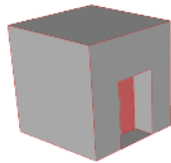
extruded face along the inverse
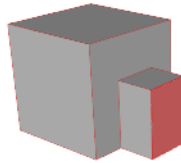
extruded face along the normal

3 Click one of the selected faces and drag the cursor to extrude the face either along the normal (up) or along the inverse normal (down).

TIP While a face is still highlighted you can adjust the extrusion size. Double-clicking a different face will apply the extrusion tool to it instead.

Extruding faces numerically

As an alternative to using the pointer to extrude face(s), you can enter the exact values for the size and the scale of the projection in the corresponding fields in the tool properties.

To extrude a face numerically:

1   Select a face(s) that you want to extrude (see "Selecting objects and components" on page 131).
2   Do one of the following:
    ▪ Select **Scene > Extrude Tool**.

    ▪ Click the **Extrude face** tool .
3   Enter the exact size and scale values in the corresponding fields in the tool properties:

Extrude size 0.000   Extrude scale 1.000

Setting the 3D object display properties

As you create your model, visualizing it in different ways can help you work more accurately and efficiently. You can display your model differently in viewports. For example, you can show objects as wireframe in one viewport, semi-transparent in another, with sharpened edges in another, and textures in another. You can apply display settings to all viewports too. Changing the display of a model changes only the way it looks on the computer monitor to help you model more efficiently; it does not alter the texture of the object in the scene.

The display options are shown in the **Display** toolbar. To show the toolbar, select **Window** > **Display Properties**.

Viewing objects in the viewport

Objects are displayed in the **3D Workspace** by default.

To toggle their display on/off, click on the **View 3D Objects** icon in the **Display** toolbar.

Choosing solid or wireframe shading

By default, ImageModeler displays objects at the highest level of complexity, fully shaded and smooth, to show the most accurate visual representation of objects in your scene.

The **Solid** shade option consumes the most computer-processing power. Depending on how complex your model is, what you want to see onscreen at any given time, and the task you are currently performing, you may prefer to display your model as **Wireframe**:

wireframe   **solid**
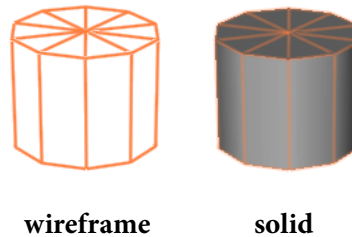
You will likely switch between the shade settings as you build and evaluate your model.

NOTE You can change the color of the wireframe in the **Colors** page in the **Preferences** dialog.

To change the shading of your model:

1 Select the viewport in which you want to change the object's display.

2 In the **Display** toolbar, click on either the **Wireframe** or **Solid** icon , depending on how you want to display the model.

3 To apply changes to all viewports, click (**Apply to All Views**).

NOTE Until you have activated the **Apply to All Views** option, all changes in any viewport will be applied in all the others. Deactivating this option will make each viewport independent from the others.

Adjusting the shade transparency

By default, the smooth shading option is opaque; you cannot see through the object. If you want to see through the image, for example, to see details of the camera shot beneath it, adjust the transparency level to change the degree of opacity.

To adjust the transparency of smooth shaded models:

1 Select the viewport in which you want to change the object's transparency.
2 In the **Display** toolbar, click on the **Transparency** checkbox to select the option and adjust the value in the corresponding field:
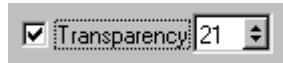
3 To apply changes to all viewports, click the **Apply to All Views** button.

Hiding back-facing polygons

By default, ImageModeler shows you only one side of a model: the one facing you. You can turn off backface culling, a process that shows all sides of a model; it's as though you can see through it. While this can be helpful if want to visualize your model this way, selecting components nearest to you is sometimes difficult.
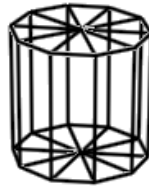
**without
backface culling**   **with backface
culling**

To show or hide back-facing polygons:

1 Select the viewport in which you want to change the object's display.

2 In the **Display** toolbar, click ⬡ (**Backface Culling**) to check (to hide) or uncheck (show) back-facing polygons.

3 To apply changes to all viewports, click ⊞ (**Apply to All Views**).

Smoothing jagged lines with anti-aliasing

Computers can display horizontal or vertical lines easily and accurately, but curves or diagonal lines often appear to have jagged edges. Anti-aliasing softens the line by changing slightly the color of nearby pixels, a process that tricks the human eye into seeing a smooth (or less jagged) line.
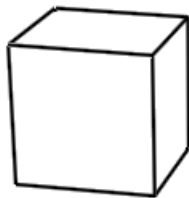
**with
anti-aliasing**
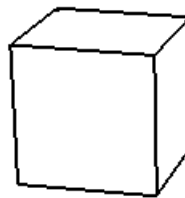
**without
anti-aliasing**

Turn **Anti-aliasing** on to see smooth edges. Turn it off to optimize performance (redrawing speed).

To turn **Anti-aliasing** on or off:

1 Select the viewport in which you want to change the object's display.

2 Select **Edit > Preferences** (Windows) or **ImageModeler > Preferences** (Mac) and click the **Display** tab.

3 Check or uncheck the **Anti-aliasing** box to activate or deactivate the option, respectively.

NOTE Preference settings are always applied to all views.

Smoothing and sharpening edges

The smart edge display lets you sharpen or smoothen one or more selected edges. The smart edge display works in both the smooth and wireframe display shading (see "Choosing solid or wireframe shading" on page 161). The figure below shows a regular sphere (with wireframe shading) and one with a sharpened edge:

To show or hide edge styles:

1 Select the viewport in which you want to change the object's display.

2 In the **Display** toolbar, click on the **Smart Edge Display** icon to check (to hide) or uncheck (show) edges:

soft edges **borders** **sharp edges**

without smart edge display **with smart edge display**
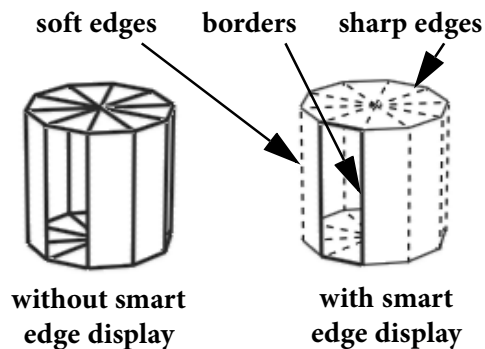
- **Soft edges** are drawn in stipple. The **Sharp Angle Limit** specified in the **General** tab of the **Preferences** panel defines soft edges. This angle controls the number of degrees used to set the angle over which an edge is automatically considered to be sharp. The default angle is 30^0.

- **Sharp edges** are drawn with a straight line. By default, sharp edges are those less than 30^0.

- **Border edges** are drawn in bold if the edge belongs only to one face. In the previous image, one of the side faces of the cylinder is deleted in the right figure; thus, the borders of the missing face are drawn in bold, signifying that they belong only to one face.

3 To apply changes to all viewports, click the **Apply to All Views** button.

To set smart edge display:

1 Select the edge(s) you want to set (see "Selecting objects and components" on page 131).

2 Click **Scene > Set Edge Style** and select one of the following:

- **Sharpen** to sharpen the edges.

- **Soften** to soften the edges.

- **Auto** to match the **Smart Edge Angle** specified in the **General** tab of the **Preferences** panel.

Importing existing 3D objects

Typically you import a 3D object only to apply a texture to it, not to make further modifications.

NOTE You can import the following file formats:

Import formats	Extension
Autodesk platforms	*.obj
Autodesk˚ XML	*.rzi

NOTE You get only the 3D information and not the 2D information of the formats.

To import an OBJ, a RZI file:

1 Do one of the following:

- Select **File** > **Import**.

- Select **Scene** > **Create Primitive Tool** or click (**Add Primitive** icon) and click **Import** in the toolbar.

The **Import** dialog opens in the **Object Library** folder.

TIP Right-click in the **Scene Browser** and select **Import** from the contextual menu to open the **Import** dialog.

2 Browse to select the file you want to import.

3 Click **Open**.

4 Choose whether you want to use the integration tool to precisely place the imported object, or whether you want ImageModeler to import it using default coordinates.
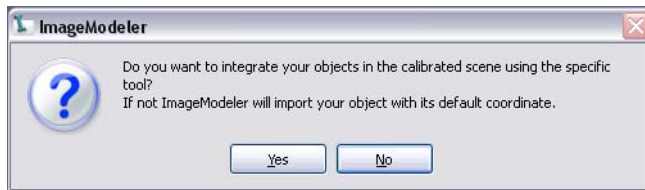
Using the Integration Tool

The **Integration** tool is dedicated to ease the integration of imported objects and scenes into calibrated projects. The tool is automatically activated when objects are imported into a project, but it can also be activated on a selected object or a selection of objects.

To use the **Integration** tool:

1 Import or select an object.

The object appears in the **Workspace** and its vertices are highlighted when you move the pointer over the object.
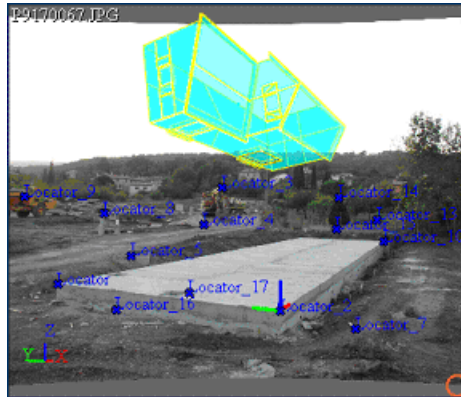
2 Click ▣ (the **Integrate** icon) in the **Modeling toolbar** (or select **Scene > Integration 2D/3D**)

3 Click a vertex and drag it to either a locator, another object's vertex, an edge, or a face. A line appears between the source vertex and the destination:
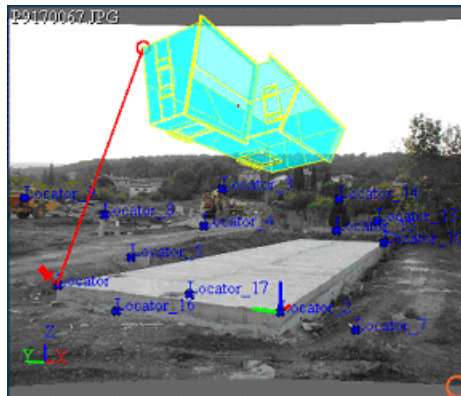
TIP Toggle the **Dynamic** mode to check integration before applying (see "Setting the Integration tool properties" on page 171).

4 Drag the next vertex drag it to either a locator, another object's vertex, an edge, or a face:
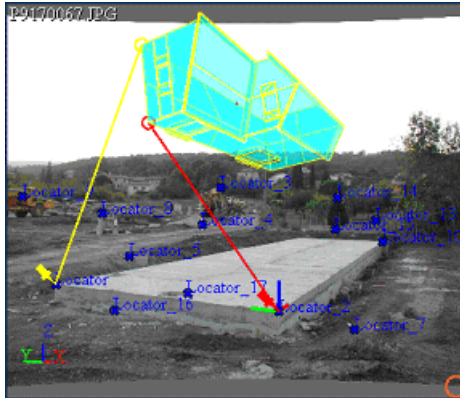
5 Continue to click and drag the other vertices until you have placed the object in the required position:
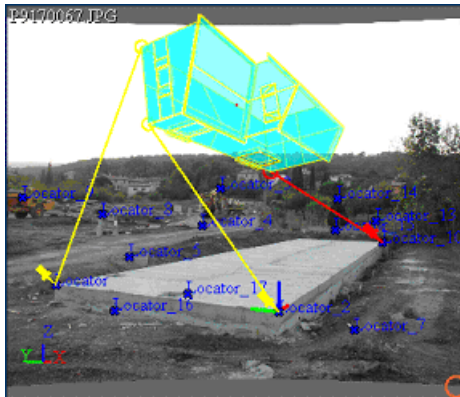
Using the Integration tool manipulators

The **Object Manipulator** is drawn in upper left corner of each viewport, to allow rotation, scale and translation of the object/scene to integrate.

rotation manipulator

scale manipulator

translation manipulator

The **Object Manipulator** changes the rotation and scale values of the imported object. However, these changes are purely visual to facilitate the selection of the source vertices and do not affect the resulting integration.

Setting the Integration tool properties

The **Integration** tool has properties in a toolbar that you can set to help integration of the imported object:
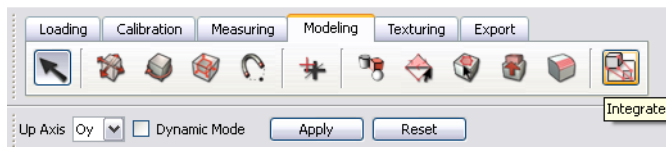
- **Up Axis**: This option sets the up axis of the imported object. For example, you should change the option if the object seems to be lying down on the screen to get it well oriented according to the local coordinate system of the calibrated project. Select from either **Ox** (X-up), **Oy** (Y-up), **Oz** (Z-up).

- **Dynamic**: This option determines if the object moves when you drag the sources to their targets or if unselected, the option is **static** and the object stays on the same place on the viewport. Only links are drawn in the default mode.
- **Apply**: Applies the current placement.
- **Reset**: Removes all the placement links.

7

Texturing a Model

Texturing and the workflow

You apply a material to the surface of a model in a process called "texturing". ImageModeler can extract a texture from a 2D image and apply it to a model. By default, projects have a single material with a default color and this material is automatically assigned to all faces. When you extract textures from photographs (or assign an RGB color), ImageModeler creates a new material and assigns it to the model's faces. You can also assign a constant color to reduce the amount of data.

Texturing Memory Usage

ImageModeler has a texture memory manager that can support high definition images and panoramas by assigning more memory to their handling and display. These settings allow ImageModeler to:

- improve your productivity with a quicker refresh time when you change an image background
- give you better precision for the 3D model's texture details, supporting many high definition images and panoramas

However, you may also need to change down some settings to better support your system's graphics card or to increase your system performance when your project does have many high definition images.

To conserve memory usage and increase system performance:

1   Select **Edit** >**Preferences** > **Display** (Windows) or **ImageModeler** > **Preferences** > **Display** (Mac).
2   Conserve memory usage settings:
   - Check **texture compression** (you need an OpenGL 1.2 card that supports compression)
   - Uncheck **antialiasing**
   - Deacrease the **texture proxy size**

- Decrease **image plane resolution** (for example, 512 gives enough image quality without zooming the viewport)

- Define the maximum size of your texture cache (256 by default)
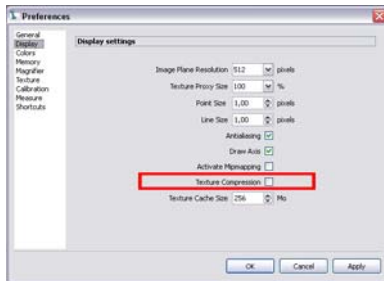
NOTE The **Texture Memory Manager** will automatically release the oldest created texture from memory if the global size exceeds the texture cache size.

The texturing workflow

After you have calibrated a project, you are ready to texture models that you have created or imported. Enter the **Texturing** mode by clicking the workflow tab to show the toolbar:
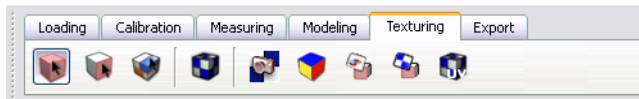
For more information about the toolbar, see "Working with the ImageModeler tools" on page 19.

The main steps in the texturing workflow are:

1 **Create the mapping group(s) for each object.** When default mapping groups are not consistent (due to topological modifications inside the mesh), you must generate a new mapping group by setting how the UV points in the mapping group will be projected on the 2D map for each object or face selection.

2 **Edit UV mapping (optional)**. You can more precisely define how textures will be projected on the 2D maps by editing the mapping groups with actions such as move, rotate, scale, flip, unfold, normalize, unpack and pack.

3 **Extract textures**. Deform or blend calibrated images to create textures.

4 **Edit textures in an external 2D application (optional)**. Use an external editor (such as Photoshop) to edit textures.

In addition, you can **optimize the size and number of textures**, if necessary. You can reduce the texture size to downscale it from full resolution for Web applications or reduce the number of textures for easier editing (see "Optimizing the size and number of textures" on page 201).

Before texturing a model...

- Make sure that you have calibrated the cameras correctly (see "Evaluating the calibration in multi-image projects" on page 63).
- Your project must contain a 3D model, either that you have created or you have imported into the scene (see "Step 1: Creating objects" on page 109).

Step 1: Create Mapping Groups

UV mapping

UV mapping defines the UV texture coordinates that typically connect to points, or vertices, in a 3D mesh to position a 2D image texture onto the mesh. Like virtual tacks, they pin an exact spot on a texture image to a point on an object's surface.

A mapping group represents the 2D development of a set of faces (usually connected) that belong to the same object (generally created by vertex projection). In ImageModeler, object mapping is composed of 1 to N mapping groups. Each mapping group is associated to a unique set of faces (from a single mesh) and a unique texture. As the mapping group defines the texture layout (and therefore some extraction parameters), you should carefully verify its accuracy before you begin the extraction process.

Mapping groups are located in the **Mapping Group** folder of the **Scene Browser**. There are three states for mapping groups:

- Black icon mapping groups represent textures not yet extracted
- Green icon mapping groups represent valid, extracted textures
- Red icon mapping groups represent textures that do not correspond to the mesh topology or UV placement.

NOTE Red mapping groups require a new projection to be applied to the object, and the texture should be re-extracted.
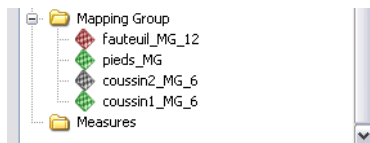
The mapping group property page displays the associated mesh and material (if any). These can each be selected by clicking ">". The properties page also indicates the UV density—and the density of the material determins the quantity of pixels per area for the texture. This is directly proportional to the size of the object and its projected area. The density keeps the proportion between textures, and ImageModeler calculates a UV density that can be used during the extraction process.

NOTE If **distance units** are set to "meters", a density of 100 means that you have 100 pixels per meter.

General	
Name	fauteuil_MG_12
Density U	4.080441
Density V	3.250000
Material	uteuil_MG_12_TX [>]
Mesh	fauteuil [>]
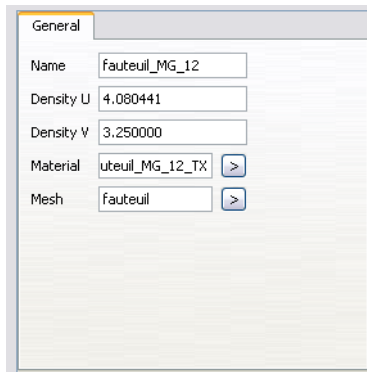
Generating Mappings

1 In the **Scene Browser**, select either an **Object** or a **Mapping Group**

2 Do one of the following:

- Select **Mapping** > **Create UV Mapping**
- Right-click either the Object or Mapping Group and choose **UV Projection**

3 Choose mapping projection:

- **Planar** projects the selection onto a plane—use this option for selections of faces (the faces should not be closed).

- **Cubical** projects the selection onto a cube map—this option can be used for objects or faces.
- **Cylindrical** projects the selection onto a cylindrical map—there is no restriction for the use of this option
- **Spherical** projects the selection onto a spherical map—there is no restriction for the use of this option.
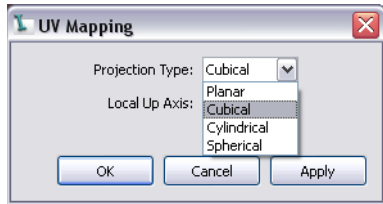
4 Choose the main axis of the projection:
- Y (local)
- Z (local)
- X (local)
- -Y (local)
- -Z (local)
- -X (local)

Step 2: Editing a UV Mapping

1 Select a texture in the **Scene Browser**.

2 Do one of the following:

- Right-click in a viewport and select Switch to UV View.
- Press "\"

The **UV View** is displayed. The UV coordinates projection is shown in green:
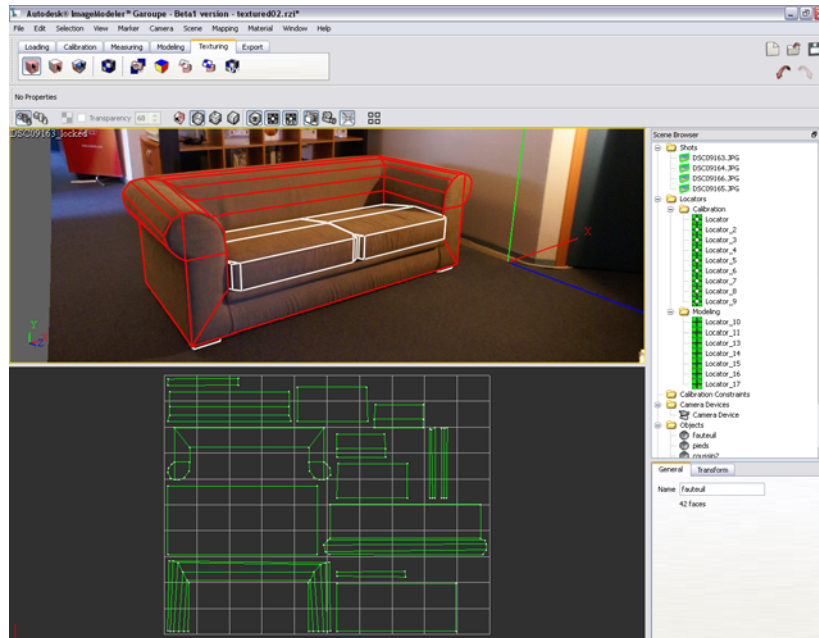
TIP If you are working with a single image, the viewport splits into the 3D view and the UV Mapping view. If you are working with multiple images, you can have one instance of the UV View in one viewport, while displaying the 3D views in the others. Toggle the view by right-clicking in a viewport and selecting **Switch to UV View**, or use the keyboard shortcut: ****.

TIP Use the mouse scroller to zoom in the UV map.

3 Navigate within the UV mapping view by right-clicking and choosing:
- Choose **Fit in View** option to size the map to the viewport.
- Zooom in the view according to the position of the cursor over the view
- Toggle the UV grid display

NOTE The editing is applied in "real time" so that you can check its 3D position in the **Workspace**.

Transforming UV point-selections

The **Transform Tool** allows for translating, rotating and scaling UV points. To use this tool, do one of the following:

- Normalize—fits all UV point coordinates on the UV map [0.1].'
- Rotate—Rotate the whole UV map with dedicated values or 90°, 180° or 270°.
- Flip—Flip the shole UV map horizontally or vertically.

Packing or Unpacking a Mapping Group

Use the pack/unpack option to either create a single texture map for an object (the mesh will be normalized according to the ratio of the UV density), or to break down the map into more manageable pieces.

1 Right-click an object in the **Scene Browser**
2 Select **Unpack Mapping Group**

Step 3: Extracting a texture

Texture extraction is automatic in ImageModeler. By default, the application chooses the textures to extract from the entire set of the calibrated images. However, some shots that were suitable for camera calibration may not be suitable for texture extraction. For example some images may be too light or too dark, or objects may occlude the object to texture on one or more images.

How do you select shots to extract from?

You can specify which shots to include in the extraction process by:

- When you follow the extraction procedure, a dialog appears allowing you to select from a list of shots to choose which ones will be used in the extraction (see "Step 3: Extracting a texture" on page 183).
- Right-click on a shot in the **Scene Browser** and select **Use for Texture.**
- If you never want a shot to be used to extract a texture, you can deselect the **Use to Extract Textures** option in the shot's **Property Box**. The shot will not appear in the list of shots to extract from during the extraction process.

Consider the following when selecting shots...

Regardless of when you specify which shots to include in the extraction process, you should consider the following:

- The more shots you use to extract textures, the better the result. Providing ImageModeler with as much texture information as possible produces more accurate and better quality textures in the final model. The more shots, though, the longer it takes for ImageModeler to extract the textures.
- A face must be shown in at least one image that you use to extract textures; otherwise no texture data can be computed.
- Every face takes texturing information from all the selected images. The result is a blended texture that completely removes discontinuities.

Modeling and texture extraction tasks vary between single-shot and multi-shot projects. When you first load image(s) into ImageModeler to start your project, you choose either Single or Multiples. Each of these paths gives you different modeling and extraction tools.

Single-shot Projects

In a single-shot project, there is only one image (or panorama) that is providing the textures so the process is relatively simple. After selecting the objects you want to texture, the mapping step is completed and the remaining options for texture extraction are:

- Texture size—which can be defined by density value, or by a custom value or a percentage from the best extraction size of the original shot.
- Use Hidden Objects for Visibility—this option tells ImageModeler whether to extract "black area" where another object other than the extracted one is masking it.

NOTE Visibility is important extracting texture on a surface/mesh. The extraction process calculates for each point of view (shot or camera position) which parts of the surface/mesh are hidden by other objects of the scene.

If "Use Hidden Objects for Visibility " is used: All objects, even those that are hidden (see Hide Object in Edit menu) are used for texturing. If this option is not used: only objects that are visible are used for texturing.

Multiple-shot Projects

In a multi-shot project, you need to choose more options:

- Select the images you want to use
- Define the resolution of the texture size—define the density for each mapping group; the percentage of the size that can be extracted (depending on the size of the object); custom define fixed-width value for each texture extraction.
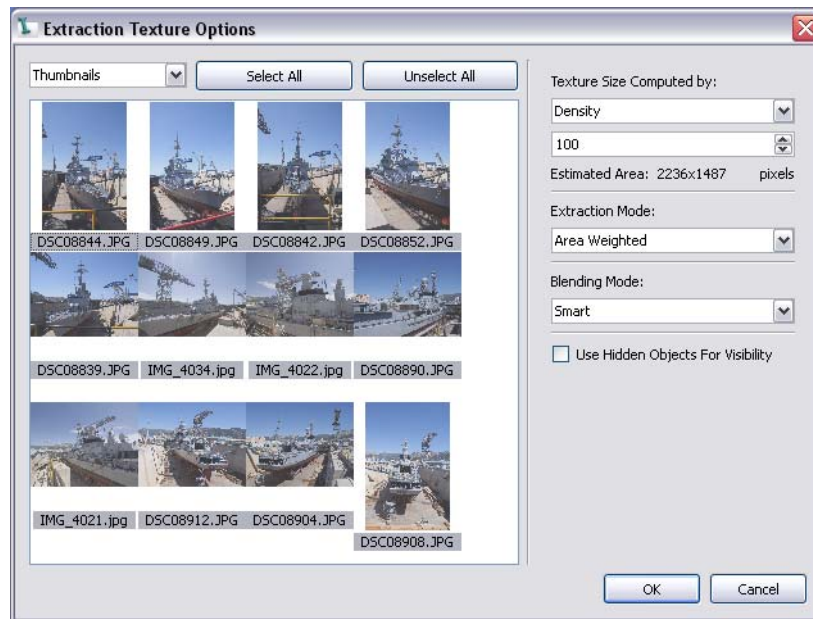
When you extract a texture from the photographs, it is applied directly to the 3D model. For every mapping group linked to this object, the extraction process produces a texture file. You select an object or any mapping group in the **Scene Browser** and then run the extraction process (see "The texture extraction process" on page 189).

In some situations, objects may occlude the object to texture on one or more image used to extract the texture. You can select shots for extraction that do not contain the occlusion during the automatic texture extraction process without impacting the quality of the extraction (see also "Texture extraction of selected faces" on page 201).

For example, if a project contains two images:

image 1

image 2

Selecting "image 1" and "image 2" for texture extraction results in a textured model containing a tree that masks part of the model:

Selecting only "image 2" for texture extraction, which does not contain the tree, results in a textured model without the occlusion:

If you do not have any images without objects masking the face you want to texture, you can touch up the texture in any paint program.

NOTE The quality of the input images determines the maximum quality you can obtain for the textures.

Setting Texture Extraction Preferences

1 The **Default Texture Density** defines a value in pixels per surface unit for extracted texture sizes. For example, if units are in centimeters and the default texture density is 5, each pixel in an extracted texture will represent 2mm (5 pixels for each centimeter).

2 The **Texture Border** defines how far in pixel units the UV projection will match to the border of the UV map.

3 The **Pre-sort Texture Shot** sorts the images displayed in the **Extraction Texture Options** window in order to show only images pertinent to texture extraction, and orders them based on their contribution to texture creation in the project. The 1st image in the list is the one which contributes the most to the texture extraction process for the project.
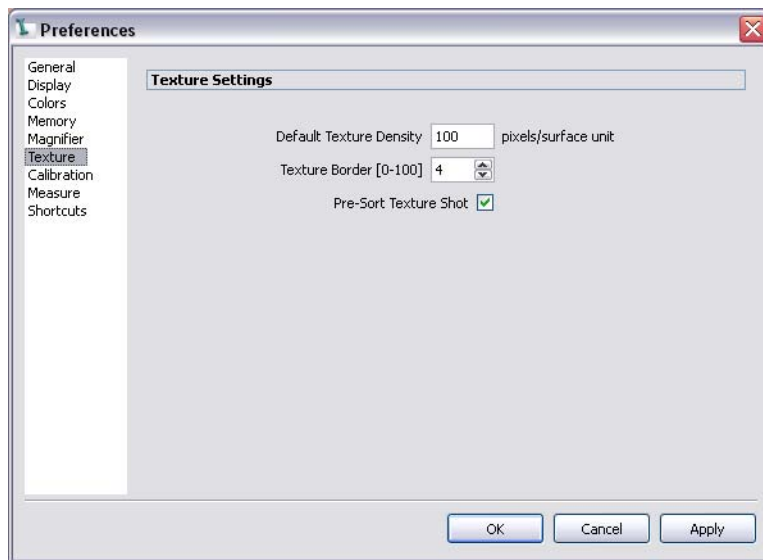
The texture extraction process

To extract a texture:

1 Click on the **Texturing** tab in the workflow toolbar

2 Select one or more objects or mapping groups.

3 Do one of the following:

- Select **Material > Extract Texture**.

- Select the **Extract textures** icon ⬛ in the toolbar.

The **Texture Extraction Options** dialog appears:
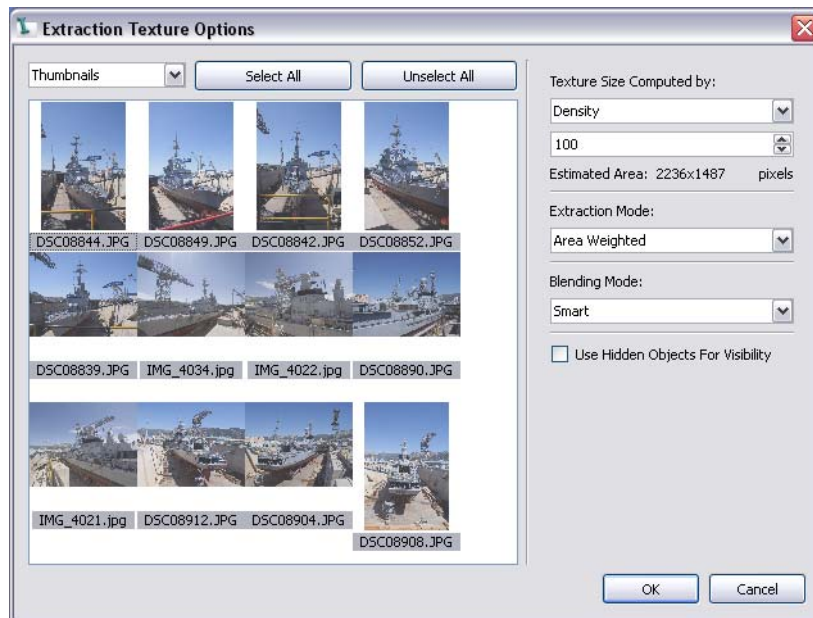
TIP You can prevent shots from appearing in this list by deselecting the **Used for Texture Extraction** option in the shot's **Property Box**.

4 All shots are selected by default. If necessary, select the shots from which you want to extract the texture by clicking on them. For example, deselect an image if it contains an occlusion that you do not want to include in the final model.

Click the **Unselect All** to deselect all images and **Select All** to reselect them.

5 Select an **Texture Size Computed** by:

- **Best—**percentage of best size which can be extracted, depending on the size of the object inside the images.

- **Density—**number of pixels per surface unit for each mapping group.

- **Custom—**fixed-width value for each texture extraction.

NOTE You can also reduce the size of a texture after extraction (see "Resizing textures" on page 204).

6 Select an **Extraction Mode**:

- **Area Weighted—**calculate the best image to use for each pixel in the texture based on the area of each image and contribution to the texture-creation process (same as the pre-sorting process for texture shots in **Edit** > **Preferences** > **Texture** (Windows) or **ImageModeler** > **Preferences** > **Texture** (Mac), see "Setting Texture Extraction Preferences" on page 188).

- **Vertex Weighted—**calculate which image to use for each vertex of the 3D model.

- **All Shots—**no calculation is made, all selected images are projected inside the texture.

7 Select a **Blending Mode**:

- **Smart**—calculates energy path inside the overlapping area of the extraction.

- **Linear**—uses gradient transparency mask

- **PSD (manual)**—saves all images which contribute to the texture process as a layer inside a PSD file and allows you to paint the mask for each layer for manual blending.

NOTE Generally Smart Blending offers the best result.

8 Click **OK**.

The new material appears in the **Scene Browser** with the object's name plus the suffix _TX_#, where # is an incremental number assigned by ImageModeler to make the name unique. You can change the name of the material in the **Properties Box**. Use only numbers, letters, or the underscore character. All other characters are invalid.

Capturing Patterns

The Capture Pattern tool allows you to extract textures that can be applied on other objects—used for texture repetition or to compelte a part of an object where no texture extraction is possible.
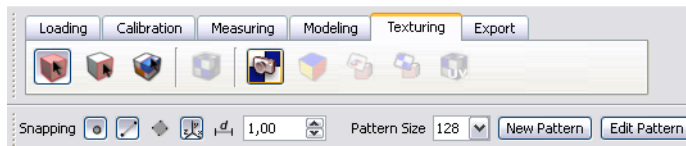
1 Do one of the following:
   - Select Material > Material Capture Tool.
   - Click Capture Pattern in the Texture Toolbar.

A white plane appears in the 3D Workspace.

2 Click to place three corners of the Capture Pattern tool that define the area you want to capture.
3 Press Enter to validate the selection. The texture appears in the in the 3D Viewer in the bottom left corner of the 3D Workspace.
4 Place the cursor in the 3D Viewer and drag and drop the texture onto a surface.

Texture file formats

When you save a project, all the textures are saved in a folder called
"<projectname>_TX" in the same directory as the RZI project file. Texture names
reflect the names of the materials they are linked to. For example, for a material called
"mouth", the assigned texture file could be
"mouth_TX.png".

For ImageModeler projects, textures are saved as PNG files, but you can specify a
different format when you export a texture (see "Export file formats" on page 214).

Toggling the display of textures

You can toggle the display of textures if the object is displayed in the **Solid** mode. No
texturing is shown on wireframe models.

To show or hide textures in the **3D Workspace**:

1 From the **Display** toolbar, click on the **Textures** icon to check (to show) or
   uncheck (hide) textures.
2 To apply changes to all viewports, click the **Apply to All Views** button.
3 Go to preferences to specify how textures should be displayed by selecting **Edit >
   Preferences > Display** (Windows) or **ImageModeler > Preferences > Display**
   (Windows) and set the texture size to either 10%, 20%, 30%, 50%, 100% of the
   original size.

NOTE This is only a display restriction; it does not change the real texture size. It is useful
for working with large projects with large textures, so they can still work with fluid
responses.

Locating corresponding materials and faces

Sometimes, you may have difficulty locating a face and its corresponding material. ImageModeler allows you to either select the material in the **Scene Browser** and locate the corresponding faces in an object, or select faces of an object and locate the corresponding material in the **Scene Browser**.

If you want to find faces with the same material or assigned color by selecting a face:

1 Select a textured face in the 3D workspace.

2 Select **Edit** > **Face Selection** > **Same Material** (or right-click and choose **Same Material**).

The faces linked to the same material are highlighted.

If you want to find faces with the same material or assigned color by selecting a material:

1 In the **Scene Browser**, click a material or an assigned color. The material or color is highlighted.

2 Select **Material** > **Select Assigned Faces** (or right-click and choose **Select Linked Material**).

The faces linked to the selected material or color are highlighted.

TIP Right-click on a material in the **Scene Browser** and select **Select Assigned Faces** from the contextual menu.

What can you do to improve your results?

- **Model is not sufficiently detailed**. You may need to improve your model if it does not provide enough detail for the texture extract process. For example, you want to model a box:
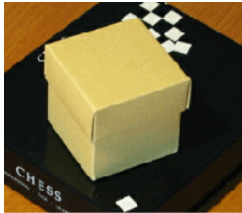
If you create a simple cube primitive surrounding the box (left images), you lose some information valuable for the texture extraction process (right images):
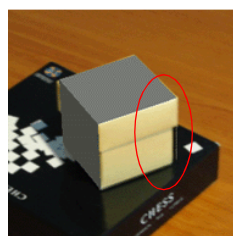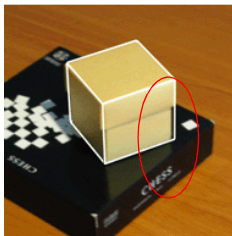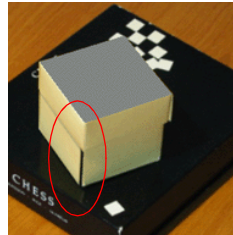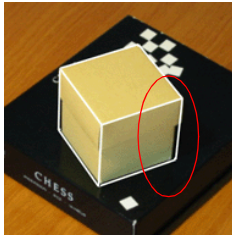
**cube primitive
for modeling**

**model after
texture extraction**

The simple cubic polygon does not provide enough detail to give good results in the texture extraction process. You should improve your model by editing the cube primitive to fit the shape of the box. For example, using the **Extrude** tool, you can

add detail to your model to better define the shape of the box (left images) and then re-extract the textures.

Notice that the textured model (right images) contain no missing textures:
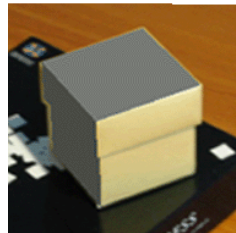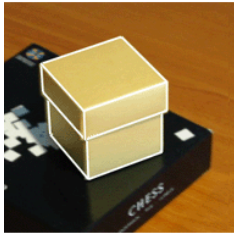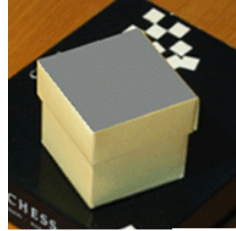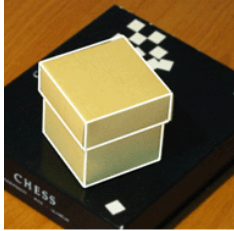
improved model   **improved texture**

texture distorted by   **good texture**
the unfolding, and   **without unfolding**
hard to make further
edition

You can reduce the number of faces in the texture extraction process (see "The texture extraction process" on page 189). Reducing the number of faces reduces the size of the patch, which may simplify it and reduce the number of unfolding artifacts.

- **The model contains occlusions or masks**. Sometimes it may not be possible to shoot your images without occlusions. You can open an image editing software directly from ImageModeler, edit or touch up your texture. Then, you can reload the texture:
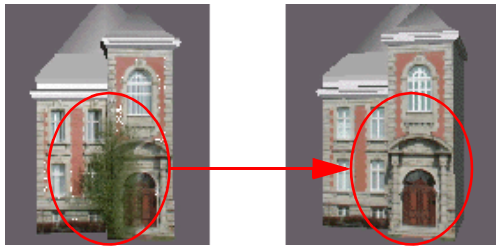
Alternatively, you can exclude images containing an occlusion from the texture extraction process (see "The texture extraction process" on page 189).

- **The model contains non-textured zones**. If you want to control a non-textured zone of the object, you can assign a constant color (see "Assigning a constant color to an object or a face" on page 197) or replace the missing texture by other ones:
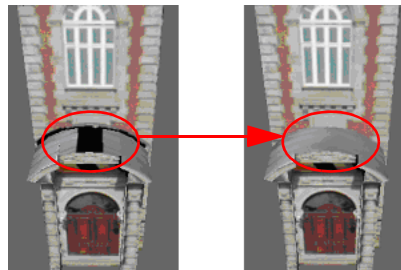
- **Textures have poor resolution**. If the resolution of a texture is too low and the result appears pixelated, you can re-extract that texture with a better resolution.

Step 4: Editing textures

After you have extracted textures for a model, ImageModeler allows you to select materials and edit them in an external 2D editor, and automatically reload them.

- **Edit textures in an external graphics package**. You may want to edit the textures if, for example, you need to reduce contrast or to fix blurry portions of the textures.
- **Assign a constant color to an object or face**. If a model has a uniform shape or color and you want to reduce the amount of data, or you want to control a non-textured zone of the object, you can assign a constant color to an object (see "Assigning a constant color to an object or a face" on page 197).
- **Assign an image to an object or a face**. You can apply an image to parts of a model that are not visible in the original images (see "Applying a texture without extraction" on page 198.
- **Assign a texture to an object or a face**. Parts that are not visible in the original pictures can be textured with generic textures or duplicates of textures already extracted textures (see "Applying a texture without extraction" on page 198).

Assigning a constant color to an object or a face

If you do not want to assign a texture to an object, you can assign it a constant color. If the model has a uniform shape or color, you can assign a constant color to reduce the amount of data. Also, if a model has a non-textured zone, you can control that zone's appearance by assigning a color to it.

To assign a constant color:

1 Select an object or a face(s) to which you want to assign a color (see also "Selecting objects and components" on page 131). The object or the face(s) is highlighted.
2 Do one of the following:
    - Select **Material > Assign Color**.

    - Click on the **Assign Color** icon .

The color palette opens.

3 Choose a color from the **Color** dialog, and then click **OK**.

The new material appears in the **Scene Browser** with the object's name plus the suffix _Col_#, where # is an incremental number assigned by ImageModeler to make the name unique.

To better keep track of materials, rename them to something meaningful, such as "MetalDoor1".

TIP To change at (a later time) the color you assign, click the material in the **Scene Browser** to select it, and then click the **Color** parameter in the **Property Box** to open the **Color** settings.

Applying a texture without extraction

Sometimes it may not be possible to shoot your images without occlusions. ImageModeler allows you to use an existing texture extracted from another mapping group in the scene, or to import an image file and apply this as a texture of the selected object or face, using the existing mapping group.

Additionally, you can duplicate parts of already extracted textures that are listed in the **Scene Browser** onto other places, for example, a wall texture or parst of it can be reapplied to another wall.

To apply an image from the hard drive:

You can map an image from your hard drive onto an object or the selected faces of an object.

1 Select the objects or faces that you want to edit (see also "Selecting objects and components" on page 131). The object or the faces are highlighted.

2 Do one of the following:

- Select **Material > Assign Image**.

■ Click on the **Assign Image** icon .

The file browser opens.

3 Select an image to map and click **OK**.

NOTE Open the **UV Editor** to change the default mapping.

To apply a texture from a hard drive file:

1 Select an object or a face(s) that you want to edit (see also "Selecting objects and components" on page 131). The object or the face(s) is highlighted.

2 Do one of the following:

■ Select **Material > Assign Texture**.

■ Click on the **Assign Texture** icon .

The **Assign Texture** dialog opens:
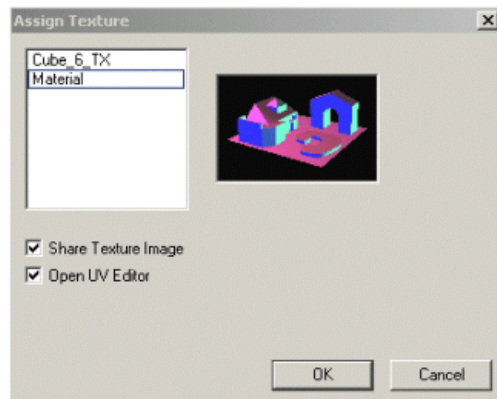
The dialog shows the list of existing materials and its corresponding thumbnail.

3 Select a texture from the list.

4 Click the **Share Texture Images** checkbox if you want to assign the texture to several faces or objects.

5 Click the **Open UV Editor** checkbox if you want to change the default mapping.

6 Click **OK**.

To apply a texture directly from the **Scene Browser**:

1 Select an object or a face(s) that you want to edit (see also "Selecting objects and components" on page 131). The object or the face(s) is highlighted.

NOTE If you do not select any faces or objects, then the material is assigned to the face highlighted as you move the pointer over an object.

2 Select a material directly in the **Scene Browser** and drag and drop it onto the target face or faces. As the pointer moves over the target face, the face is highlighted.

For example, the texture on the left wall of the building is assigned also to the right wall:
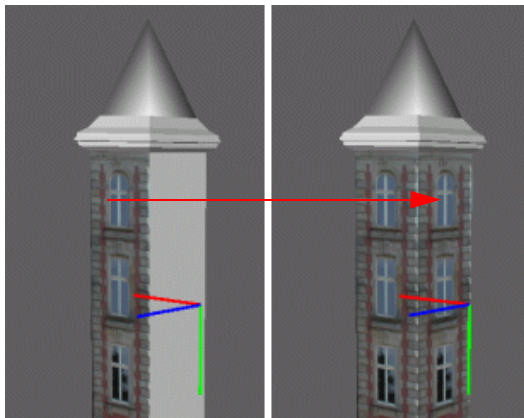
NOTE The black area when textures are missing is minimized by the option **Minimize Black Surface in Texture Map**, which is checked by default in the **Texture** page of the **Preferences** dialog.

Optimizing the size and number of textures

Texture extraction is automatic in ImageModeler. By default, the application chooses the textures to extract from either the entire set or a selection of the calibrated images. You can optimize the number of textures for easier and faster editing and to reduce the number of files for Web applications.

- **Manually selecting and extracting faces** of a model produces only one output file (see "Texture extraction of selected faces" on page 201).
- **Increasing the number of faces in a group** for extraction decreases the number of output textures (see "Defining how faces are grouped for extraction" on page 204).
- **Reducing the size textures** reduces the file size for Web applications (see "Resizing textures" on page 204).

Texture extraction of selected faces

Extracting textures for individual or sets of faces allows you to group textures for faces and produce one output file.

Before extraction, consider the following:

- To quickly extract textures, it is necessary to select a set of polygons that is almost planar and that do not overlap.
- Select faces that have at least one other edge in common with another face to form a connected patch of adjacent faces. In other words, do not select unconnected faces.
- Select a patch of faces that have no hole in it when unfolding is checked (see "Understanding unfolding" on page 202).

- Check that no other faces are selected behind your selection. Even if the camera cannot see some faces, they can still be selected if their normals face the camera (see "Hiding back-facing polygons" on page 163).

To extract a texture:

Select a face(s) by clicking on the corresponding icons in the toolbar (see also "Selecting objects and components" on page 131), then follow "The texture extraction process" on page 189.

NOTE Be sure not to select back faces (see "Hiding back-facing polygons" on page 163 for more details).

Understanding unfolding

By default, ImageModeler calculates an average plane when it extracts textures from the faces of an object. The application then "unfolds" the 3D geometry of the model onto this calculated plane to apply the texture, and then maps each face to one or more input images depending on the orientation of the face. Hidden surface detection and perspective correction techniques are applied.

When should you turn on/off unfolding?

For sharp-edged objects, such as buildings, the unfolded texture may be deformed. If this is the case, you can try turning off unfolding during the texture extraction process (see "The texture extraction process" on page 189).

For smooth objects, such as a human head, the unfolded texture is generally satisfactory. However, when making your selection for unfolding, you should try to group adjacent faces as much as possible.
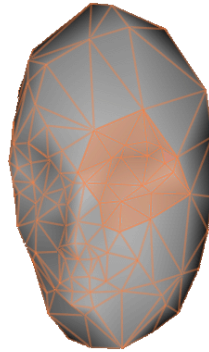
You should avoid the following selections when choosing faces to unfold:

- Selections containing "holes" (top left).
- Separate selections: keep one border (top right).
- Long and thin selections (bottom left).
- Star-shaped selections (bottom right).
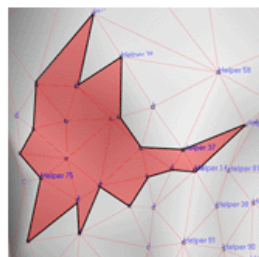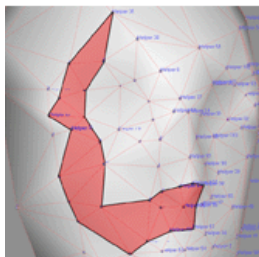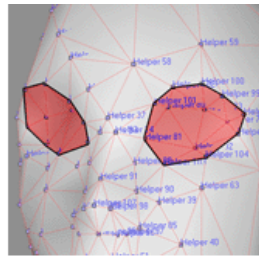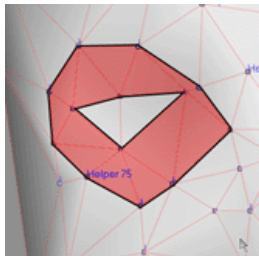
Never select all the faces of a closed object, for example, a sphere, a cube, or a cylinder. ImageModeler is not able to construct one single texture for a closed object.

Defining how faces are grouped for extraction

By default ImageModeler groups faces together for extraction such that two faces have normals that form an angle of less than 90°. You can decrease or increase this maximum angle. When you increase the angle, more faces are grouped and the number of textures decreases.

To change the degrees per extraction:

1 Click **Edit** > **Preferences** (Windows) or **ImageModeler** > **Preferences** (Mac). Click the **Texture** tab.
2 Type the value in degrees in the **Maximum Angle per Texture** field.

Resizing textures

You can reduce the texture to downscale it from full resolution, for example, to produce smaller files for Web applications.

To resize the texture:

1 In the **Scene Browser**, click the material you want to resize. The material is selected.
2 Select **Material** > **Resize Texture** or if you want to resize all textures, select **Material** > **Resize All Textures**.
3 Specify the scale factor (a percentage of the current size).

NOTE You can also set the texture size when extracting materials (see "The texture extraction process" on page 189).

Removing textured faces

Select the faces that you want to remove and click **Edit > Face Selection > Remove Textured Faces**.

8

Exporting

About Exporting from ImageModeler

The ImageModeler export feature allows you to export files in a number of popular formats, as well as allowing you to export only selected objects (in *.rzi and *.obj formats).

ImageModeler 2009 has its own XML-based file format (*.rzi) that describes all the elements that can be created in ImageModeler:

- 3D Objects
- cameras
- 2D points (markers)
- 3D points (locators)
- materials (colors and textures)
- mapping groups
- measures (distance and angles)
- calibration constraints (points, distance, planar, angular)

Backwards compatibility

ImageModeler 2009 will read ImageModeler v4.0 *.rzi files, VTour *.rzv files and MatchMover *.rzml files. However, note that ImageModeler cannot read movie files—so MatchMover *.rzml file support is limited to image sequences only.

NOTE *.rzi files generated by ImageModeler 2009 are not fully supported by ImageModeler v4 or VTour. There is no backwards compatibility because new elements have been introduced in the latest version.

Project Versioning

The ImageModeler versioning feature lets you create versions of your project using the latest file name and adding the suffix "_v####" as the version number. This way you can still quickly save your projects, but you will be keeping the previous and historic versions as well.

To save your projects in versions:

- Select **File > Save As Version** or press **Ctrl + Shift + S** (Windows) **Shift + Command + S** (Mac)
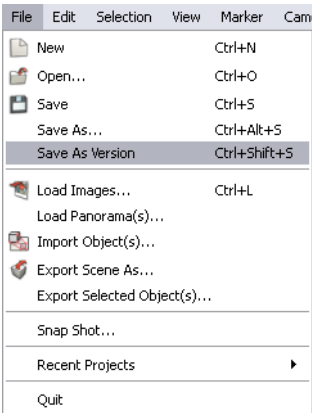
Rendering a snapshot

The ImageModeler **Snapshot** option captures an active viewport and renders it as a JPG image file.

1 Select a viewport in the **Workspace**.

2 Select a viewpoint to render by using the pan, zoom, orbit, frame selected, frame all, look at selected options.

3 Do one of the following:

- Select **File > Snap Shot**.

- Click ![Snap Shot icon] (the **Snap Shot** icon) in the **Export** toolbar.

4 The **Snap Shot** dialog opens:
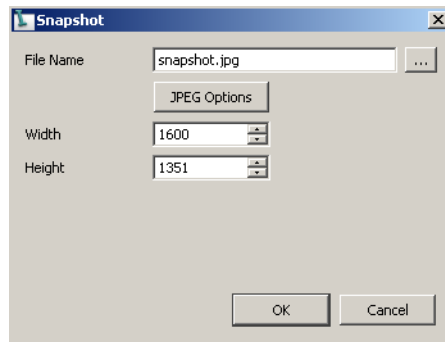
- Set the **Output Image** file name and destination.

- Set the **Width** and **Height** in pixels for the rendered image. The upper size limit is constrained by the size of the original input images.

Exporting to other 3D packages

You can export ImageModeler markers, locators, cameras, 3D objects and mesh selections, or materials, or any combination of them. If you choose to export materials, you can also specify a texture file format.

By default, when you export you create a RZI file, an ImageModeler XML file. However, ImageModeler supports several file formats and each export format supports several components which allows you to specify which ones to export.

See "Export file formats" on page 214 for a summary of the export formats and components that you can export.

To export an ImageModeler project:

1 Select the **Export** toolbar:
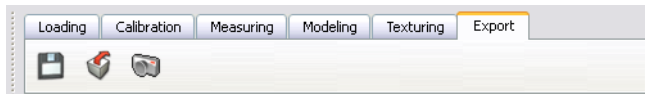
2 Click .

The **Export** dialog opens:
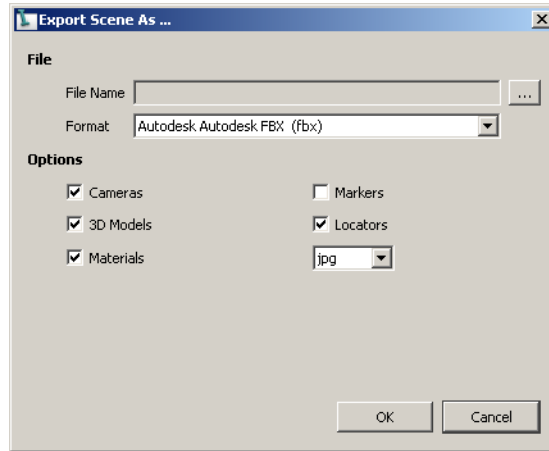
3 Browse to the directory where you want to save your file.

4 Enter a **File Name**.

5 From the **Format** drop-down list, select an export format.

6 Under **Options**, check the component(s) you want to export. If you choose
Material, select also a **Texture Format** from the drop-down list.

7 Click **OK**.

ImageModeler exports your file.

Export file formats

The following table summarizes which components are supported by the export formats:

Export format	Extension	Export...				
		Cameras	Markers	Locators	3D Models	Textures
RealDWG[1]	*.dwg			*	*	
RealDWG 2010[1,2]	*.dwg			*	*	
FBX	*.fbx	*		*	*	*
Maya	*.ma	*		*	*	*
OBJ	*.obj			*	*	*
XML	*.rzi	*	*	*	*	*

[1] *DWG export is not available on the Mac.*

[2] *Using Autodesk's RealDWG 2010 technology.*

A
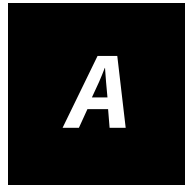
Glossary

Blending – Combination of two or more images by adding them on a pixel-by-pixel basis.

Cubic – Projection that produces six images corresponding to the front, back, right, left, top, and bottom of the cube.

Cylindrical – Projection that creates a cylinder, which accurately represents a single row panorama without distorting the top and bottom from the original image.

Distortion - The lens effect that causes straight lines close to the edge of a photograph appear curved.

Dolly - Dollying lets you move the camera back and forth.

Equalizing – Process of balancing the level of brightness between all the images.

Film Back – Value that represents the size of your film.

Focal length - The distance between the front of the lens and the film back, the plate where the film is exposed. Focal lengths greater than 50 mm create a narrower angle of view; focal lengths less than 50 mm create a wider angle of view.

FOV – Field of view.

IFF – Maya® image file format.

Interlace – Division of video frames into halves (odd and even), or fields, increase the frame rate without increasing the needed bandwidth.

JPG – JPEG file format.

Locator – a physical feature that can be easily identified in more than one image (preferably in all of the images in the project). Some objects have features that represent better targets than others. Buildings, for example, normally offer many good

reference points: corners, intersection of elements, and so on. A locator must have at least 2 reference markers in two images to be used in the calibration.

Marker – the reference points in each image used to describe a locator feature in the images.

Orbit - Orbiting around an object lets you "fly" all around the object to see it from any angle. On screen it looks as though you are tumbling the object, but you are not; you are the one who is moving.

Pan – Panning lets your view (the camera) move from side to side or up and down over an object.

Parallax – Changes the perspective between two adjacent pictures caused by the camera position changing between shots.

PIC – Softimage® Pictures file format.

Pixels – Array of picture elements, usually consisting of red, green, and blue color values, each with five to eight bits of precision.

Planar – Projection that creates a flat map, perpendicular to the center image.

PNG – Portable Network Graphics file format.

PPM – Portable Pixelmap file format.

Primitive – a simple or "primitive" 3D object, such as a cube or a cylinder or a sphere. Primitives can be combined with Boolean operations to create a more complex 3D objects.

Projection – Process of reducing three dimensions to two dimensions for display. It is the mapping of the visible part of a three-dimensional object onto a two-dimensional screen.

QuickTime – Export format that renders a Cylindrical or Cubic QTVR projection, respectively, ready to be viewed in the QuickTime® Player.

Rendering – The process of creating a high-resolution panorama from the photos you have stitched.

Residual Value - the distance in pixels between the 2D marker placed in the image and the 3D locator constructed by ImageModeler and reprojected onto the image.

Roll – Rotates the camera along the line of sight. If animated, a swaying effect is achieved.

SGI – SGI™ Image file format.

Spherical – Projection that creates a cube and represents an entire 360° × 180° panorama in a single image.

TGA – Truevision Targa file format.

TIFF – Tagged Image file format.

Triedron – A geometric marker that defines a right-angle 3D corner, starting from a point of origin and showing the X, Y and Z axes.

Vertex/Vertices – Tagged Image file format.

VRML – Export format that renders a cubic projection, ready to be viewed in the VRML viewer.

Zoom – Changes the field of view.

B
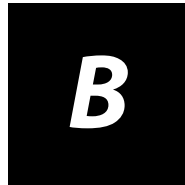
ImageModeler Shortcuts

Keyboard Shortcuts

Keyboard shortcuts are available all the time, regardless of the workflow stage you are in. The majority of the shortcuts in ImageModeler can be customized. To access the Shortcut Manager:

- Windows: select **Edit** > **Preferences** > **Shortcuts** (or press "**P**" and select **Shortcuts**)
- Mac: **ImageModeler** > **Preferences** > **Shortcuts**

Navigation Shortcuts

NOTE In modeling mode using Windows, changing shots with Ctrl + wheel or Ctrl + arrow only cycles through calibrated cameras. In modeling mode on a Mac, changing shots with Command + wheel or Command + arrow only cycles through calibrated cameras.

Action	Windows shortcuts	Mac shortcuts
Changing image: Cycle backward	Ctrl + left arrow	Command + left arrow
Changing image: Cycle forward	Ctrl + right arrow	Command + right arrow
Dolly (only in 3D views)	Ctrl + Alt + left-click	Command + Option + left-click
Orbit	Alt + right-click	Option + right-click
Pan	Alt + left-click	Option + left-click
Roll	Shift + Alt + right-click	Shift + Option + right-click
Zoom	Mouse wheel or Ctrl + Alt + left-click	Mouse wheel or Command + Option + left-click
Zoom area	Shift + Alt + left-click	Shift + Option + left-click
Center the active view on the current point under the cursor	C key	C key

Action	Windows shortcuts	Mac shortcuts
Center all views on the current point under the cursor	C pressed twice	C pressed twice
Zoom in on section under the cursor	Z key - Z pressed twice zooms back out again.	Z key - Z pressed twice zooms back out again.

* The **Thumbnail View** *is only visible when there is only one viewport showing.*

Menu Shortcuts

NOTE If a shortcut is not listed, that particular menu item does not have a customizable shortcut.

File menu

Action	Window shortcuts	Mac shortcuts
New	Ctrl+N	Command + N
Open	Ctrl+O	Command + O
Save	Ctrl+S	Command + S
Save As	Ctrl + Alt +S	Option + Command + S
Save As Version	Ctrl + Shift + S	Shift + Command + S
Load Images	Ctrl+L	Command + L
Quit	Alt+F4	*See ImageModeler menu*

ImageModeler menu - Mac only

Action	Window shortcuts	Mac shortcuts
Preferences	*See Edit menu*	Command + ,
Quit ImageModeler	*See File menu*	Command + Q

Edit menu

Action	Windows shortcuts	Mac shortcuts
Undo	Ctrl + Z	Command + Z
Redo	Ctrl + Y	Command + Y
Hide or Show	Ctrl + H	Command + H
Show only selected	Ctrl + Shift + H	Command + Shift + H
Duplicate	Ctrl + D	Command + D
Delete	Del	Del
Preferences	P	*See ImageModeler menu*

Selection menu

Action	Windows shortcuts	Mac shortcuts
Selection Tool	F2	F2
Select All	Ctrl + A	Command + A
Unselect All	Ctrl + Shift + A	Shift + Command + A
Selection Mode>		
Objects	F3	F3
Vertices	F4	F4
Edges	F5	F5

Action	Windows shortcuts	Mac shortcuts
Faces	F6	F6
Mapping Groups	F7	F7
Face Selection>		
Increase	Shift + Up	Shift + Up
Decrease	Shift + Down	Shift + Down
Same Material	Shift + M	Shift + M
Remove Textured Faces	Ctrl + T	Command + T
Edge Selection>		
Edge Loop	L	L
Selection Bookmark>		
Store Selection 1 to 5	Ctrl + 1 to Ctrl + 5	Command + 1 to 5
Restore Selection 1 to 5	1 to 5	1 to 5

View menu

Action	Windows shortcuts	Mac shortcuts
View Bookmark>		
Store View 1 to 5	Ctrl + 6 to Ctrl + 0	Command + 6 to 0
Restore View 1 to 5	6 to 0	6 to 0
Lock View	Ctrl + K	Command + K
Fit View	=	=
Look at Selected	Home	Home
Next Shot	Ctrl + right arrow or Ctrl + mouse scroller	Command + right arrow or Command + mouse scroller
Previous Shot	Crtl + left arrow or Ctrl + mouse scroller	Command + left arrow or Command + mouse scroller
Toggle UV View	\	\

Camera menu

Action	Windows shortcuts	Mac shortcuts
Calibrate	F9	Command + R

Scene menu

Action	Windows shortcuts	Mac shortcuts
Triangulate	T	T
Subdivide	S	S
Invert Face Normals	I	I
Merge Faces	M	M
Merge Objects	Ctrl + M	Command + M
Glue Vertices	G	G

Mapping menu

Action	Windows shortcuts	Mac shortcuts
Create UV Mapping	F10	Command + U
Unfold UVs	U	U
Transform Tool	Y	Y

Materials menu

Action	Windows shortcuts	Mac shortcuts
Extract Texture	F11	Command + E

Window menu

Action	Windows shortcuts	Mac shortcuts
Layout>		
Single view	Spacebar	Spacebar
Four views	Spacebar	Spacebar
Full Screen	Ctrl + Shift + F	Shift + Command + F

Help menu

Action	Windows shortcuts	Mac shortcuts
Contents	F1	F1

Tool Dependent Shortcuts

Windows shortcuts	Mac shortcuts	Action	Tool
Esc	Esc	Exit the tool and activate the default tool of the working tab (generally Selection)	All
		Deactivate the constraint selector	Constraints
Backspace	Backspace	Remove a 2D marker in a single view	Selection Marker, Create Marker, Move Marker
		Apply local undo (one tool step back)	Create Face Split

Windows shortcuts	Mac shortcuts	Action	Tool
Enter	Enter	Apply current placement state	Integration
		Apply current primitive placement and create it	Create Primitive
		Close face from create points	Close face from create points
		Apply current extrusion	Extrude
Tab	Tab	Switch between Translate/Rotate/Scale manipulators	Translate Rotate Scale
		Switch active constraint to another	Create Face Split Create Primitive
		Switch Dynamic mode on/off	Integration
Shift	Shift	Add to the selection	Selection
		Lock the active constraint	Lock the active constraint
Ctrl	Ctrl	Remove from the selection	Selection
		Avoid intersection between scene elements	Constraints
V	V	Activate constraint selector	Constraints
Z	Z	QuickZoom around mouse area	All Tools

Windows shortcuts	Mac shortcuts	Action	Tool
A	A	Activate Guiding Axis drawing	All tools with snapping constraints
R	R	Reset snapping constraints	All tools with snapping constraints

C
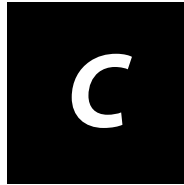
How to Take Quality Shots

About taking quality shots

The models you create can only be as good as the photos you take, and you cannot model or texture what you cannot see in the photos. Spend a little extra time to obtain quality shots that get good coverage of the subject. The following sections outline the main recommendations for taking photographs, lighting your scene, and choosing equipment.

Equipment recommendations

Choosing lenses

ImageModeler uses the focal length of the lens you use to take the photographs in the calibration process. While ImageModeler can use photographs captured with almost any type of lens, try to use the same lens to capture all the photographs of your subject. For example, if you use a lens that has a focal length of 50 mm, use it for the duration of the shoot. If you are using a zoom lens, select a zoom setting and do not change it. To compose shots, move the camera toward or away from the subject rather than using the lens to zoom in and out.

Sometimes you must use lenses with different focal lengths. For example, to model a building you may need to capture some aerial shots using a 135 mm telephoto lens and some ground level shots using a 24 mm wide-angle lens. If you change lenses or zoom settings during the shoot, write down the lens used to capture each image.

Using digital vs. film cameras

Ideally, all the photographs of your subject should have the same brightness and color balance. This ensures that the model's textures blend together to give a natural appearance. Digital cameras are somewhat easier to work with than film cameras in this respect because most digital cameras allow you to choose a white balance setting and either lock the exposure or set the exposure manually. If you are using a film camera, use the same film stock and scan all the film using the same scanner settings. If you use a lab to scan your images, request that the entire roll of film be scanned using the same brightness and color settings.

Lighting your scene

In general, diffuse lighting provides the best texture detail. Use direct lighting, however, if you know your final model will be displayed against a background that also contains directional lighting.

Diffuse vs. direct lighting

ImageModeler produces such realistic models in part because the photos, which make up the model's textures, reveal the subject as it appeared in a real lighting environment. If part of your subject is cast in shadow then the resulting model will lack detail in the shaded regions and suggest a strong light source that may look unnatural when the final model is placed against a different background. Diffuse lighting reveals details and avoids harsh shadows.

If you are creating a model that will, for example, be placed into a movie sequence, light the subject to match the lighting in the movie. This is the same technique used by special effects artists when they light an actor standing in front of a blue screen. Direct lighting causes harsh shadows and hides details. Use it only when you know your model will be placed into a scene with similar lighting. The first image below uses direct lighting and the second image uses diffuse lighting.

Using fixed source lighting and flash photography

Neither the subject nor the light source should change position in photographs. If the lighting changes or the subject moves, each image will have different shading. When images with conflicting shadows are used for texturing, the model will have an unnatural appearance. For this reason, do not use turntables or on-camera flashes. On-camera flashes produce hot spots that give the model an unrealistic appearance.

The image below shows the result of using an on-camera flash. See how the flash produces hot spots, eliminates detail, and gives the subject a very unnatural appearance.

Recommendations for taking shots

The following sections outline the main recommendations for taking photographs for use in ImageModeler and describe what to avoid when taking your shots.

- Capture more shots than required

Consider capturing more images than required, rather than fewer. Discarding images that are not required is easier and less time-consuming than re-shooting the subject.

- Focus the camera on the subject

Sharp images produce visible detail, making it easier for you to create models that look more realistic. To obtain sharp images, focus the camera on the subject, not on the background.

Make sure the entire subject is in focus, especially if the camera is positioned very close to the subject. Be aware that some auto-focus cameras focus on the surface nearest to the camera, leaving other surfaces out of focus. Prevent this by moving camera a little further away from the subject.

- Avoid motion blur

Moving the camera causes motion blur. If the camera moves during the shot the image will appear blurred, even if the camera was properly focused. Motion blur is most likely to occur when taking handheld shots using a slow shutter speed of 1/60th, 1/30th, or 1/15th, for example. If you need to use a slow shutter speed, mount the camera on a tripod.

- Obtain adequate coverage of the subject

ImageModeler gets all of the depth information about an object from the different perspectives shown in the photographs. So, the photographs must capture the overall geometry of the subject in addition its surfaces. To photograph a box, for example, compose shots in which both the top and two sides of the box are visible in the same image. Do not photograph each side of the box separately because these images contain very little information about the subject's spatial properties.
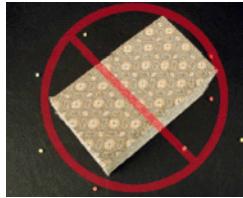
The image provides too little depth information.
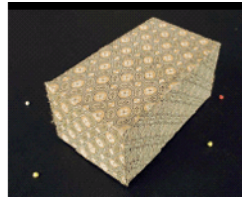
The image provides the necessary depth information.

Make sure that you include your entire subject in each shot. For example, in the first image below. the top and the right side of the subject is cut from the shot. The second image is a better shot because it includes the entire subject.
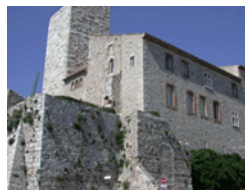
- Avoid occlusions

Blocked areas (called occlusions) are areas that are hidden by another part of the subject. They most often occur when you photograph irregularly shaped objects. If part of the subject is blocked occluded, be sure to photograph the subject from another angle to capture the blocked region.

For example, in the image below, the top of the laptop blocks the keyboard. This subject needs also to be photographed from the opposite direction. (The newspaper was used to provide background features to aid in calibration.)

Similarly, in the following image, the building in the lower right of the first photograph blocks the subject: the building behind. You need to change the viewpoint of the camera to include the entire subject.
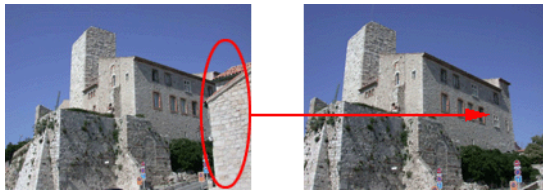
- Shoot from an appropriate distance

Producing final models with high-quality, photo-realistic detail depends on the detail present in the original photographs. Position the camera close enough to the subject to capture the level of detail you need, but be far enough away from the subject to include some the subject's background.

The space surrounding the subject aids in the process of calibration, for example, if you are photographing a subject that has been placed on a table, include some of the table in the shot.

In the following example, the camera is too far from the subject to capture any details in the first image. In the second image, the camera is close enough to capture detail and include some background. In the final shot, the camera is too close to the subject to be usable.

- Maintain a constant zoom

Try to maintain a constant zoom when shooting your subject. If you use a constant zoom, the focal length is more constrained than when you use a varied zoom and ImageModeler finds the focal length of the image more precisely. For example, in the first image below, the details are lost, and in the second image, there is too much detail.

- Shoot scene volume information

Shooting scenes at an angle emphasizes the 3D volume of a scene much more precisely than shooting a "face-on" view. Shooting at a slight angle just above or below the plane parallel to the horizon gives details of zones normally hidden by a "flat" photograph. The first image below shows a bad angle of view; the photo is too "flat". The second image is the preferable angle of view, which shows volume information.

Tip: You can always add a "face-on" photograph, which is little use in the calibration step (although it can be calibrated), but which will certainly be useful for the texture extraction process. The middle image below shows a "Face-on" view for texture extraction. The left and right images below show angled views for use in the calibration process.

- Choose the lighting appropriately.

Do not use shots with different lighting. If you do, ImageModeler will not be able to calibrate the scene correctly. The first image shows the correct lighting; the second image is too bright.

- Avoid varying color intensities

Do not use shots with different color intensities. If you do, ImageModeler will not be able to calibrate the scene correctly. The first image below shows the correct color balance; the second image has poor color balance.

- Do not use modified or artistic shots

Resist composing artistic shots; you can be creative when you model. Avoid choosing cropped images or images that have been modified because they might complicate the distortion correction and you risk displacing the principle point and changing the focal length of the image.

For example, for ImageModeler to correctly perform the calibration process, you must not rotate photos in your graphics package. Take all photos using the same camera orientation.

- Avoid shooting reflecting surfaces

Using polarizing filters when shooting a scene can limit the effects of rays of the sun on a reflecting surface, such as a windowpane.

Prefer shooting an outdoor scene in cloudy weather rather than in sunny weather because clouds hide the sun, remove the effects of reflection on surfaces like glass or metal, and also help avoiding pronounced shading differences in a shot. For texturing purposes, the more uniform the shading is in a scene, the better the texturing result will be.

Further recommendations

Working with wide-angle lens and distortion

ImageModeler works with photographs taken using a wide-angle lens, if the focal is not too small (greater than 20 mm). Photographs taken with objectives with very short focal lengths are greatly distorted and result in errors during the calibration process. For scenes that do not permit a general view in one photograph, it is preferable to shoot several photos of a scene using a lens with a longer focal length and stitch the photos using Autodesk®’ Stitcher®.

Initializing the scale of a scene

In many cases, e.g. for architectural purposes, you may want to capture data at scale. When shooting your images, you can add information in the scene to help you set the reference scale in ImageModeler. For instance, placing a two-meter stick on the wall of a building will give you an accurate visual reference to perform distance measurements on the building within ImageModeler (see "Creating a new ruler to measure angles" on page 100).

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