Motion 3
Supplemental Documentation
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3D Compositing

Create sophisticated 3D motion graphics with depth and new levels of realism in a multiplane compositing environment. Move objects in three dimensions and add cameras that change your scene's point of view.

3D compositing introduces a number of new concepts to the art of motion graphics. At first glance, these concepts might seem daunting. But you already have an advantage: Because you move around in a real three-dimensional world, you'll likely find the virtual 3D world of the Motion Canvas intuitively familiar.

Real-World Coordinates
The position of any object in the real world can be described using a simple coordinate system. For example, you could describe your computer's position as being four feet across from the door, three feet up from the window, and five feet in front of the floor. In a coordinate system, each of the three numbers used to describe an object's position corresponds to a coordinate axis. The place where the zero values along each axis meet is called the origin. In this example, the X equals 4, Y equals 3, and Z equals 5.
Coordinates and Object Position in Space
The location of an object in Motion can be described in these terms as well. The coordinate system used by Motion specifies the center of the Canvas as 0, 0, 0. Moving an object to the left subtracts from the X value, while moving to the right adds to the X value. Moving an object up adds to the Y value, and moving an object down subtracts from the Y value. Moving an object closer adds to the Z value, while moving further away subtracts from the Z value. The main difference between a 2D scene and a 3D scene is that in a 3D scene, you can change your point of view, so that moving an object up doesn’t always mean increasing its Y Position value.

Note: In a new project, the Canvas is oriented with the Z axis pointing straight at you. This orientation preserves the traditional two-dimensional orientation of the X and Y axes, which span the default Canvas from left to right (X) and top to bottom (Y).

3D Conventions
There are a few conventions commonly used to discuss and display three-dimensional environments.
- Object movement is along an axis.
- Object rotation is around an axis.
- Each axis is color-coded: X is red, Y is green, and Z is blue.
- Positive rotation is counterclockwise around an axis.
3D Transform Tools
There is no inherent difference between 2D and 3D project files in Motion. At any point, you may decide to start working with groups or layers in 3D. Doing so requires no preplanning on your part; in fact, it’s possible to go back and forth between manipulating objects in 2D and 3D space. This section covers the tools you can use to move objects around in the Canvas.

![Image of a lion with 3D Transform tool controls]

The image in the screen shot above has just been imported into the scene and is positioned at the scene’s origin. Use the 3D Transform tool—located to the right of the Select/Transform tool in the Toolbar—to move the image.

To use the 3D Transform tool:
- Select the 3D Transform tool in the Toolbar (press Q).

![3D Transform tool controls]

Two things happen immediately when you select the 3D Transform tool. The onscreen controls change, and the object’s HUD changes.
Onscreen Controls
When you select the 3D Transform tool, three colored arrows appear in the Canvas near the center of the image. Each arrow corresponds to one of the three coordinate axes. In the default view, the Z axis points directly out toward you, so that only the tip of the blue Z arrow is visible. Drag one of the onscreen arrows to move the image along a particular axis.

To move an object using the onscreen controls:
1. Select the object you wish to move.
2. Drag one of the colored arrows representing the desired axis of movement.

When dragging, the active arrow turns yellow, and an info window displays the current coordinates of the object as well as the distance the object has moved. As always, coordinates are given in the form of X, Y, and Z.

Near the three colored arrows are three small circles. These are rotation handles. Placing the pointer over any of these circles invokes a rotation ring for a particular axis.

To rotate an object around a single axis using the onscreen controls:
1. Select the object you wish to rotate.
2. Move the pointer to the rotation handle (small circle) corresponding to the desired axis of rotation.
   The rotation ring appears.
3. Drag the ring to rotate the object.
An info window displays the current Rotation values as well as the distance the object has been rotated.

To freely rotate an object around all axes using the onscreen controls:

1. Select the object you wish to rotate.
2. Press the Command key.
   All three rotation rings appear.
3. Drag anywhere inside the rings to freely rotate the object.
   An info window displays the current Rotation values as well as the distance the object has been rotated.

*Important:* Rotation performed with the 2D Select/Transform tool is only around the Z axis.
Note: When the 3D Transform tool is active, a third set of onscreen controls is available: *scale handles*, which appear on the edges of the bounding box surrounding the selected image.

3D Transform Onscreen Controls Display
It is possible to toggle on and off a subset of the 3D transform onscreen controls.

- Press comma (,) to display the axis arrows (but not the rotation handles or scale handles).
- Press period (.) to display the rotation handles (but not the axis arrows or scale handles).
- Press the slash key (/) to display the scale handles (but not the axis arrows or rotation handles).

When you press any of the above keys a second time, the display toggles back to the default, with all three of the onscreen controls visible.

3D Transform HUD Controls
In addition to the onscreen controls, the HUD provides another method of transforming objects in 3D space.

Move
Three controls in the Move section of the HUD let you drag the selected object in one or more axes at once. Drag inside one of the Move controls to change the relevant parameter values of the object in the Canvas:

- **Move Z**: Drag here to move the selected object in the Canvas along the Z axis. Dragging to the right increases the Z value, and dragging to the left decreases the Z value. Hold down the Command key when dragging to simultaneously scale the object as it is translated (moved), preserving its size relative to the camera.
• **Move XY:** Drag here to move the selected object in the Canvas along the X and Y axes. Dragging right or left increases or decreases the X value. Dragging up or down increases or decreases the Y value. Using this control is identical to moving a 2D object directly in the Canvas. Hold down the Command key when dragging to constrain movement to the axis corresponding to the initial direction of the drag.

• **Move XZ:** Drag here to move the selected object in the Canvas along the X and Z axes. Dragging right or left increases or decreases the value of X. Dragging up or down increases or decreases the value of Z. Hold down the Command key when dragging to constrain movement to the axis corresponding to the initial direction of the drag.

**Tip:** As in the Inspector, holding down the Shift key while you drag in the HUD makes larger changes. Holding down the Option key while you drag makes smaller changes.

**Rotate and Scale**

Two additional drag controls in the HUD let you rotate and scale the selected object in the Canvas:

• **Rotate XYZ:** Drag here to rotate the selected object in the Canvas in all axes. Starting at the origin, dragging up and down rotates the object around the X axis. Dragging to the left and right rotates the object around the Y axis. Hold down the Command key while dragging to constrain rotation to the Z axis.

• **Scale:** Drag here to uniformly scale the selected object in the Canvas. Dragging to the right or up or both increases the Scale value. Dragging to the left or down or both decreases the Scale value. Hold down the Command key while dragging to constrain scaling to the axis corresponding to the initial direction of the drag.

**Adjust Around**

The Adjust Around pop-up menu, located under the Move, Rotate, and Scale controls in the HUD, allows you to select which relative coordinate space is used for transforms. The Adjust Around pop-up menu has three options:

• **Local Axis:** The default, this option orients the onscreen transform controls to the object’s local axes.

• **World Axis:** This option orients the onscreen transform controls to the axes of the 3D grid in the Canvas.

• **View Axis:** This option orients the onscreen transform controls to the view space of the current view. The Z axis is aligned along the view’s line of sight. For more information on views, see “Views” on page 17.
Relative Coordinates

To better understand the concept of relative coordinates, think of a system of satellites, like the earth, the moon, and the sun. The moon’s parent is the earth, and the earth’s parent is the sun. Usually, when considering these three bodies, the moon’s position is described in terms of its position relative to the earth (the moon’s parent), and the earth’s position is described relative to the sun (the earth’s parent). In Motion, an object’s position and orientation are always relative to its parent.

When you add a new group to a Motion project, that group is created at the origin coordinates of its parent. In the case of a root-level group (a group that is not nested within any other groups in the Layers list), the parent is the project itself. An object placed inside of a group has its position described relative to its parent: the group.

In the previous example, a group has been positioned at X, Y, and Z coordinates of 50, 50, and 50, respectively. The group is located 50 units away from its parent’s origin on all axes (the parent in this case being the project itself). The image inside the group is positioned at 0, 0, 0. Because the image’s position is relative to its parent, the group, it shares its parent’s origin and has an apparent position in the world of 50, 50, 50.
Moving the image to a position of 25, 25, 25 displaces it by 25 units from the group’s origin in all axes. While the image’s apparent position relative to the world is 75, 75, 75, its Position values in the Inspector are 25, 25, 25 because its position is always relative to its parent.

Rotation values are also relative to an object’s parent.

Important: World and view transforms are limited to the HUD and onscreen controls; all transforms made in the Inspector are relative to an object’s parent’s space.

Layer Order and Depth Order
When compositing in 2D, the Layers list shows the layer order, which determines which objects appear on top of other objects. Objects that are higher up in the Layers list appear on top of objects lower than them in the Layers list.
Important: The children of 2D groups are always composited in layer order.

If you were to move Group A below Group B in the Layers list, Group B would be rendered on top of Group A.

The Layers list also shows object relationships in terms of parenting. The parent-child relationship is displayed in the Layers list through the use of indenting and disclosure triangles.
The Layers list is not the only indicator of order when considering objects in 3D. When depth-sorted, an object can be at the bottom of the Layers list and yet appear to be on top of everything else in the Canvas, because of the object’s position relative to the current camera. The most common way to adjust depth order is to change the Z position of a layer or group.

**Important:** The children of 3D groups are composited in depth order by default.

With the 3D groups above, objects are composited in depth order; their position in the Layers list does not correlate to their position in 3D space relative to the camera.

In the above example, the Blue A group is above the Red A group in the Layers list but it appears behind the Red A group in the Canvas because it is depth-sorted. The same principle applies to the Blue B group and the Red B group.
3D Transformations in 2D Groups

All objects have 3D transformations available, even when in 2D groups. All can be rotated around any axis and moved along any axis. Keep in mind that objects in 2D groups are not depth-sorted, and cannot intersect, regardless of their position in 3D space.

Both of these groups are positioned at the same point in 3D space, but because they are layer-ordered, group A does not intersect with group B. If you change the parent group to 3D, the two groups will intersect.

*Note:* If two groups are coplanar (occupy the same plane), they are composited in layer order, regardless of whether the objects’ parent is a 2D group or 3D group. In a 2D composite, all objects are coplanar.
3D Workspace and Views

In a 3D workspace, everything is seen from the viewpoint of a camera. The default views presented in the 3D workspace are *reference cameras* that can be used and manipulated to help place and animate objects but are not used for rendering output. If you wish to render specifically from one of the camera views, you must create a *scene camera*. For more information on cameras, see “Cameras” on page 26.

Views

There are several different *view layouts*, with each layout consisting of an arrangement of *viewports*. But each layout works exactly the same as another, and the views are manipulated in precisely the same way no matter how many views there are. Each viewport displays the scene from the point of view of a camera. Reference camera views have a specific default position and orientation.

There are two types of default reference cameras:

- **Orthogonal**
- **Perspective**

An orthogonal camera views the scene by looking straight down one of the world axes: X, Y, or Z. The default orthogonal “cameras” do not actually appear in the Layers list, Timeline, or Canvas. The Front and Back cameras look straight down the Z axis. The Top and Bottom cameras look straight down the Y axis. The Left and Right cameras look straight down the X axis.
Orthogonal cameras do not show *perspective*. Perspective cameras—and scene cameras that you add to a project—distort the view the way a real-world camera would.

![Rotated in orthogonal camera view](image1.png) ![Rotated in perspective camera view](image2.png)

In order to have access to reference camera views and camera controls, you must first add a camera to your scene.

**To add a scene camera to a Motion project:**
- Choose Object > New Camera (or press Command-Option-C).

A camera object is added to the Layers list, the Timeline, and the Canvas (represented there by a wireframe icon). The 3D Transform tool in the Toolbar becomes active, the Camera HUD appears (if it isn’t visible, press F7), and the Camera tab in the Inspector becomes available.

If you add a camera to a project that contains no existing 3D groups, the following dialog appears:

![Dialog](image3.png)
Once you add a camera to a project, the Camera menu becomes available in the upper-left corner of the Canvas.

3D Overlays
There are five 3D overlays that can appear in the Canvas: the 3D View tools, the 3D Compass, the Inset view, the 3D grid, and the 3D scene icons. You can toggle the appearance of each of the overlays in the Canvas.

To toggle the appearance of 3D overlays, do one of the following:
- Choose View > 3D Overlays, then choose the type of 3D overlay you wish to show or hide.
Choose the type of 3D overlay you wish to show or hide from the View pop-up menu in the Toolbar.

3D View Tools

Camera Menu

The Camera menu, located in the upper-left corner of the Canvas, lists the currently active camera view. Choose from a list of reference cameras and scene cameras, as well as several view-related commands.

The Camera menu is divided into three sections:

- The top section allows you to select the currently active camera as well as any other scene cameras you have added to the project. If a scene contains more than one camera, the camera that is topmost in the Layers list and in the Timeline at the current frame is the active camera. For more information on scene cameras, see “Cameras” on page 26.
- The middle section allows you to select one of the default reference cameras: Perspective, Front, Back, Left, Right, Top, Bottom.
- The bottom section allows access to two commands: Reset View, which resets a camera to its default view, and Frame Objects, which frames the selected objects in the active view. If no objects are selected, Frame Objects resets the reference camera to view all the objects in the scene.
3D View Tools
The 3D View tools can be used to control both reference and scene cameras.

The scene camera indicator appears to the left of the 3D View tools only when a scene camera is the active camera. There are three 3D View tools:

- **Pan**: Drag in this box to move the camera along the X and Y axes relative to the current view.
- **Orbit**: Drag in this box to orbit the camera around the currently selected scene object. If nothing is selected, the camera orbits around its focal plane. For more information on the camera focal plane, see “Camera Controls” on page 26. Orbit can affect X, Y, and Z Position values, as well as X and Y Rotation values.

  **Note**: If you use the orbit control to change one of the orthogonal reference cameras, an asterisk appears next to the view’s name in the Camera menu, indicating that the view is no longer a true orthogonal view.

- **Dolly**: Drag in this box to dolly the camera, moving it along the Z axis relative to the current view.

  **Important**: Double-clicking a 3D View tool resets all parameters that can be affected by the tool.

3D View Tool Shortcuts
It is possible to use the Pan, Orbit, and Dolly tools with keyboard commands and a three-button mouse:

- **Pan**: Drag in the Canvas while holding down the Option key and the right mouse button.
- **Orbit**: Drag in the Canvas while holding down the Command key and the right mouse button.
- **Dolly**: Drag in the Canvas while holding down the Command key, the Option key, and the right mouse button.
3D Compass
Located in the lower-left corner of the Canvas, the 3D Compass acts as an orientation and shortcut device. It has active and passive states, depending on whether the pointer is positioned over it. In its passive state, it displays the orientation of the three world axes (X, Y, and Z). In its active state, the compass presents color-coded shortcuts to the reference (orthogonal and perspective) cameras.

To select a reference camera view using the 3D Compass:
1. Position the pointer over the compass.
   The compass changes to its active state, displaying a labeled icon for each of the reference camera views.
2. Click the icon representing the camera you wish to activate.
   The view in the Canvas updates to the selected reference camera view.

To select a scene camera view using the 3D Compass:
1. Position the pointer over the 3D Compass.
   The compass changes to its active state.
2. Control-click the 3D Compass, then choose a scene camera from the shortcut menu.
   The view in the Canvas changes to the selected scene camera view.

Note: You can also choose a reference camera view from the 3D Compass shortcut menu.
**Inset View**
When you move an object, an Inset view appears in the lower-right corner of the Canvas, showing the scene from a different camera’s point of view. If you are currently viewing the scene through the active camera, the Inset view shows the Perspective camera’s point of view. If you are currently viewing the scene through any other camera, the Inset view shows the active camera. Use the Inset view to see the results of changes that you make in orthogonal views.

Use Motion Preferences to set the Inset view’s size and when it appears in the Canvas. For more information on Inset view properties, see chapter 1, “Getting to Know Motion,” in the Motion 3 User Manual.

**3D Grid**
The 3D grid shows the *ground plane* of the 3D world. The ground plane is, literally, a plane attached to the “ground” of the scene, where Y equals 0. The ground plane represents the dividing line between “up” and “down,” between positive Y values and negative Y values. It is centered on 0, 0, 0.
3D Scene Icons
3D scene icons are the onscreen representations of cameras, lights, and edge-on lines. An edge-on line is drawn when an object’s edge is facing the camera—which normally results in an invisible object. This allows you to select objects that would otherwise be invisible. None of the 3D scene icons appear in exported images and movie clips.

Tip: Double-click a camera scene icon to select it and change the current view to that camera.

View Layouts
Motion allows you to have multiple views active at the same time in the Canvas to help with animating and positioning objects in 3D space. The View Layouts pop-up menu, located in the Status Bar, just above the 3D View tools, lets you choose from seven different view layouts. Each layout is represented by an icon in the pop-up menu:
- Single: The default value, displays a single window in the Canvas.
- Two-up, side by side: Displays two windows in the Canvas, one next to the other.
- Two-up, top and bottom: Displays two windows in the Canvas, one on top of the other.
- Three-up, large window below: Displays three windows, two next to each other on top and a larger window below.
- Three-up, large window right: Displays three windows, two stacked on the left side and a larger window spanning the right side.
- Four-up, large window right: Displays four windows, three stacked on the left side and one larger window on the right side.
• **Four-up:** Displays four windows, all the same size.

To open multiple windows in the Canvas:
- Choose a layout from the View Layouts pop-up menu. The Canvas displays the layout you choose.

**Active View**
When working with multiple views, the last view you clicked in is the active view. The active view is indicated by a yellow border. Only the active view can contain onscreen controls.

The view in the upper-left quadrant is active.
Cameras
In 3D mode, anything you see in the Canvas represents the viewpoint of a camera, either a default reference camera or a scene camera that you create. You can explicitly create cameras that can be used to look at your scene from different points of view. You can place, animate, and apply behaviors to cameras in your scene. Creating multiple cameras gives you the ability to make different cameras active at different times, allowing you to “cut to” different views over the course of the project.

Creating a Scene Camera
The scene cameras that you create are used for rendering output. Scene cameras appear in the Canvas as wireframe camera icons and as objects in the Layers list and Timeline.

To add a scene camera to a Motion project:
- Choose Object > New Camera (or press Command-Option-C).

A camera object is added to the Layers list, the Timeline, and the Canvas (represented there by a wireframe icon). The 3D Transform tool in the Toolbar becomes active, the Camera HUD appears (if it isn’t visible, press F7), and the Camera tab in the Inspector becomes available.

Camera Controls
You can modify a scene camera’s properties via the Camera HUD or the Camera and Properties tabs in the Inspector.

Parameters in the Inspector
There are six parameters in the Camera tab of the Inspector:
**Camera Type:** A pop-up menu that sets the type of camera used. There are two options: Framing (the default value) and Viewpoint. A Framing camera has its origin at the *focal plane*. The focal plane of a camera is a plane located at a distance equal to the camera's focal distance along its local Z axis (or line of sight) and oriented perpendicular to the camera's local Z axis. A Viewpoint camera has its origin at its *center of projection*.

*Tip:* The position of a Framing camera's origin makes it useful for orbiting moves. Rotating the camera causes it to orbit, whereas rotating a Viewpoint camera causes it to pivot.

**Angle of View:** A slider and value slider that set the angle of view of the camera, which is the number of degrees in which the camera sees. Value can be selected from 0 to 180 degrees.
**Note:** When you animate the Angle of View parameter on a Framing camera, the result is an opposing dolly effect. An opposing dolly zooms in the opposite direction that the camera moves. When you animate the Angle of View parameter on a Viewpoint camera, the result is a regular camera zoom.

Near Plane: A slider and value slider that set the distance at which the camera begins to see objects. Objects closer to the camera than this distance are not rendered from this camera’s point of view.

Far Plane: A slider and value slider that set the distance at which the camera ceases to see objects. Objects further from the camera than this distance are not rendered from this camera’s point of view.

Near Fade: A slider and value slider that set the softness factor for the near plane. The softness factor sets a boundary range over which near objects fade in.

Far Fade: A slider and value slider that set the softness factor for the far plane. The softness factor sets a boundary range over which far objects fade out.

**Scaling a Camera**

You can use the Scale parameter in the Properties tab of the Inspector to scale what a camera sees. Changing the Scale value does not affect a camera's Angle of View parameter. Changing the Scale value only affects Framing cameras.

Imagine if you shrank down to only a few inches tall. While the world around you hasn’t actually changed size, it would appear, to you, to be much larger. Similarly, if you grew to 50 feet tall, the world would seem smaller, even though it hasn’t changed. Scaling a camera up or down has the same effect.
Positioning Cameras
Cameras share the same transform properties as any other object in Motion and can be positioned in all the same ways: by using the onscreen controls and by editing parameters in the HUD or Inspector. For more information on the onscreen controls, see “3D View Tools” on page 21. Additionally, cameras can be positioned using the Walk Camera tool.

Note: As a convenience, it is possible to move an orthogonal camera view to display the scene from a position and orientation other than its default.

Walk Camera Tool
The Walk Camera tool allows you to position the camera in 3D space as you would in a video game, using a keyboard-and-mouse navigation method.

To use the Walk Camera tool:
1. Select the Walk Camera tool in the Toolbar.
2. Use the Up, Down, Right, and Left Arrow keys to move the camera in 3D space; hold down the Option key in conjunction with the arrow keys to move the camera more slowly.
3. Drag in the Canvas to orient the camera.

Important: A camera cannot be nested in a 2D group. If you try to create or add a camera to a 2D group, the following dialog appears:

A camera added to a 2D group is automatically disabled.

Animating Cameras
Cameras can be animated directly in the Canvas by the same means used to animate any other object in a project. Cameras can also be animated through the use of behaviors, including special Camera behaviors. For more information on Camera behaviors, see “Camera Behaviors” on page 31.
**Active Camera**

If a scene contains more than one camera, the camera that is topmost in the Layers list and in the Timeline at the current frame is the *active camera*. Although the active camera is the default camera used for export, you can select any scene camera to export.

![Active Camera Diagram](image)

Camera 2 is the active camera at the position of the playhead.

**Isolate**

The Isolate command (and Isolate button) temporarily aligns the current view with the selected object and hides all other objects in the scene. This facilitates access to distant or obscured objects.

![Isolate Button](image)

**To isolate an object:**

1. Select the object you wish to isolate in the Canvas, Layers list, or Timeline.
2. Do one of the following:
   - Choose Object > Isolate (or press Control-I).
   - In the Layers tab or Timeline, click the Isolate button.
The current view changes to align itself with the selected object, and all other objects in the scene are hidden.

When an object is isolated, a temporary camera is created and listed in the Camera menu. The camera shares its name with that of the isolated object.

To exit the isolated view, do one of the following:
- Choose Object > Isolate (or press Control-I).
- In the Layers tab or Timeline, click the Isolate button.
- Choose a different camera from the Camera menu.

**Using Multiple Views with the Isolate Command**
You can isolate as many objects as you have views. It is possible to edit an object in an isolated view while looking at the results through a scene camera in another view. Once an object is isolated in a view, you can activate another viewport and isolate a different object.

**Camera Behaviors**
While most types of behaviors in Motion can be applied to cameras, there is an additional set of special Camera behaviors.

To add a Camera behavior:
1. Select a scene camera in the Layers list, Timeline, or Canvas.
2. Click and hold the Add Behavior icon in the Toolbar, choose Camera from the pop-up menu, then choose an item from the submenu.
There are four camera-specific behaviors: Dolly, Sweep, Zoom In/Out, and Zoom Layer.

**Dolly**  
Moves the camera a specified distance along the camera's Z axis.

**Parameters in the Inspector**

- **Distance**: A slider and value slider that set the distance of the dolly movement.
- **Speed**: A pop-up menu that sets the type of interpolation used for the movement. The value can be set to Constant, Ease In, Ease Out, Ease Both, Accelerate, or Decelerate.

**HUD Controls**

The HUD contains the same controls as the Inspector.

**Sweep**  
Pivots the camera across a specified arc.

**Parameters in the Inspector**

- **Start**: A dial and value slider that set the starting angle of the camera's orientation relative to the camera's current orientation. A nonzero value causes the camera to jump to this value at the start of the behavior.
- **End**: A dial and value slider that set the final angle of the camera's orientation relative to the camera's Start parameter value.
- **Speed**: A pop-up menu that sets the type of interpolation used for the rotation. The value can be set to Constant, Ease In, Ease Out, Ease Both, Accelerate, or Decelerate.
- **Axis**: A pop-up menu that sets the axis around which the sweep occurs. Value can be set to Tilt X, Swivel Y, or Roll Z.

**Zoom In/Out**  
Animates the camera's Angle of View parameter.

**Parameters in the Inspector**

- **Zoom**: A slider and value slider that set a proportional value used to modify the camera's Angle of View parameter.
- **Speed**: A pop-up menu that sets the type of interpolation used for the movement. The value can be set to Constant, Ease In, Ease Out, Ease Both, Accelerate, or Decelerate.

**HUD Controls**

The HUD contains the same controls as the Inspector.
**Zoom Layer**

Moves a camera to the position of a target object’s anchor point. Once the camera reaches the object’s anchor point, the angle of view changes while offsetting the camera's position. This behavior also allows you to animate the camera’s angle of view during the camera’s movement, based on the behavior’s Transition value. This behavior is best used with a Framing camera.

**Parameters in the Inspector**

**Object**: An image well to set the target of the camera's movement. Drag an object from the Layers list into the well.

**Transition**: A slider and value slider that determine how far into the behavior the camera stops moving and the camera’s Angle of View parameter begins to animate instead.

If Transition is set to 50% in a Zoom Layer behavior that has a length of 300 frames, the camera move takes 150 frames to arrive at the position of the target object and then stops moving for the duration of the behavior, and the camera’s Angle of View parameter animates over the rest of the duration. If Transition is set to 100%, the camera move takes the full 300 frames to arrive at the position of the target object, and the camera’s angle of view does not animate. If the Zoom Layer behavior’s duration is 100 frames, and Transition is set to 50%, the camera move takes 50 frames to arrive at the position of the target object.

**Speed**: A pop-up menu that sets the type of interpolation used for the rotation. The value can be set to Constant, Ease In, Ease Out, Ease Both, Accelerate, or Decelerate.

**Zoom**: A slider and value slider that set a proportional value used to modify the camera's Angle of View parameter. A nonzero value determines how much the angle of view (and thus perspective) changes relative to the camera's initial angle of view. A zero value for Zoom leaves the Angle of View parameter unchanged.

**HUD Controls**
The HUD contains the same controls as the Inspector.
Drag and Drop onto the Canvas
Dragging and dropping an object onto the Canvas adds the object to the scene at the focal plane of the current camera. Dragging an object into the Layers list or clicking the Apply button in the Preview Area of the File Browser positions the object at 0,0,0.

Using Cameras to Set Up Useful Working Views
When building a 3D project, it can be useful to position cameras to examine your project’s layout from different viewpoints. Rather than repeatedly moving the Perspective camera, you can add scene cameras to use as “spatial bookmarks.” You won’t want to use these cameras during export, so be sure to disable them before rendering.

2D and 3D Group Interaction
The 3D group type adds a new level of flexibility to your projects, but also creates complex interactions between group types.

Groups can either be 2D or 3D, and it is possible to change a group’s type at any time.

To change a group’s 2D/3D type:
- In the Layers tab or Timeline, select the group you wish to change, then do one of the following:
  - Choose Object > 3D Group (or press Control-D).
  - Click the 2D/3D icon in the Status column in the Layers list.
Root-Level Behavior
At the root level of the project, 2D groups behave differently than when they are nested inside 3D groups. (For more information about root-level groups, see “Relative Coordinates” on page 12.) 2D groups at the root level are locked to the camera, even if the camera is animated. 2D groups at the top of the Layers list are always rendered in the foreground, and 2D groups at the bottom of the Layers list are always rendered in the background. Adjacent root-level 3D groups can intersect based on depth order.

In the example above, the two gray balls in the 2D Foreground layer are always composited on top of the rest of the scene. The 2D Background layer is always composited beneath the rest of the scene. Group A and Group B intersect because they are 3D groups, but neither of them can intersect with either of the 2D root-level groups.

2D and 3D Group Behavior
While 2D and 3D groups share a lot of common properties, there are distinct differences in how they and their children behave and interact with other objects in a project. 2D and 3D groups can be parents or children of each other; there are no restrictions on mixing group types.

The Group Tab in the Inspector
In the Inspector, the Group tab appears when a group is the selected object. The Group tab contains the Type parameter, which allows you to toggle a group between 2D and 3D mode. A 2D group has different available parameters than a 3D group.

When the Type parameter is set to 3D, the Flatten and Layer Order parameters become available. When the Flatten checkbox is selected, all of the elements in the 3D group are flattened like a “card” or “billboard.” When the Layer Order checkbox is turned on, the group’s children are sorted by their order in the Layers list rather than depth order (position along the Z axis). For more information, see “Layer Order and Depth Order” on page 13.
When the Type parameter is set to 2D, the Fixed Resolution parameters become available, allowing you to manually define the size of a group. By default, Fixed Resolution is disabled and the size of the group is determined by the layers within that group. For more information, see “Fixing the Size of a Group” in chapter 2 of the *Motion 3 User Manual*.

*Note:* When turned on, Fixed Resolution crops the group to the size specified in the Fixed Width and Fixed Height parameters, around the anchor point of the group.

**2D Group Properties**
A 2D group has the following properties:
- Its children are composited in layer order.
- Filters are applied to the group in local space; that is, “flat” to the image.

- The group is lit as a single object; its children are not lit individually.
  *Note:* 2D groups at the root level are not lit.
- Because it is always flat, a 2D group has Crop, Drop Shadow, and Four Corner parameters.
- It can have a fixed resolution.

**3D Group Properties**
A 3D group has the following properties:
- Its children are composited in depth order (according to their position along the Z axis).
• Filters are applied to the group in view space. In other words, the filter affects the group as if it was applied to the lens of the camera viewing the group.

• Its children are lit individually.
• Only a 3D group with the Flatten parameter enabled has the Crop, Drop Shadow, and Four Corner parameters.

**Working with Objects Inside Flat Groups**
When moving an object along its Z axis inside a flat group—which includes 2D groups and flattened 3D groups—the object appears to grow larger or smaller rather than move closer to or further away from the camera.

Should you be unable to find an object in your project, you can locate it by resetting its Position parameter to 0, 0, 0. This centers the object in the flat group.

You can use the Isolate command to align the active view with the axis of the flat group. This facilitates making adjustments to objects inside the group. For more information on the Isolate command, see “Isolate” on page 30.

**Rasterization**
Some operations, as well as the application of certain filters or a mask, cause a group to be rasterized. When a group is rasterized, it is converted into a bitmap image. Rasterization affects 2D and 3D groups in different ways. When a 2D group is rasterized, the blend modes on objects within the group no longer interact with objects outside of the group. In addition, when a 3D group is rasterized, the group as a whole can no longer intersect with objects outside of the group. The rasterized 3D group is treated as a single object and uses layer order (in the Layers tab), rather than depth order (along the Z axis), when being composited with the rest of the project’s elements.

**Note:** When a 3D group is rasterized, cameras and lights in the project still interact with objects within the rasterized group.
Changes to the following parameters trigger rasterization of a group:

**2D Groups**
- Making Blending changes (Opacity, Blend Mode, Preserve Opacity)
- Turning on Drop Shadow
- Turning on Four Corner
- Turning on Crop
- Applying any filter
- Adding a mask
- Adding a light outside of a group

**3D Groups**
- Blending changes
- Applying certain filters
- Adding a mask
- Adding a light outside of a 3D group with the Flatten parameter enabled

Once an operation triggers rasterization of a group, the following occurs:
- A rasterization indicator (resembling an LED) appears next to the parameter in the Properties tab.

![No rasterization; no LED](image1)

Normal Blend Mode causes rasterization; LED on

- A small outline appears around the 2D or 3D group icon (to the left of the group name) in the Layers tab and Timeline layers list.

![No rasterization](image2)

Rasterization indicator around group icon

**Important:** 3D particle emitters, 3D replicators, and non-flat text objects are treated as 3D groups for the purposes of rasterization.
Examples of 2D Group and 3D Group Rasterization

In the example above, there are two groups: The first group (topmost in the Layers list) contains the image of a lone elephant. The second group contains the image of a family of elephants. In the left example above, the single elephant image—in the topmost group—has its Blend Mode set to Vivid Light. Because the group is not rasterized, the Blend Mode passes through the group and operates on the background.

In the right example above, the topmost group is rasterized, so the elephant image's Blend Mode no longer passes through the group.

In the left example above, Group A and Group B intersect because they are not rasterized.

In the right example above, Group A has been rasterized, so Group A and Group B no longer intersect.

**Important:** If a group's Blend Mode is set to Pass Through and any of the group's children have different Blend Modes applied, the children are not rasterized.
Lighting

Lighting can be applied to a motion graphics project to enhance the depth and scope of compositions, or it can help in creating realistic environments for composites.

Motion’s lighting system only works on 3D groups and their children.

**To add a light to a project:**

- Choose Object > New Light (or press Command-Shift-L).

A light object is added to the Layers list, the Timeline, and the Canvas (represented there by a wireframe icon), and the 3D transform tool in the Toolbar becomes active.

If you add a light to a project with no existing 3D groups, the following dialog appears:

![Lighting dialog](image)

If you select Keep as 2D, a light at the root level has no effect until you have at least one root-level 3D group. By default, groups and objects display the shading from lights as soon as lights are added.

**How Lights Are Activated**

A light is activated when it is a child of the following objects:

- The project (for example, a light is at the root level of the project)
- A flattened 3D group

**Important:** If you move a 3D group containing a light into a 2D group, the following dialog appears, unless the group’s Flatten parameter is turned on:

![Flatten dialog](image)

**Properties Affecting the Appearance of Lights**

When you are adding lights to a scene, two groups of properties contribute to the appearance of lights: light properties and object lighting properties. You can adjust light properties by selecting a light object in your project, then modifying the parameter values in the Light tab in the Inspector. You can manipulate object lighting properties by selecting a nonlight object in your project (an image, movie clip, shape, and so on), then adjusting the Lighting parameters in that object’s Properties tab.
Light properties—the quality of the light source itself—fall into the following categories: the type of light, its intensity, and its color. A light bulb, the sun, and lighting in a dance club each have a different appearance, and lighting properties can be used to simulate these differences.

**Combining Multiple Light Types**
Each type of light has its own unique attributes. It may take a combination of light types to achieve your desired effect. Most scenes with lights should include an ambient light to add depth or prevent total darkness.

Like real-world lights, you can use multiple lights to mix color. If one red and one blue spot light are pointed at a white object, they mix to make magenta.

**Light Parameters**
When you create a light, or select a light object in the Layers tab, the Light tab becomes available in the Inspector. The Light tab contains the following parameters:

**Light Type:** A pop-up menu that lets you choose from four categories of light.

- **Ambient:** An ambient light emits light in all directions. This type of light has no position and no representation in the Canvas. An ambient light illuminates all objects in the scene from all directions equally. Additionally, ambient lights are the only lights that do not affect highlights. The most common use for ambient lights is to add an overall fill effect, or color cast.

  **Note:** There is no global ambience property in Motion, so you may have to add an ambient light to prevent total blackness.
• **Directional:** A directional light emits parallel rays of light in a specified direction from a source located at an infinite distance. Only the rotation of this light has bearing on its effect. A directional light icon, in conjunction with the transform controls, can be used to assist in visualizing the direction the light is traveling in a scene. The directional light appears as a cylinder with one end removed. The circle represents the back of the light, and the lines indicate the direction in which the light is travelling.

![Directional light](image1) ![Example of a directional light](image2)

• **Point:** A point light emits light outward from a single point in 3D space in all directions. Optionally, you can add falloff based on an object’s proximity to the light. This is Motion’s default light, and it produces results similar to that of an incandescent light bulb.

![Point light](image3) ![Point light example](image4)
• **Spot:** A spot light emits light from a conical light source and casts an elliptical pattern on objects hit by the light. Using a spot light allows for a high degree of accuracy when you wish to limit the area affected by the light.

![Spot light example](image1.png)

**Color:** A standard set of controls that enable you to select the color of the light.

**Intensity:** This is the "dimmer switch" for lighting. If you use a Directional light at 100% intensity pointed straight at a red object, the object looks red. If you lower the intensity, the object and scene get darker. However, if you increase the intensity above 100% you can begin to overexpose your scene, eventually causing the object to appear white. The Intensity value slider can be used to set a value between 0 and 400, but there is no upper limit for Intensity (use the value slider to set a value above 400).

**Note:** Multiple lights interacting with an object will combine to increase the object’s apparent brightness. If you have two spot lights overlapping in space and pointing in the same direction with Intensity set to 100%, you will see the same result as having a single spot light with its Intensity set to 200%.

**Falloff Start:** A slider and value slider that enable you to adjust where the falloff point of a light begins. In the real world, light falls off—or has less of an effect—as the distance from the light increases. Usually falloff starts at the center of the light. Setting Falloff Start adds some additional control to your lighting. This parameter applies only to light types that utilize a Position parameter (Point and Spot).
In the example below, a light is positioned slightly above the origin of the scene. There are three rings of cards at a distance of 200, 500, and 1000 units from the light. (In this example, a visible light source—the “bulb” at the center of the rings of cards—is simulated for illustrative purposes.) The light’s Intensity is set to 100% and Falloff is set to 10%. When Falloff Start is set to 0 (left, below), the light has already begun to fall off by the time it hits the innermost ring. When Falloff Start is set to 200 (right, below), the inner ring is lit at 100% intensity and the outer rings are slightly brighter.

When Falloff Start is increased to 500 (left, below), both the inner and middle rings are lit at 100% intensity, and the outer ring is brighter than before. Finally, when Falloff Start is set to 1000 (right, below), all of the rings are lit at 100% intensity.
In the next example, the image on the left contains a light with Intensity set to 100%, while the image on the right has a light Intensity of 500%. In the image on the right, the outer rings are slightly brighter, but the innermost ring is overexposed. If the Falloff Start of the light in the image on the right was to be increased to 1000, all the rings would be overexposed.

![Intensity set to 100; Falloff Start set to 0](image1)
![Intensity set to 500; Falloff Start set to 0](image2)

**Falloff**: A slider and value slider that control the rate of falloff for a point or spot light based on the Falloff Start setting. At low values, light falls off over a long distance from the light source; therefore, the light travels further in the image. At high values, the falloff occurs more rapidly.

**Spot Cone Angle**: A dial and value slider that become available only when Light Type is set to Spot. The Spot Cone Angle is measured from the center of the light outward. The angle may be set to a value between 0 and 90°. The distance of the light from its target affects the result of this parameter. If the light is close, a wider spot cone angle may be needed to light more of the object. If the light is further away, a lower Spot Cone Angle may be needed to isolate objects.

**Cone Softness**: A dial and value slider that become available only when Light Type is set to Spot. Like Spot Cone Angle, this parameter can be set to a value between 0 and 90°. Its starting point begins at the outer edge of the Spot Cone Angle. If set to 0, spot lights have a hard edge. Low values produce a slight softening effect to the boundary of the lit area. Higher values produce a wide, more natural fade. Adding softness expands the area of your light, so you may need to adjust the angle to achieve the desired effect.

**Object Lighting Properties**
All “lightable” objects have properties that control how they react to lights in a scene. You can adjust these properties for a given object via the Lighting section of the Properties tab.
The Properties tab of the Inspector contains the following Lighting controls:

**Shading:** A pop-up menu that enables you to set how an object responds to lights in the scene. If set to On, the object can be lit. If set to Off, the object ignores scene lights. If set to Inherited (the default), the object uses the Shading value of its parent.

**Note:** It is possible to set the Shading parameter of a child of a group (however deep it may be nested) to On; that setting overrides any group settings previously applied to the child object.

**Highlights:** A checkbox that toggles whether or not lit objects show highlights. This parameter has no effect if Shading is set to Off.

**Shininess:** A slider and value slider that set how strong an object’s highlights appear. Higher values create a glossier appearance.

You may have to finesse both object surface properties and lighting parameters to achieve the desired result.

**Enhancing Lighting Effects**
Lights in Motion do not cast shadows. In some cases, an object’s Drop Shadow parameter may be an effective substitute if the camera is stationary.
Another method to simulate shadows is to modify a duplicate of the object being lit.

Simulated shadow created with a modified duplicate of the text object

Light sources are not visible. You can simulate a visible light source by combining a point light and an image or shape.

Simulated visible light source created by combining a light with a shape

*Note:* Use the Match Move behavior to move a simulated light source with a light in a movie clip. For more information on the Match Move behavior, see “Match Move Workflows” on page 58.
Motion Tracking

Use tracking behaviors to match move objects, stabilize clips, or track filter effects.

About Motion Tracking
Motion tracking is a method of recording the movement of an element (a shape or reference point in a movie clip) in the Canvas, then applying that recorded movement data to another element in the Canvas. For example, you can use motion tracking techniques to “pin” a post-production graphic to the side of a moving bus, “track” a blurry circle to a person’s face to preserve an innocent bystander’s anonymity, or “replace” a daring stuntman’s head with the lazy mug of a leading actor.

Motion provides a set of automated tracking behaviors that allow you to do all of this and more:

- **Match moving elements in movie clips:** You can apply tracking data from a background element (such as a billboard) to a composited foreground element (such as a graphic of a logo) so that both elements appear to be locked together. This technique is known as **match moving**.
- **Match moving animated objects in the Canvas:** You can apply the motion data of an animated object to another object in the project. For example, you can attach a smoke particle emitter to an animated spaceship so that a rocket exhaust trail “follows” wherever the spaceship moves.
- **Stabilizing camera movement in movie clips:** You can apply tracking data to remove unwanted camera movement or jitter in a movie or image sequence. For example, you can smooth handheld camera shots.
- **Unstabilizing movie clips:** You can restore movement to a previously stabilized movie. This technique is useful when you have stabilized a clip in order to add a foreground effect but wish to restore the original camera movement to the final composite.
• **Tracking the position parameter of a filter**: You can apply tracking data to the position parameter of a filter. For example, you can make the center point of a Light Rays filter follow a moving flashlight beam in a movie clip. The tracking data from the flashlight beam is applied to a single parameter of the filter (the Center parameter), rather than to the filter as a whole.

• **Tracking the control points of a shape or mask**: You can apply tracking data from reference points in a movie clip to the control points of a shape or mask. For example, you can use this technique to attach a mask to a moving element in a movie clip, thereby isolating that element to apply additional effects to it.

Motion lets you track one or multiple reference features in a clip:

• **One-point tracking**: Track a single reference pattern (a small area of pixels) in a movie clip to record position data.

• **Two-point tracking**: Track two reference patterns in a movie clip and use the relationship between the two tracked points to record position, scale, and rotation data.

• **Four-point tracking**: Often referred to as *four-corner pinning*. Track four reference patterns in a movie clip to record position, scale, and rotation data. The four trackers analyze the relationship between four reference patterns, such as the corners of a picture frame or television monitor. This data is applied to each corner of an image or clip to “pin” the clip so that it appears locked in the picture frame or television monitor.

• **Multiple-point tracking**: Track as many reference patterns in a clip as you like. You can manually add trackers within the Analyze Motion and Stabilize behaviors. When you apply a Track Points behavior from the Shape behaviors subcategory to a shape or mask, a tracker is automatically assigned to each shape control point.

**Note**: Although Motion provides a 3D workspace, tracking in Motion is planar. In other words, tracking does not occur in Z space. For example, if you are analyzing two features in a clip—and that clip is moving in 3D space—you are recording the changes in position, scale, or rotation over time in the clip but not its actual 3D transformation.

The object that is tracked is called the *background or source* element. The object to which the tracking data is applied is called the *foreground or destination* element.
How a Tracker Works

A tracker analyzes an area of pixels over a range of frames in a movie clip in order to “lock onto” a pattern as it moves across the Canvas. You specify the snapshot of pixels in one or more reference frames, and Motion proceeds to track that snapshot for a specified duration of time. This duration of time is based on the length of the tracking behavior, the length of the defined play range, or the length of the clip. In Motion, that snapshot is known as a reference pattern, and its area is automatically defined around the onscreen tracker.

Ideally, the reference pattern should be a consistent, easily identifiable detail with high contrast—this makes the pattern easier to track.

The tracker advances to each subsequent frame, sampling many positions within the search region around the center point of the tracker. Some of those positions “fit” the previously designated reference pattern more closely than others, and the tracker finds the position where the search region most closely matches the reference pattern (with subpixel accuracy). For every frame analyzed, the tracker assigns a correlation value by measuring how close the best match is.

In addition to searching for the reference pattern's position, the tracker identifies how the pattern transforms (scales, rotates, or shears) from one frame to the next. Imagine you are tracking a logo on the shirt sleeve of a person walking past the camera. If the person turns slightly as he passes the camera, the reference pattern becomes rotated. The tracker looks not only for the reference pattern, but also for any shifts in that pattern's scale or rotation.

When the tracker's position and correlation values for a given frame have been determined, Motion records this information in keyframes. This process is then repeated for every frame, until the end of the track range has been reached.

The recorded data is stored as keyframes in the tracking behavior. The data allows for you to quickly apply the tracks to many project elements.

Note: The Stabilize behavior uses an advanced technology that analyzes the motion of the entire frame of a clip, without the use of trackers.

There are six tracking behaviors in Motion, four in the Motion Tracking behaviors subcategory, one in the Shapes behavior subcategory, and one in the Parameter behaviors subcategory.
Motion Tracking Behaviors

Motion uses behaviors to collect, store, and apply the motion data. Because the data is stored within the behavior (as keyframes), it can easily be applied to other objects within a project. A Motion Tracking behavior can also be used to share animation data that is created by behaviors or keyframes between objects. The Motion Tracking behaviors are applied in the same manner as all other behaviors.

When a tracking behavior performs its analysis, track points appear in the Canvas, and tracking keyframes are created within the behavior. These keyframes live within the behavior that is applied to an object—the keyframes are not applied to the object itself.

Note: Onscreen track points and tracking keyframes are not created when using the default motion analysis in the Stabilize behavior.

When applicable, you can convert tracking data that is recorded or referenced by the Match Move, Stabilize, or Unstabilize behavior to object keyframes. When converted, the tracking behavior is removed and the transform keyframes are “baked” into the object. For more information on converting behaviors, see “Converting Tracks to Keyframes” on page 84.

There are four Motion Tracking behaviors:

- **Analyze Motion**: This behavior is used only to generate and contain tracking information from a clip. Unlike the Match Move and Stabilize behaviors, Analyze Motion has no capability to alter the object being tracked. The tracks gathered by the Analyze Motion behavior can be applied to other project elements via the Match Move behavior.

  Note: The Analyze Motion behavior can only be applied to footage (a QuickTime movie or image sequence).

  The Analyze Motion behavior can generate as many trackers as you like.

- **Match Move**: This behavior is used to “match” a foreground element to a background element so that they appear locked together. This effect can be achieved in three different ways:

  - You can match a foreground element to a background element using one-point (position), two-point (position, scale, or rotation), or four-point (corner-pinning) tracking. Unlike other tracking behaviors, Match Move can perform the compositing operation, or you can perform further modifications (blur, color corrections, and so on) before you create the final composite.

  - You can reference a track recorded in another tracking behavior. A referenced track is chosen from the tracking behaviors pop-up menu, located in the behavior’s HUD or Inspector.
You can quickly apply the animation data of an object, such as animation created by behaviors or keyframes, to another element in the project without analyzing the source object. Drag the animated source object to the Source well in the behavior’s HUD or Inspector to apply its movement to the destination object.

**Note:** The Match Move behavior can be applied to nearly any object type.

**Stabilize:** This behavior removes unwanted motion in a clip, such as camera jitter. The stabilization can be applied to the horizontal or vertical movement in the clip, or to a combination of horizontal and vertical movement. This effect can be achieved in one of three ways:

- Motion can analyze and automatically stabilize a clip without the use of any trackers. In this case, the Stabilize behavior evaluates the entire frame of a clip using motion analysis to record the movement of the camera. This behavior offers two ways to use this recorded data: clip smoothing, which eliminates unwanted jitter while maintaining the general motion of the camera; and clip locking, which stabilizes a subject. This behavior can analyze and affect position, scale, and rotation.

- In addition to full-frame motion analysis, you have the option to manually add trackers for one-point (position) tracking or two-point (position, scaling, or rotation) tracking. You can also add as many trackers as you like. When you add manual trackers to the Stabilize behavior, Motion stabilizes the clip using data from the trackers rather than from an automatic motion analysis. When using this method, the tracker moves the entire frame so that the track point falls in the same spot in each subsequent frame.

- You can load in tracks recorded in another Stabilize behavior. To load another track, choose a track from the tracking behaviors pop-up menu, located in the tracking behavior HUD or Inspector.

**Note:** The Stabilize behavior can only be applied to footage (a QuickTime movie or an image sequence).

**Unstabilize:** This behavior does not perform any tracking. Instead, the Unstabilize behavior applies the movement recorded by another tracking behavior, such as Stabilize, to a clip or object. This allows you to match the camera shake in a clip to foreground elements added in post-production. To load the tracking data, choose a track from the tracking behaviors pop-up menu, located in the tracking behavior HUD or Inspector.

**Note:** The Unstabilize behavior can be applied to nearly any object type.
Shape Track Points Behavior
The Track Points behavior, a member of the Shape behavior subcategory, allows you to do either of the following:
- Track the control points of a shape or mask (including paint strokes) to reference features on a source clip. For example, you can draw a mask around a car in a clip and then track the control points of the mask to the moving car, cutting the car out of the background. You can then apply effects to only the isolated car, and the surrounding image is not affected.
- Apply existing tracking data that was recorded by the Analyze Motion, Match Move, or Stabilize tracking behavior to the control points of a shape or mask.

Note: The Track Points behavior can be applied only to shapes (including paint strokes) and masks.

Track Parameter Behavior
The Track Parameter behavior, a member of the Parameter behavior subcategory, allows you to track a parameter of a filter, such as the Center parameter of a Circle Blur filter, to a reference feature of a clip.

The tracking data is obtained in one of two ways:
- Once the Track Parameter behavior is added to a filter's position parameter, a clip can be analyzed from within the behavior and the recorded data applied to the position parameter.
- Tracking data from another tracking behavior can be referenced by the Track Parameter behavior. The recorded data from the referenced behavior is applied to the position parameter.

Note: The Track Parameter behavior is designed for use with a filter's position parameter.

Motion Tracking Workflows
The following sections provide general overviews of the steps required to generate a track using the Motion Tracking behaviors. Complete parameter descriptions are detailed in subsequent sections.

Tracking in one pass rarely yields perfect results without some fine-tuning. For information on various tracking methods and tips, see “Strategies for Better Tracking” on page 82.
Important: With the exception of the Stabilize behavior's automatic analysis mode, the tracking analysis begins at the current playhead position for all workflows. To define a tracking region, set an Out point for the tracked clip. To set an Out point, position the playhead at the correct frame, select the clip, then choose Mark > Mark Play Range Out (or press Command-Option-O).

General Motion Tracking Workflow (with Analyze Motion)
This section is a general overview of the tracking workflow that is common to most of the Motion Tracking behaviors. The Analyze Motion behavior is used in this example.

The Analyze Motion behavior analyzes and stores tracking information from a clip. The behavior does not transform the tracked object. This data can be referenced by other tracking behaviors.

For a full description of the Analyze Motion parameters, see “Analyze Motion Controls” on page 99.

To generate a track for a clip using the Analyze Motion behavior:
1 In the Layers list, Timeline, or Canvas, select the footage that you want to track, click the Add Behavior icon in the Toolbar, then choose Motion Tracking > Analyze Motion from the pop-up menu.

Note: You can also select the footage, select the behavior in the Library, then click the Apply button in the Library Preview area, or drag a behavior from the Library to the footage.
The tracker is added to the footage. By default, a single tracker appears at the center of the Canvas.

2 Play your background clip several times to determine a good track point, then go to the frame where you want to start the track.

3 In the Canvas, drag the tracker to the reference point you want to use.

   *Note:* For more information on using the onscreen tracker, see “Adjusting the Onscreen Trackers” on page 80. For more information on selecting a good tracking reference point, see “Strategies for Better Tracking” on page 82.

4 To add trackers, click the Add button in the Behaviors tab of the Inspector.
   Each new tracker is added to the center of the Canvas.

5 Drag the additional trackers to the reference points you want to use.

6 To track a specific range of frames, adjust the start and end points of the tracking behavior in the Timeline or mini-Timeline.

7 Click the Analyze button in the HUD or Behaviors tab of the Inspector.

Once the tracking analysis begins, a progress window opens and track points on motion path appear in the Canvas. The track point at the current playhead position is emphasized.
The tracking keyframes contained in the behavior appear in the Keyframe Editor.

Because the Analyze Motion behavior does not transform the source object, only the tracking keyframes appear in the Keyframe Editor. When using a Match Move or Stabilize behavior, the tracking keyframes appear as well as the transform curves of the source object (for Stabilize) or destination object (for Match Move).

A “confidence” curve is also displayed in the Keyframe Editor. This curve provides a visual indication of the tracker’s accuracy relative to its parameter settings in the Inspector. The confidence curve is not for editing purposes.

To stop a track, click the Stop button in the progress window or press Escape (Esc).

**Tip:** If it appears that the tracker loses its reference pattern, do not immediately click the Stop button. Allow the analysis to continue for a few seconds. When the tracker fails, the playhead jumps to the exact frame at which the track was lost.
The analyzed track, contained in the Analyze Motion behavior, can now be loaded into other tracking behaviors (via a pop-up menu in the HUD or Inspector of the other tracking behaviors).

**Note:** The Stabilize behavior can only load tracks from other Stabilize behaviors.

### Loading Data into a Behavior

If the project contains any footage or animated objects when a Match Move, Stabilize, or Unstabilize behavior is applied, the nearest footage or animated object below the behavior in the Layers list is automatically applied to the behavior and appears in the behavior’s Source well. This data is overwritten once a tracking analysis is done, or you choose another track from the tracking behaviors pop-up menu.

You can assign an animated object or tracking data to a tracking behavior in four ways:

- Choose another tracking behavior from the tracking behaviors pop-up menu.
- Drag a tracking behavior or footage object to the Source well in the HUD or Behaviors tab of the Inspector.
- Drag an animated object to the Source well in the HUD or Behaviors tab of the Inspector. The referenced animated object is applied as the source for the current behavior. This option only applies to the Match Move and Track Points behaviors.
- Drag a tracking behavior or footage object directly to the current tracking behavior in the Layers list. The referenced tracking behavior or footage object is assigned as the source for the current behavior.

**Note:** To clear a Source well, drag the item away from the well and release the mouse button.

### Match Move Workflows

This section provides a general overview of several Match Move behavior workflows, including four-corner pinning. For a full description of the Match Move parameters, see “Match Move Controls” on page 100.

To use a Match Move behavior, you need a minimum of two objects in your project: a background or source element and a foreground or destination object. The source object provides the movement as either an animated object or a recorded track. The movement from the source object is applied to the destination object.
Using Match Move to Track a Background Element

The Match Move behavior is applied to the foreground element and tracks a feature in the background element. This data is applied to the foreground element so that it “matches” the movement of the tracked feature in the background clip.

To “match move” a foreground object using the Match Move behavior:
1. Play your background clip several times to determine a good track point.
2. Apply a Match Move behavior to a foreground element.
   A single tracker (the Anchor checkbox in the Behaviors tab of the Inspector) is activated. The Anchor tracker records position data.
3. Determine if you need to activate additional trackers for two- or four-point tracking.
   - For two-point tracking, select the Rotation-Scale checkbox in the Behaviors tab of the Inspector (under the Anchor checkbox).
   - For four-point tracking, choose Four Corners from the Type pop-up menu in the Behaviors tab of the Inspector and proceed to “Four-Corner Pinning with Match Move” on page 63.
4. Go to the frame where you want the track to begin.
5. In the Canvas, drag the tracker (or trackers) to the point (or points) you want to track.
   As you drag the tracker in the Canvas, the region around the tracker becomes magnified to help you find a suitable reference pattern.
6. Click the Analyze button in the HUD or Behaviors tab of the Inspector.
   The foreground element is tracked to the background element.
7. If you are using two-point tracking, turn on (or off) the Position, Scale, or Rotation buttons (in the Adjust row) to add (or remove) tracking parameters.
In the following example, only Position is enabled in the Adjust row of the Behaviors tab. As a result, the white elliptical shape does not change its scale or rotation based on the position of the two trackers.

In the next example, Position, Scale, and Rotation are enabled in the Adjust row of the Behaviors tab. Consequently, the white elliptical shape changes its position, scale, and rotation based on the position of the two trackers, preserving the illusion that it is physically attached to the picture frame.

Note: When using four-point tracking, scale and rotation are automatically applied to the corner-pinned object.

Using Match Move to Apply Animation Data to a Project Element
You can instantly apply the animation of a source object to a destination object via the Match Move behavior, without any tracking analysis. The source object can be animated by behaviors or keyframes.

The following simple example uses a “magic wand” (made up of rectangle shapes) that is animated on a motion path. The animation of the wand is then tracked to a particle emitter to create the illusion of sparkles flying off the tip of the wand.
To apply the transformation of a source object to a destination object:

1. Apply a Match Move behavior to an element in the project.

   In this example, a Match Move behavior is applied to a nonanimated particle emitter.

The closest animation data (such as position or rotation changes caused by keyframes or behaviors) beneath the Match Move in the Layers list is automatically applied as the source and is displayed in the Source well. In this example, the animated wand is the source animation.

   **Important:** Animated objects, behaviors, and footage can be dropped in the Source wells.

2. Ensure that the Type parameter is set to Transformation in the Behaviors tab of the Inspector.

3. Position the object with the applied Match Move behavior in the Canvas at the location you want.
In this example, the particle emitter is positioned at the tip of the wand.

![Image](image1.png)

The particle emitter and the wand now share the same animation path.

![Image](image2.png)

4 Play the project.

The particles match the movement of the wand.

![Image](image3.png)
Four-Corner Pinning with Match Move

The Match Move behavior allows you to track four points on a background clip and apply the motion to the four corners of a foreground element. There are two possible four-corner pinning workflows. In the first example, a foreground element is pinned to a background element using the four-corner trackers. In the second example, the foreground element is corner-pinned prior to using the four-corner trackers.

Note: You can also perform four-point tracking using the Analyze Motion or the Stabilize behavior. For more information, see “Using a Non-Match Move Four-Point Track for Corner-Pinning” on page 71.

There are special considerations when corner-pinning groups. For more information, see “Tracking and Groups” on page 97.

Option 1: Pinned Image Is Locked to the Reference Points

This workflow is ideal for a four-corner pin in which the transformed or “pinned” image is the same size as the background “frame” (or reference patterns) to which it is being tracked. In the following example, a foreground image is pinned to a background clip of a picture frame.

To track an image using four trackers:
1 Drag the playhead to the frame where you want to start the track and apply a Match Move behavior to the foreground element.
2 In the Behaviors tab of the Inspector, choose Four Corners from the Type pop-up menu.

![Inspector with Four Corners selected](image)

*Note:* The Four Corners option is not available when Match Move is applied to a 3D group. To corner-pin a 3D group, turn on the Flatten checkbox in the Group tab of the Inspector.

In the Canvas, a tracker appears at each corner of the foreground object. In the Inspector, the default track list (Anchor and Rotation-Scale), is replaced with the Top Left, Top Right, Bottom Right, and Bottom Left trackers.

3 In the Canvas, drag each tracker to a “corner” of the background element (in this example, the corners of the picture frame provide the four-corner track points).

As with the Analyze Motion trackers, a magnified inset appears in the Canvas as you drag the trackers.

![Canvas with trackers dragged](image)

4 Click the Analyze button in the HUD or Behaviors tab of the Inspector.
The foreground element is “pinned” on the background element.

Note: In this example, a reflection is created on the table using a duplicated and transformed copy of the tracked image.

To fine-tune the track, you may need to make minor adjustments to the foreground element, such as modifying its scale or rotation. When you choose the default Attach to Source option from the Transform pop-up menu in the Behaviors tab of the Inspector, you cannot transform the tracked object. To transform the tracked object, choose Mimic Source from the Transform pop-up menu.

5 To transform the foreground element after the tracking data has been applied, choose Mimic Source from the Transform pop-up menu in the Behaviors tab of the Inspector, then make your adjustments in the Properties tab of the Inspector.

For more information on the Mimic Source and Attach to Source transform options, see “Match Move Controls” on page 100.

Option 2: Corner-Pin the Object Before Tracking
In this workflow, a foreground object is pinned to a background picture frame using the Four Corner parameter in the Properties tab prior to applying the Match Move behavior.

To adjust the four corners of an element and then corner-pin the element:
1 Select the foreground element you want to corner-pin.
2 In the Toolbar, choose the Four Corner tool from the Select/Transform tools.

3 Drag each corner of the foreground element into the correct position.
   Once a corner is dragged in the Canvas, the Four Corner checkbox is turned on in the Properties tab.

   **Tip:** You may want to lower the opacity of the foreground object to better see the reference points on the background clip. You may also want to disable snapping so the image you are adjusting does not snap to the Canvas guidelines.

4 Go to the frame where you want to start the track and apply the Match Move behavior to the foreground element.

5 Choose Four Corners from the Type pop-up menu in the Behaviors tab of the Inspector.
In the Canvas, a tracker appears at each corner of the foreground object. In the Inspector, the default track list (Anchor and Rotation-Scale) is replaced with the Top Left, Top Right, Bottom Right, and Bottom Left trackers.

6 If necessary, drag each tracker in the Canvas and fine-tune its position in the Tracker Preview of the Inspector.

**Important:** To fine-tune or offset the trackers without modifying the shape of the foreground image, choose Mimic Source from the Transform pop-up menu.

7 Click the Analyze button in the HUD or Behaviors tab of the Inspector.

The foreground element is “pinned” on the background element.

**Option 3: Transform the Object Prior to Corner-Pinning**

In this workflow, a foreground object is transformed to fit a background picture frame using the scale, rotation, and position parameters in the Properties tab prior to applying the Match Move behavior.

To transform and corner-pin an image:

1 Select the foreground element you want to corner-pin.
2 Using the onscreen transform controls or the Properties tab of the Inspector, adjust the foreground element's scale, position, or rotation to its "frame."

3 Go to the frame where you want to start the track and apply the Match Move behavior to the transformed element.

4 Choose Four Corners from the Type pop-up menu in the Behaviors tab of the Inspector.

5 Do one of the following:
   • To adjust the trackers without affecting the foreground image, choose Mimic Source from the Transform pop-up menu, then position the trackers on the reference patterns (in this example, the four inside corners of the picture frame).
   • To adjust the trackers and affect the foreground image, choose Attach to Source from the Transform pop-up menu, then position the trackers on the reference patterns.

6 Click the Analyze button in the HUD or Behaviors tab of the Inspector.
   The foreground element is "pinned" on the background element. Because this workflow may not yield ideal results (the foreground element may not scale or move correctly with the background image, for example), you may need to apply a mask to or crop the foreground image.
Masking and Tracking

When a mask is added to an object with applied tracking data, the data is automatically applied to the mask. In the following images, the foreground image is tracked to four points on the background clip, but still needs to be masked to fit into the picture frame (without unevenly scaling the image).

Although the mask is attached to the foreground image, you may need to animate changes in the mask’s position and scale to accommodate changes in the background clip over time.

Note: As an alternative to using masks, you can also crop an object with applied tracking data using the Crop controls in the Properties tab of the Inspector.

You can track the control points of a mask to a clip or apply existing tracking data to the control points of a mask. For more information, see “Track Points Workflow” on page 76.
Offset Four-Corner Pinning
Depending on your source footage, you may need to corner-pin an element using reference points that are offset from the final “pinned” size of the foreground element. You do this by offsetting the trackers using the Mimic Source option. In the simple example below, the reference patterns to be tracked are located inside a frame, rather than at the corners.

Because the track reference points are not flush with the inside edge of the frame, you must offset the image from the four trackers. Otherwise, the final corner-pinned image will appear too small.
The following example demonstrates how to offset the trackers without affecting the foreground image.

**To track reference points that are offset from the foreground image:**

1. Use one of the workflows above to set up a four-corner pin using the Match Move behavior.

2. Choose Mimic Source from the Transform pop-up menu in the Behaviors tab of the Inspector.

3. In the Canvas, drag the trackers to the offset reference points.

   The image is not affected and remains locked to its original placement.

4. Click the Analyze button in the HUD or Behaviors tab of the Inspector. The foreground element is “pinned” on the background element.

**Using a Non-Match Move Four-Point Track for Corner-Pinning**

This section discusses an additional four-corner pin workflow that references a four-point track from an Analyze Motion behavior.

*Note:* You can also perform this workflow using the Stabilize behavior.
To record four-point tracking using Analyze Motion:

1. Go to the frame where you want to start the track and apply an Analyze Motion behavior to the background element.

   By default, a single tracker appears in the Canvas.

   For four-point Analyze Motion and Stabilize operations, the trackers should be positioned in a clockwise order, starting in the upper-left corner. This ensures the proper alignment of your element when the transformation is applied.

2. Drag the tracker (Track 1) to the desired reference pattern in the top-left corner of the background element.

3. In the Behavior tab of the Inspector, click Add to add a second tracker, then drag the second tracker (Track 2) to the desired reference pattern in the top-right corner of the background element.

4. Add another tracker (Track 3) and drag it to the desired reference pattern in the bottom-right corner of the background element.

5. Add another tracker (Track 4) and drag it to the reference pattern in the bottom-left corner of the background element.

6. Click the Analyze button in the HUD or Behaviors tab of the Inspector.

   The track is generated and its data saved in the behavior.

   **Note:** You can save tracking behaviors to the Library for later use.

To apply the recorded four-point tracking to a foreground element:

1. Apply a Match Move behavior to the foreground element you want to corner-pin.

2. If the Analyze Motion data is not automatically applied, choose the existing four-point Analyze Motion track from the tracking behaviors pop-up menu.

3. Choose Four Corners from the Type pop-up menu in the HUD or Behaviors tab of the Inspector.

4. Click the Analyze button in the HUD or Behaviors tab of the Inspector.

   The four-point tracking data from the Analyze Motion behavior is applied to the foreground element.
**Note:** When using the Match Move behavior for four-point tracking, the trackers are automatically placed in the correct order in the Canvas after Four Corner is chosen from the Type pop-up menu in the Behaviors tab of the Inspector.

**Stabilize Workflow**

This section provides a general overview of using the Stabilize tracking behavior to stabilize a movie or image sequence. For a full description of the Stabilize parameters, see “Stabilize Controls” on page 105.

With the Stabilize behavior, there are three ways to analyze a clip:

- Use the default advanced motion analysis technique that evaluates the entire frame of a clip at once to extract animation data without the use of onscreen trackers.
- Use onscreen trackers that analyze a reference pattern (a small group of pixels) in the Canvas. These are the same trackers used by the Match Move and Analyze Motion behaviors.
- Use a combination of the advanced motion analysis and the onscreen trackers.

**Important:** For information on using the onscreen trackers with the Stabilize behavior, see “Adding Trackers to the Stabilization” on page 93.

Once this information is derived, you can apply it in two ways. The clip can be smoothed, eliminating unwanted jitter while maintaining the general motion of the camera, or the clip can be locked, stabilizing the subject. The smoothing can affect translation, rotation, or scale, making it more flexible for certain operations than the other tracking behaviors.

The Stabilize behavior is primarily useful for removing unwanted trembling from less than stable crane or jib arm moves, eliminating teetering from handheld walking shots, or reducing vibrations in automotive shots.

**Note:** As useful as the Stabilize behavior is, be aware that motion blur that is present in the image will remain, even though the subject in the shot is successfully smoothed or locked. This may or may not affect your approach to the composite.

**To stabilize a clip using the Stabilize behavior:**

1. Apply a Stabilize behavior to the clip you want to stabilize.
   **Note:** Unlike the other behavior workflows, the Stabilize behavior’s automatic mode analyzes the entire clip, rather than from the current playhead position.

2. Set the options for the analysis:
   a. Choose an option from the Method pop-up menu in the HUD or Behaviors tab of the Inspector:
      - Choose Stabilize to lock down an image, removing problems such as camera shake.
      - Choose Smooth to smooth camera movement in the clip.
b Choose an option from the Borders pop-up menu:

- Choose Normal to maintain the size of the stabilized footage. The resulting transformations that are made to the stabilized image may cause moving black borders to appear around the edges of the clip.

Note: For suggestions on correcting the black borders, see “Removing Black Borders Introduced by Stabilizing” on page 95.

- Choose Zoom to expand the clip to the full size of the Canvas. This prevents black borders from appearing around the edges of the stabilized clip.

Normal borders maintain the size of the stabilized clip but create black borders around the clip’s edges.

Zoomed borders scale the stabilized clip so the clip does not move away from the edge of the Canvas.

c Choose an option from the Direction pop-up menu:

- Choose Horizontal and Vertical to apply the stabilize transformation to the X and Y dimensions.
- Choose Horizontal to apply the stabilize transformation to the X dimension.
- Choose Vertical to apply the stabilize transformation to the Y dimension.
Enable or disable the Adjust options:

- Turn on Position to apply the analyzed position data to the clip.
- Turn on Scale to apply any analyzed scale data to the clip.

**Note:** The Scale option is not related to the Zoom option in the Borders pop-up menu.

**Note:** You can change the Method, Borders, Direction, and Adjust parameters before or after the clip is analyzed.

3 Click the Analyze button in the HUD or Behaviors tab of the Inspector.

**Note:** The clip is stabilized according to the defined parameters. Unlike the Motion trackers, the default Stabilize analysis does not create keyframes in the Keyframe Editor. However, the stabilized object’s transformation can be converted to keyframes. For more information, see “Converting Tracks to Keyframes” on page 84. For more information on correcting problems associated with stabilization, see “Troubleshooting Stabilizing Effects” on page 93.

**Note:** As with most objects with applied behaviors, the animation path created by the transformation appears in the Canvas when the stabilized object is selected.

### Unstabilize Workflow

This section provides a basic overview of using the Unstabilize tracking behavior to reapply camera shake or movement into a finished clip.

The Unstabilize behavior’s sole function is to apply movement recorded by another tracking behavior, such as Stabilize, to a clip or object. This allows you to match the camera movement from a background clip to foreground elements, or unstabilize a stabilized clip.

**Note:** A project must include a tracking behavior with recorded motion data in order to use the Unstabilize behavior.

**To use the Unstabilize behavior:**

1 Select the object you want to unstabilize, click the Add Behavior icon in the Toolbar, then choose Motion Tracking > Unstabilize from the pop-up menu.

2 Do one of the following:

- In the HUD or Behaviors tab of the Inspector, choose a tracking behavior from the pop-up menu.
- Drag an analyzed tracking behavior to the Source well in the HUD or Behaviors tab of the Inspector.

The motion is applied to the destination object.
Track Points Workflow
The Track Points behavior is designed for use with shapes and masks. The Track points behavior can be used in the following ways:

- Track the control points of a shape or mask to a clip.
- Apply tracking data from another tracking analysis to the control points of a shape or mask.
- Apply the animation of an object to the control points of a shape or mask.

*Note:* To apply the analyzed movement of an object to a shape or mask as a whole (not to the shape’s control points), use the Match Move behavior.

For a full description of the Track Points parameters, see “Track Points Controls” on page 109.

Tracking Control Points to a Clip
This section provides a brief overview of using the Track Points behavior to track the vertices of a shape or mask to a clip.

To track a shape or mask using the Track Points behavior:

1. Select the shape or mask you want to track, click the Add Behavior icon in the Toolbar, then choose Shapes > Track Points from the pop-up menu.

   The behavior is added to the shape, and trackers appear for each control point on the shape. The trackers are ordered in the same order that the shape was drawn: Control Point 1 is Track 1, Control Point 2 is Track 2, and so on.

   *Note:* Trackers are not added to disabled shape control points. You can still enable and disable control points once a Track Points behavior is applied to a shape. For more information on working with shape control points, see Chapter 12, “Using Shapes and Masks,” in the *Motion 3 User Manual.*

   In this example, the Track Points behavior is applied to a loose mask of seven control points isolating a car in a clip.
Note: Keep in mind that paint strokes usually have a very large number of control points. You should simplify a paint stroke by deleting or disabling control points prior to applying a Track Points behavior to the stroke. To track the stroke as a whole, rather than by its control points, use the Match Move behavior.

2 Drag the trackers to their reference patterns.

As you drag, a magnified view of the area around the tracker appears.

3 To disable a tracker, turn off its checkbox in the Behaviors tab of the Inspector.

Note: Any control points without an associated tracker are not modified.

4 Click the Analyze button in the HUD or Behaviors tab of the Inspector.

The mask control points are tracked to the reference patterns. In this example, the moving car is masked so that it is isolated. Blur and desaturation effects are subsequently applied to the background, without affecting the car.

Note: As with all behaviors, you can drag or copy (Option-drag) a Track Points behavior to a new shape in the Layers list. When you apply the behavior to a new shape, the behavior is reset.
Using an Object as the Animation Source
This section provides a brief overview of using the Track Points behavior to apply the animation of an object to the vertices of a shape or mask. For this workflow, your project must contain an object that is animated with keyframes or behaviors.

To apply the animation of an object to the control points of a shape or mask:
1. Apply the Track Points behavior to the object you want to animate.

   If an animated object exists beneath the object with the applied Track Points behavior in the Layers list, the animation of the lower object is automatically applied to the Track Points behavior, as displayed in the Source well in the HUD and Inspector.

   In this example, the Track Points behavior is applied to the Bezier shape, and a line used as the source animation is animated with the Spin behavior.

   ![Source object](image)

   ![Bezier shape with applied Track Points behavior](image)

   ![HUD’s Source well displays the referenced source object.](image)

   **Note:** To reference another animated object, drag that object to the Track Points behavior’s Source well or directly to the behavior in the Layers list.

   The spinning animation of the line is applied to the Bezier shape. The tangents remain aligned at their original angles along the shape.

   ![The spinning animation of the line is applied to the Bezier shape.](image)

2. To align the tangents to the transformation of the source object, turn on the Align Tangents checkbox in the Behaviors tab of the Inspector.
The Bezier shape changes form because the vertex tangents match the transformation of the source animation.

*Note:* By default, Attach to Source is chosen from the Transform pop-up menu. For more information on the Transform pop-up menu, see “Track Points Controls” on page 109.

**Track Parameter Workflow**

The Track Parameter behavior allows you to track a position parameter of a filter to a reference feature of a clip, or to apply existing tracking data to a position parameter of a filter. For example, you can track the center of a Light Rays filter to a moving light in a clip.

*Note:* This behavior is only applicable to filters with position parameters, such as Scrape, Ring Warp, Light Rays, Slit Tunnel, and so on.

For a full description of the Track Parameter behavior, see “Track Parameter Behavior Controls” on page 110.

**To use the Track Parameter behavior:**

1. In the Canvas, position the center point of the filter over the reference pattern.

   In this simple example, the center point of a blur is positioned over the license plate of a car.

   *Note:* To use a filter’s onscreen controls, select the filter in the Layers list, then choose the Adjust Item tool from the Select/Transform tools in the Toolbar. For more information on using filters, see Chapter 10, “Using Filters,” in the *Motion 3 User Manual.*
2 In the Behaviors tab of the Inspector, Control-click the Center parameter, then choose Track from the shortcut menu.

In the Canvas, the filter's onscreen control is replaced with a tracker. The Behaviors tab becomes active and the Track behavior parameters are displayed.

**Note:** In the Filters tab, a behavior icon appears next to the Center parameter, indicating that it is influenced by a behavior.

If necessary, adjust the tracker in the Canvas. If the reference pattern you want to track is offset from the center of the filter, use the Offset Track checkbox. For more information on using the Offset Track parameter, see “Tracking Obscured or Off-Frame Points” on page 91.

3 Click the Analyze button in the HUD or Behaviors tab of the Inspector.

The filter’s center is tracked to the clip.

**Note:** You can make changes to the filter parameters after the analysis is performed.

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**Adjusting the Onscreen Trackers**

The Analyze Motion, Stabilize, and Match Move behaviors share common onscreen and interface controls.

A tracker consists of a single onscreen control: the tracker.

The default onscreen tracker color is yellow. Depending on the color of your subject, you may need to change the color of the tracker to see the tracker in the Canvas.

Once the tracking analysis begins, a progress window opens and track points appear in the Canvas. The track points are the post-analysis motion path (the path that looks like a string of pearls) that appears in the Canvas. The track point at the current playhead position is emphasized.
To position the tracker, do one of the following:

- Drag the tracker in the Canvas.

As you drag, the area around the tracker in the Canvas is magnified and its position is displayed in an info window. This area is a visual aid for positioning the tracker and does not represent a search area or region.

**Note:** Unlike many correlation trackers, you do not manually specify a search area when setting up a tracker in Motion. Motion automatically searches, with subpixel accuracy, a default area around the track point.

The Behaviors tab of the Inspector includes a Tracker Preview area that updates as you drag the tracker in the Canvas.

- Drag in the Tracker Preview area to further fine-tune the position of the tracker.

As you drag in the preview area, the tracker in the Canvas also updates.

- Click the tracker’s disclosure triangle in the Behaviors tab of the Inspector, and use the Position controls to numerically adjust the tracker’s position.
To move multiple trackers at the same time:

- Drag to select or Shift-select the trackers in the Canvas, then drag them to a new position.

A selected tracker appears white.

**Note:** Because you risk moving the onscreen trackers when Shift-selecting, dragging to select may be a better option.

To turn off the onscreen trackers, do one of the following:

- Control-click a tracker in the Canvas, then choose Hide Selected Tracker from the shortcut menu.

- Turn off the appropriate Track checkbox in the Behaviors tab of the Inspector.

Once the tracker is turned off, it is not used in the analysis.

To turn on the onscreen trackers:

- Turn on the appropriate Track checkbox in the Behaviors tab of the Inspector.

To change the color of the onscreen tracker:

1. Select the tracker and click the Behaviors tab in the Inspector.
2. Click the tracker’s disclosure triangle and use the Color controls to change the color of the tracker.

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**Strategies for Better Tracking**

Selecting a good tracking reference feature in a movie or image sequence is pivotal in achieving an accurate track. Tracking is often trial and error—tracking a single reference pattern with a single analysis pass rarely yields a perfect result. More often, a successful track is a combination of automatic and manual tracking, experimenting with different parameter settings, as well as resetting reference points at different locations in the clip.
Finding a Good Reference Pattern
The first step in selecting a good reference pattern is to play the footage several times. As you review the clip, try to locate a reference pattern that follows as many of the following rules as possible:

- The pattern contains perpendicular edges, such as dots, intersections, and corners (lines and straight boundaries should be avoided as tracking reference patterns).
- It is a high-contrast pattern.
- It contains even changes in brightness or color (an example of an uneven color or brightness change is a sharp-edged shadow that passes over your reference pattern).
- It appears in every frame of the clip (does not move offscreen or become obscured by other objects).
- It is distinct from other patterns in the same “neighborhood” in the clip.

Manually Coaxing Your Track
Another technique you can use is to manually insert tracking keyframes. For example, if you have 100 frames to track, you can manually create a keyframe every 10 frames.

To manually create tracking keyframes using the Record button:
1 Enable Record (press A).
2 In the Canvas, position the tracker at the reference point you want to track.
   A tracking keyframe is created in the behavior.
   Note: You can press Shift-Period to jump forward 10 frames, or press Shift-Comma to jump backward 10 frames.
3 Repeat step 2 until you've completed the track.

To manually create keyframes without enabling Record:
1 In the Canvas, position the tracker at the reference point you want to track.
2 Do one of the following:
   - For Analyze Motion, Match Move, or Stabilize (with manual trackers), choose Object > Add Position Keyframe or Object > Add Result Keyframe (or press Control-K).
   - For Stabilize (automatic mode), choose Object > Add Motion Vector Keyframe.

Manually Modifying Tracks
You can manually modify track points.

To manually adjust an onscreen track point:
1 Position the playhead at the frame you want to modify.
   The track point at the current playhead position is highlighted.
2 Do one of the following:

- Drag the highlighted track point in the Canvas to adjust its position.
- Drag in the Tracker Preview area in the Behaviors tab of the Inspector.

**Note:** You can only use the tracker’s Position parameter to adjust the onscreen tracker, not an onscreen track point.

For fine-tuning, you can zoom in and out of the clip using the Zoom tool.

The zoom follows the pointer, so place the pointer on the track point in the Canvas and drag right to zoom in. Drag left to zoom out of the clip. To return to normal view, choose 100% from the Zoom Level pop-up menu (in the lower-right section of the Toolbar).

You can also adjust a tracking curve in the Keyframe Editor. For more information on using the Keyframe Editor, see chapter 6, “Keyframing and Curves,” in the *Motion 3 User Manual.*

**Converting Tracks to Keyframes**

Tracking data that is recorded or referenced by the Match Move, Stabilize, or Unstabilize behavior can be “baked” into keyframes on the transformed object. The tracking keyframes are applied to the tracked object and the behavior is deleted from the project. You can then modify the animation curves in the Keyframe Editor.

Because it does not transform the image, tracks recorded by the Analyze Motion behavior cannot be converted into keyframes. However, a Match Move or Stabilize behavior that references data from an Analyze Motion behavior can be converted into keyframes.

To convert a tracking behavior to keyframes:

1 Select the Match Move, Stabilize, or Unstabilize behavior that you want to convert.
2 Choose Object > Convert to Keyframes (or press Command-K).
   A dialog appears confirming the conversion.
3 Click OK.
   The behavior is converted into editable keyframes and the tracking behavior is deleted.

For more information on converting behaviors to keyframes, see Chapter 5, “Using Behaviors,” in the *Motion 3 User Manual.* For more information on using the Keyframe Editor, see Chapter 6, “Keyframing and Curves,” in the *Motion 3 User Manual.*
When Good Tracks Go Bad
Once an analysis is complete, you may need to retrack a portion of the clip. Rather than tracking over bad keyframes, it is recommended that you delete any bad keyframes prior to retracking. If “bad” keyframes are not deleted, the tracker may continue to use the old reference point.

To delete bad tracking keyframes:
1 Position the playhead at the frame in which you want to reset the reference pattern.
2 In the Keyframe Editor, drag to select the keyframes you want to delete.
3 Control-click in the Keyframe Editor, then choose Cut from the shortcut menu (or press Delete).
4 In the Canvas, drag the tracker to the reference point, then click Analyze. New track keyframes are created.
Tip: When dealing with multiple problem trackers, you may want to turn off the trackers you are not correcting to simplify the Keyframe Editor. Additionally, when fine-tuning tracks in the Keyframe Editor, you may want simplify what is displayed in the graph. The following image displays the curves for a simple four-corner pin.

To quickly solo a curve, Option-click the parameter's checkbox in the Keyframe Editor's parameter list.

Smoothing Tracking Keyframe Curves
You can smooth a track with the Keyframe Thinning function in the Animation menu in the Keyframe Editor parameter list. Prior to smoothing the curve, you may want to copy the behavior (as a backup) to the Library or duplicate the behavior in the project.
**To smooth a track curve:**

1. In the Keyframe Editor, click the Animation menu for the track you want to smooth, then choose Reduce Keyframes from the pop-up menu.

---

**Before the curve is simplified, a keyframe appears at every frame.**

---

Reduce Keyframes applies a thinning algorithm to the keyframes for the chosen parameter. This reduces the number of keyframes in a parameter while attempting to maintain a similar shape to the curve. The thinning algorithm can be adjusted in two ways. Increasing the Maximum Error Tolerance results in fewer keyframes. Increasing the Smoothing Factor makes smoother curves between keyframe values.

This example uses 5, which means that 5 track points centered on the currently evaluated point are used to compute the current point’s new, smoothed value. This is a standard Gaussian (bell-curve type) filter. In other words, if you leave it at 5, when the value of frame 12 is computed, frames 10, 11, 12, 13, and 14 are considered. If set to 3, it uses frames 11, 12, and 13. The larger the Smoothing Factor, the more points are considered (and thus more calculations done) for every point in the curve.
2 Set the values in the Reduce Keyframes dialog.

As you adjust the sliders or value sliders in the dialog, the curve is modified in the Keyframe Editor.

3 Click OK.

**Averaging a Track Curve**

Another possible smoothing option is to apply the Average parameter behavior to a track curve in the Keyframe Editor. This behavior smooths the transition from one keyframe value to another. Averaged motion moves more fluidly.

**To apply an Average parameter behavior to a track curve:**

- In the Keyframe Editor, control-click the track curve, then choose Average from the shortcut menu.

The track is averaged, indicated by the simplified curve that appears behind the keyframes in the Keyframe Editor.

For more information on using Average parameter behaviors, see Chapter 5, “Using Behaviors,” in the *Motion 3 User Manual*.

**Preserving Image Quality**

Ideally, you should track an image with the most amount of raw data. The better the quality of your footage, the better the quality of the track.

**Asking Motion for a Hint**

Motion can “suggest” good reference patterns.

**To display the suggested track points:**

- Press the Option key, click a track point in the Canvas, and hold down the mouse button.
The suggested track points appear as small yellow plus signs.

![Track Points](image)

When you move a tracker toward one of the suggested points, the tracker snaps to the point.

The suggested points are not necessarily ideal tracking reference points for the feature you want to track in the clip. They are merely picking locations in the current frame that meet the track point criteria, such as an area of high contrast.

**Giving Motion a Hint**

When using the Analyze Motion behavior, you can direct a tracker where to look in a later frame for its reference pattern. This tool is ideal for the following types of clips:

- A clip that contains fast-moving features
- A clip with a subject moving in a relatively straight vector (with or without obstructions)
- A clip with swish pans (you may have to reset the “look-ahead” tracker at each panning change)

**Important:** If your track fails and you reposition your tracker, you must also reset the look-ahead tracker in the Canvas to provide a new motion vector from the new reference point.

**To define look-ahead frames:**

1. In the Canvas, position the tracker on the desired reference pattern.
In the following image, the tracker is positioned on a reference pattern on the front bumper of the car.

2 In the Behaviors tab of the Inspector, use the Look Ahead Frames slider or value slider to specify how many frames you want the tracker to look ahead.

*Note:* The maximum amount of frames for the Look Ahead Frames slider is 10 frames. However, you can enter a larger frame amount using the adjacent value slider.

3 While holding down the Command key, click the tracker in the Canvas, then drag in the direction the reference pattern is moving in the clip.

As you Command-drag the track point, an inset displays a magnified view of the frame specified in the Look Ahead Frames parameter.

4 When the look-ahead tracker is positioned on the reference pattern, release the mouse button.

*Note:* Look Ahead Frames can be used when tracking in reverse—you are looking at previous frames rather than future frames.
Tracking Images with Perspective, Scale, or Rotational Shifts

For images with significant change in size and angle, you can try a few different strategies. First, try using a larger search area. Although Motion does not allow you to adjust an onscreen tracking search area, you can increase its default search size using the Search Size parameter in the Behaviors tab of the Inspector. Click the track’s (such as Track 1) disclosure triangle to display the Search Size parameter.

A second strategy is to lower the Fail Tolerance value. With a lower Fail Tolerance value, the tracker is more likely to find a false match. With a higher value, the tracker is more strict in finding a match. Click the track’s disclosure triangle to display the Fail Tolerance parameter.

Another strategy is to jump to the midpoint frame of the clip and track forward to the end frame of the clip. Then return to the midpoint frame and track backward to the beginning of the clip.

Tracking Obscured or Off-Frame Points

In addition to experimenting with different tracker parameter settings, there is a basic technique to correct track points that are obscured by moving offscreen or by an object passing in front of them.

The following sequence is a simple example of a candidate for offset tracking. As the car moves forward, it passes a tree that temporarily obstructs the reference pattern.

When the reference pattern becomes obscured, the Offset Tracker checkbox lets you move the tracker, picking a new reference pattern in a different area from the original reference pattern. The offset between the original reference pattern and the new pattern is calculated to maintain continuity in the resulting track path.

In the following example, the track is obscured by a tree, so the tracker is moved to a nearby reference pattern and tracking continues until the original pattern reappears. Even though one region is examined, the points are saved in another region. The second tracking pattern should travel in the same direction as your original pattern.

To offset (move) the onscreen tracker control to an unobstructed area of the image:

1. Go to the frame where you want to begin the offset track.
When a track is lost during an analysis, Motion automatically jumps back to the frame at which the track failed. The “bad” track point is identified by an “x” in the Canvas.

You can use the bad track point, or use any point prior to the failed track frame, to move the tracker and select a new reference feature. In the Canvas, the track point at the current playhead position is emphasized.

2 Turn on the Offset Track button in the HUD or Behaviors tab of the Inspector.
3 Drag the tracker to a new position in the Canvas.

4 Click Analyze to restart the motion analysis.

Motion continues to keyframe the trajectory of the original track point, based on the movement of the new offset reference pattern.

**Note:** When you use Offset Track, make sure that the new reference pattern is as close to the original tracking feature as possible. Ideally, the offset feature should share the same motion as the originally tracked feature and appear on the same subject.

### Tracking Retimed Footage

When working in a project that includes tracking and retiming tasks, use the following guidelines for more successful results:

- Because the Motion tracker analyzes in a project’s frame rate, ensure that the frame rate of the footage you plan to track matches the frame rate of the project. For example, when you want to track 24 frames-per-second (fps) footage, your project’s frame rate should be 24 fps. Once the tracking analysis is completed, retime the clip using the Retiming parameters in the Media tab of the Inspector or the Retiming behaviors.
- Do not retime the footage prior to the tracking analysis.
- Do not retime the footage, perform a tracking analysis, then retime the footage again. This may adversely affect your track.

**Note:** If you really want to track a clip after it has been retimed, it is recommended that you retime and export the clip, then import the clip and perform the tracking analysis.

### Troubleshooting Stabilizing Effects

If the output of a stabilize operation is unsatisfactory, there are several things you can try to improve the result.

**Stabilize Wants to Keep It Real**

The automatic motion analysis (analysis without trackers) used by the Stabilize behavior works best with real images. Artificial images, such as those with no texture, are not recommended for use with the Stabilize behavior’s automatic mode. Shots with very strong pans are also not recommended. Images with redundant camera data yield very good results.

**Adding Trackers to the Stabilization**

If a stabilized clip has a particularly bumpy section that is not getting smoothed, you can add trackers to noncontiguous sections of a clip.

Any stabilize data from the automatic motion analysis is overwritten by the portions of the clip that are analyzed using the onscreen trackers.
To use a tracker for a portion of a stabilize operation:

1. Once the Stabilize motion analysis is complete, play the clip to determine what section you want to track.

   Important: Always analyze the entire clip before adding any trackers. The Stabilize behavior needs “meaningful” data—a large range of frames—to yield the best results.

2. Set an Out point for the tracker analysis: Position the playhead at the frame you want to stop the analysis, then choose Mark > Mark Play Range Out (or press Command-Option-O).

3. Position the playhead at the frame where you want to start the track, then click the Add button in the Inspector.

4. Position the tracker on the reference pattern you want to track in the Canvas, then click the Analyze button in the HUD or Inspector.

   The specified play range is tracked, creating track points in the Canvas and tracking keyframes in the Keyframe Editor.

   Note: When using this strategy to track multiple noncontiguous sections of the clip, use the same tracker whenever possible to simplify the track and to avoid clutter in the Keyframe Editor.

   This strategy is not recommended for small portions of the clip, such as using the default stabilization for 25 frames, a tracker analysis for 10 frames, the default stabilization for 10 frames, and so on.

Changing the Smoothing Parameters

If you’re trying to smooth the motion in a clip, you should first try adjusting the smoothing parameters. These parameters include Translation Smooth, Rotation Smooth, and Scale Smooth. This can be accomplished without having to reanalyze the clip.

Reanalyzing at a Higher Quality

When analyzing, choose Better from the Quality pop-up menu in the Behaviors tab of the Inspector. This may take longer, but the quality of the analysis is higher.

Editing the Analysis Data

If neither of the prior solutions helps, look at the Confidence parameter in the Keyframe Editor, then look for frames where the Confidence parameter falls to very low values. If the image transformation at these frames stands out, you can convert the Stabilize behavior to keyframes. This creates transform keyframes on the stabilized object, which can then be edited in the Keyframe Editor. Try deleting any keyframes that create unusual spikes at the frames where the Confidence curve value was low.

For more information on converting behaviors to keyframes, see “Converting Tracks to Keyframes” on page 84.
Removing Black Borders Introduced by Stabilizing
When you use the Stabilize behavior, the resulting transformations that are made to smooth or stabilize the shot cause moving black borders to appear around the edges of the image. While this is necessary to achieve the desired effect, you probably don’t want these black borders to appear in the final shot.

There are a few ways you can choose to handle this border.

Zooming the Clip
You can zoom the clip using the Borders pop-up menu in the Behaviors tab of the Inspector.

To zoom the clip:
- In the Behaviors tab of the Inspector, choose Zoom from the Borders pop-up menu.
  The clip is expanded to the full size of the Canvas, preventing black borders from appearing around the edges of the stabilized clip.

Scaling the Output Image to Fit the Original Frame Size
If you need to output the resulting image at the same size as the original, the quickest fix is to scale the image after the Stabilize analysis. You’ll need to enlarge the image to the point where all instances of black borders fall outside the edges of the frame. The disadvantage of this method is the resulting softening of the image, depending on how much it must be enlarged.

To scale the stabilized image:
1 Select the clip and click the Properties tab of the Inspector.
2 Adjust the Scale parameter so that the borders no longer appear at the edges of the clip.

Distorting the Edges
One last suggestion is to experiment with different filters to stretch the edges of the image to fill any gaps. For example, you can experiment with the Scrape filter to stretch out the edges of the image. This solution is highly dependent on the type of image and may introduce other image artifacts that may or may not be acceptable.
In the following image, a large border is created when the clip is stabilized.

Next, a Scrape filter is applied to the group in which the stabilized clip resides. The left image shows the clip when the filter is first applied to the group. At first, it does not appear especially helpful. In the right image, the center and rotation of the filter are adjusted, removing the black edge by stretching the right edge of the image.

*Important:* The filter must be applied to the clip’s group, not to the clip, for this technique to have any effect.

*Note:* You may need to turn on the Fixed Resolution checkbox in the Group tab of the Inspector so the effect of the Scrape filter is not cropped.

**Some General Guidelines**

The Motion tracker uses the source image for its tracking analysis. This means that the tracker automatically uses the best search area, the best color, the best contrast, subpixel accuracy, and so on in the clip to generate the best possible tracking data. Common tracking strategies, such as using filter tricks, manually resizing a tracking “box” or search area, or specifying a subpixel sampling amount are not required.

This does not mean that you do not have to work to achieve a perfect track, of course. Use the following guidelines to help you decide what may assist you and what won’t assist you in your tracking analysis.
What Will Not Help You
- Applying any filter to a clip or object prior to tracking
- Soloing or isolating a tracked clip. This does not speed tracking analysis.
- Adding multiple Stabilize behaviors. This does not help to further stabilize an analyzed clip, because the tracker analyzes the original source footage and not the result of an analyzed clip (or a filtered clip).
- Converting a track to keyframes and stabilizing again
- Selecting a tracking reference feature that does not change perspective, scale, or rotation. The Motion tracker is designed to handle changes in perspective, scale, and rotation very well.

What Will Help You
- Removing interlacing (fields) from the footage prior to tracking. To remove the fields from footage, select the footage in the Media tab of the Project pane, click the Media tab in the Inspector, then choose an option from the Field Order pop-up menu.

  Note: Interlacing can be present in clips stabilized using the automatic analysis mode in the Stabilize behavior.

- Stabilizing a clip, exporting the clip, importing the clip, then stabilizing the clip again.
- Sharpening or blurring a clip or an object with a filter, exporting the clip, importing the clip into the same group as the original footage, tracking the filtered clip, then using that tracking data as the source for other tracking behaviors

  Note: Other filter tricks may also be helpful, such as using a filter to isolate a less-noisy color channel of a clip or an object.

- Setting the View resolution to a lower setting, which may speed the tracking analysis

Tracking and Groups
There are a few special considerations when tracking groups.

Corner-Pinning Groups
You can corner-pin groups using the Match Move behavior. Use the following guidelines for the best results:

- To corner-pin a 2D group, it is recommended that you turn on the Fixed Resolution checkbox in the Group tab of the Inspector.

- To corner-pin a 3D group, you must turn on the Flatten checkbox in the Group tab of the Inspector. If Flatten is not enabled for the group, the Four Corners option will not be available from the Type pop-up menu in the Match Move parameters.

  Once Four Corners is chosen from the Type pop-up menu, Four Corner is enabled in the Properties tab of the Inspector, causing the group to be rasterized. For more information on rasterization, see “Rasterization” on page 37.

Using either of the above techniques may still result in dynamic resizing. If you receive unwanted results, export the group, import the group, then corner-pin the object.
Parallax in 3D Groups
When match moving 3D groups that contain objects that are offset in Z space, parallax is simulated. Parallax is the apparent shift of an object against a distant background caused by a shift in perspective, such as a change in camera position.

To remove a parallax effect, turn on the Flatten checkbox for the tracked group in the Group tab of the Inspector.

Saving Tracks
As with all behaviors in Motion, you can save tracking behaviors to the Library. Keep in mind, however, that a tracking behavior needs to reference the tracked source object. Therefore, it may make more sense to save the entire group that contains the tracking behavior, as well as the source footage, to the Library.

To save a group to the Library:
1. Open the Library and select the category into which you want to save the group, such as the Favorites category.
2. Drag the group that contains the tracking behavior and its source (tracked) footage from the Layers tab, Timeline, or Inspector into the stack at the bottom of the Library.
   The group is added to the Library category.

To save a behavior to the Library:
1. Open the Library and select the Favorites, Favorites Menu, or Behaviors category.
2. Drag the customized behavior you want to save from the Layers tab, Timeline, or Inspector into the stack at the bottom of the Library.
   When you save a customized item to the Library, it is saved in the /Users/username/Library/Application Support/Final Cut Studio/Motion/Library folder.
   For more information on saving behaviors to the Library, see Chapter 5, “Using Behaviors,” in the Motion 3 User Manual.

To add a group to a project from the Library:
1. Open the Library and select the category that contains the group.
2. Do one of the following:
   • To nest the group in an existing group, drag it to the existing group in the Layers tab.
   • To create a new group, drag it to an empty area in the lower portion of the Layers tab.
   The group is added to the project.

To apply a behavior to a clip from the Library:
1. Open the Library and select the Favorites, Favorites Menu, or Behaviors category.
2. Drag the behavior to the clip in the Layers list, Timeline, or Canvas.
To reference another tracking behavior in a project:
1. Add an Analyze Motion, Match Move, Stabilize, or Unstabilize behavior.
2. In the tracking behavior’s HUD or Inspector, choose a track from the tracking behaviors pop-up menu.

The track is applied to the tracking behavior.

Motion Tracking Behavior Parameters
The following section provides a detailed description of the parameters available in the different tracking behaviors.

Note: Cloned objects cannot be tracked.

Analyze Motion Controls
The Analyze Motion behavior is designed for use with footage (a movie or image sequence). This behavior can be thought of as a “traditional” correlation tracker—you position an onscreen tracker on a reference pattern on a clip. The movement of the clip at the specified reference point is analyzed, and the analyzed data is saved in the behavior. The recorded data can then be applied to other objects in the project.

The Analyze Motion behavior does not transform the input image. It is used only to generate tracks that can be referenced by the Match Move and Stabilize behaviors.

Note: Analyze Motion cannot reference other tracking behaviors.

Important: The Analyze Motion behavior can only be applied to footage objects (a QuickTime movie or image sequence).

Parameters in the HUD
The Analyze Motion HUD contains controls to start the motion track (the Analyze button), reverse the direction of the track (the Reverse checkbox), and to specify an offset track (the Offset Track checkbox). Offset tracking allows you to reposition the tracker at a new reference pattern. The HUD parameters, which also appear in the Inspector, are described below.

Parameters in the Inspector
Movement: The Movement parameter contains controls to begin the tracking analysis and to specify the direction of the analysis.

• Analyze: Click the Analyze button to begin the motion tracking analysis. Once Analyze is clicked, a status window appears that displays the tracking progress. To stop the analysis, click the Stop button in the status window or press Esc.

The start of the track is based on the current playhead position, rather than the start of the behavior in the Timeline.
• **Reverse:** When the Reverse checkbox is turned on, the clip is analyzed from the current playhead position to the first frame of the clip (or the first frame of the tracking behavior).

  **Note:** You must move the playhead to the frame from which you want to begin the reverse analysis.

**Tracker:** Click the Add button to add trackers to the Analyze Motion behavior. By default, one tracker is available. New trackers are added at the center of the Canvas.

For a description of the Tracker Preview, Offset Track, Auto-Zoom, Auto-Zoom Mode, Look Ahead Frames, and track list parameters, as well as the tracker subparameters, see “Tracker Controls” on page 112.

For information on using the Analyze Motion behavior, see “General Motion Tracking Workflow (with Analyze Motion)” on page 55.

**Match Move Controls**
The Match Move behavior can be applied to many different object types, including groups, cameras, shapes, particle emitters, and so on.

  **Important:** When applying the Match Move behavior to a group, make sure that the source footage you are tracking does not reside within the group with the applied Match Move behavior.

**Parameters in the HUD**
The Match Move HUD contains controls to load an animated object or tracking data from another tracking behavior into the behavior (via the Source well or the tracking behaviors pop-up menu), to start the motion analysis (the Analyze button), to reverse the direction of the track (the Reverse checkbox), to offset the track (the Offset Track checkbox), to specify whether the destination object is four-corner pinned (the Type pop-up menu), and to choose what transform is applied to the destination object (the Adjust parameter). The HUD parameters, which also appear in the Inspector, are described below.

**Parameters in the Inspector**
**Source:** Drag the source object for the match move to this well. The source object can be another tracking behavior, an animated object, or a footage object. When a Match Move behavior is added to an object, the nearest animated object, recorded track, or footage object beneath the behavior in the Layers list appears in this well. To clear a Source well, drag the item away from the well and release the mouse button.

When any non-footage object (such as a shape or mask) is dropped in the Source well, the trackers are no longer available in Match Move.

  **Note:** When the Match Move behavior is applied to a mask, the masked object is automatically selected as the source.
• **Tracking behaviors pop-up menu**: Choose from a list of tracking data (from other tracking behaviors) within the project.

**Movement**: The Movement parameter contains controls to begin the tracking analysis and to specify the direction of the analysis.

• **Analyze**: Click the Analyze button to begin the motion tracking analysis. Once Analyze is clicked, a status window appears that displays the tracking progress. To stop the analysis, click the Stop button in the status window or press Esc. The start of the track is based on the current playhead position, rather than the start of the behavior in the Timeline.

• **Reverse**: When the Reverse checkbox is turned on, the clip is analyzed from the current playhead position to the first frame of the clip (or the first frame of the tracking behavior).

  **Note**: You must move the playhead to the frame from which you want to begin the reverse analysis.

**Type**: This pop-up menu allows you to choose between one-point, two-point, or four-point tracking.

• **Transformation**: This option allows one-point or two-point tracking, transforming the destination object.

• **Four Corners**: This option enables four-point tracking, corner-pinning the destination object. When this option is chosen, the Direction and Adjust parameters are no longer available.

  **Note**: The Four Corners option is not available when Match Move is applied to a 3D group. To corner-pin a 3D group, turn on the Flatten checkbox in the Group tab of the Inspector.

**Direction**: This pop-up menu allows you to specify the dimension to which the recorded movement is applied to the destination object: X and Y, only X, or only Y.

**Transform**: This pop-up menu allows you to choose how the destination object (the object to which the Match Move behavior is applied) moves.

• **Attach to Source**: This option "glues" the foreground object to the recorded track or animation source. Use Attach to Source when the source object is scaling or rotating, and you want the destination object to "stick" to a particular spot on the source object. Any animation that existed on the destination object prior to applying the track is erased.

  **Note**: Although the destination object is attached to the movement of the source object, the position of the destination object can be changed (offset from the source object). The destination object cannot be scaled or rotated.
In the following example, Match Move is applied to the red “pill” shape and uses the animated white arrow as the source object. The white arrow has an applied Spin behavior and is spinning in a clockwise direction.

When Attach to Source is chosen from the Transform pop-up menu, the red shape is locked to one spot (the tip, in this example) on the arrow as it matches the movement of the arrow.

Note: When Attach to Source is chosen, you cannot transform a tracked object. For example, you cannot change the scale, position, or rotation of a corner-pinned object.

- **Mimic Source**: This option allows the destination object to “mimic” the recorded track or animation source. Any animation that existed on the foreground object prior to applying the track is added to the track.

  Note: As with Attach to Source, the position of the destination object can be changed (offset from the source object). Additionally, the destination object can be scaled and rotated.
In the following images, Mimic Source is chosen from the Transform pop-up menu. The red shape is not locked to one spot on the white arrow, but rather mirrors the arrow’s animation.

Mimic Source allows you to transform a tracked object in the Properties tab of the Inspector. For example, you can change the scale, position, or rotation of a corner-pinned object. Also when using Four Corners, Mimic Source allows you to adjust the trackers without adjusting the foreground image.

**Adjust**: This parameter allows you to choose the type of transformation applied to the destination object.

- **Position**: When enabled, the position of the source (or background) object is applied to the destination (or foreground) object. When Position is enabled, the Anchor (position) tracker is turned on.
- **Scale**: When enabled, the scale of the source (or background) object is applied to the destination (or foreground) object. The source track must include scale data for this parameter to have any effect. When Scale is enabled, the Rotation-Scale tracker is turned on.
- **Rotation**: When enabled, the rotation of the source (or background) object is applied to the destination (or foreground) object. The source track must include rotation data for this parameter to have any effect. When Rotation is enabled, the Rotation-Scale tracker is turned on.

**Anchor**: Available when one-point or two-point tracking is enabled (when Transformation is chosen from the Type pop-up menu), this checkbox turns the Anchor tracker on or off. The anchor tracker records position data. When Position is enabled in the Adjust parameters, the Anchor tracker is turned on.
When the Match Move behavior references another behavior, such as Analyze Motion, the Anchor tracker becomes the Origin tracker. The tracker's subparameters are replaced with a pop-up menu that allows you to select the tracker from the referenced behavior that you want to apply as the Origin tracker. By default, Track 1 from the referenced behavior is applied as the Origin tracker, and Track 2 is applied as the Scale-Rotation tracker. If there is only one tracker in the referenced behavior, Track 1 is applied to both Match Move trackers.

Rotation-Scale: Available when one-point or two-point tracking is enabled (when Transformation is chosen from the Type pop-up menu), this checkbox turns the Rotation-Scale tracker on or off. Rotation and scale data are recorded by using the relationship between the Anchor and Rotation-Scale trackers. When Scale or Rotation is enabled in the Adjust parameters, the Rotation-Scale tracker is turned on.

When the Match Move behavior references another behavior, such as Analyze Motion, the Rotation-Scale tracker subparameters are replaced with a pop-up menu that allows you to select the tracker from the referenced behavior that you want to apply as the Rotation-Scale tracker.

Top Left: Available when four-point tracking is enabled, (Four Corners is chosen from the Type pop-up menu), this checkbox turns the top-left tracker on or off.

Top Right: Available when four-point tracking is enabled, (Four Corners is chosen from the Type pop-up menu), this checkbox turns the top-right tracker on or off.

Bottom Right: Available when four-point tracking is enabled, (Four Corners is chosen from the Type pop-up menu), this checkbox turns the bottom-right tracker on or off.

Bottom Left: Available when four-point tracking is enabled, (Four Corners is chosen from the Type pop-up menu), this checkbox turns the bottom-left tracker on or off.
When the Match Move behavior references another behavior, such as Analyze Motion, the Top Left, Top Right, Bottom Right, and Bottom Left tracker subparameters are replaced with a pop-up menu that allows you to select the tracker from the referenced behavior that you want to apply to each Match Move tracker.

For a description of the Tracker Preview, Offset Track, Auto-Zoom, Auto-Zoom Mode, Look Ahead Frames, and track list parameters, as well as the tracker subparameters, see “Tracker Controls” on page 112.

For information on using the Match Move behavior, see “Match Move Workflows” on page 58.

**Stabilize Controls**

The Stabilize behavior uses a different method to analyze movement in a clip than the Match Move and Analyze Motion behaviors. Generally, you do not use trackers to stabilize a clip. The behavior’s sophisticated method of motion estimation automatically tracks every pixel in one frame to the subsequent frame. A motion vector is calculated based on this analysis. The analysis can be performed on the entire clip, or on a region of interest (ROI). An ROI is a user-defined area of a clip that is analyzed.

If the result of the automatic analysis requires additional correction, you can perform manual tracking on noncontiguous time regions of the clip. For example, if there is an additional camera bump affecting frames 350 to 380, you can add a tracker to analyze just that portion of the clip. The data recorded from the additional analysis is added to the data recorded by the automatic tracking to further smooth the clip.

In addition to considering horizontal, vertical, or horizontal and vertical movement in the clip, the Stabilize behavior also looks at position, scale, and rotation.

*Important:* The Stabilize behavior can only be applied to footage objects (a QuickTime movie or an image sequence).

**Final Cut Pro SmoothCam**

When a Final Cut Pro clip or sequence that contains a SmoothCam filter is exported to Motion, the filter is converted to a Stabilize behavior in Motion. Smooth is chosen from the Method pop-up menu, rather than the default Stabilize option.
Parameters in the HUD
The Stabilize HUD contains controls to load another stabilize track into the behavior (via the Source well or the tracking behaviors pop-up menu), to start the motion analysis (the Analyze button), to specify whether the clip is stabilized or smoothed (the Method pop-up menu), to define how the stabilize clip is “sized” (the Borders pop-up menu, and to choose what transform is applied to the analyzed clip (the Adjust parameter). The HUD parameters, which also appear in the Inspector, are described below.

Note: When Smooth is chosen from the Method pop-up menu, additional parameters become available in the HUD and Inspector.

Parameters in the Inspector
Source: Drag a source object for the behavior to this well. The source object can be another Stabilize behavior or a footage object.

To clear a Source well, drag the item away from the well and release the mouse button.

• Tracking behaviors pop-up menu: Choose from a list of tracking data (from other tracking behaviors) within the project.

  Note: When you select an option from the tracking behaviors pop-up menu, the Add button, which allows you to add trackers, is no longer available.

Movement: This parameter contains the Analyze button, which begins the tracking analysis.

• Analyze: Click the Analyze button to begin the motion tracking analysis. Once Analyze is clicked, a status window appears that displays the tracking progress. To stop the analysis, click the Stop button in the status window or press Esc.

  When using the Stabilize behavior (without trackers), the track begins at the start of the clip, rather than the current playhead position.

Quality: This pop-up menu defines the level of detail for the motion analysis. There are two levels of quality, Faster and Better.

• Faster: This option allows for a faster operation, but the motion analysis is less detailed.

• Better: This option provides a more detailed analysis, but is slower. This is the recommended option when the clip contains rotation.

  Note: This option is equivalent to the default setting of the SmoothCam filter in Final Cut Pro.

Track Region: When this checkbox is turned on, a red box appears in the Canvas that allows you to define a subject or area that you want to be analyzed. The area outside of the region is ignored. The track region’s onscreen controls are similar to a shape’s onscreen controls.
To adjust the track region in the Canvas, do one of the following:

- Drag in the region to change its position.
- Drag a handle to resize the region. The corner handles simultaneously resize width and height; the top and bottom center handles resize height; the left and right center handles resize width.
- Press Option while dragging a handle to resize the region from its center.
- Drag the rotation handle in the center of the region to change the angle of the region.

**Method:** This pop-up menu defines how the stabilization is applied to the clip.

- **Stabilize:** This method attempts to lock the motion of the principal subject in the shot to eliminate motion. As a result, the background will appear to move around the subject being tracked.
- **Smooth:** This method smooths the apparent motion of the camera, while allowing the general movement in the frame to proceed. It's useful for removing jitter from a camera move. When enabled, this mode has three sliders for each of the dimensions that can be smoothed.
  - **Translation Smooth:** Smooths motion in both the X and Y dimensions.
  - **Rotation Smooth:** Smooths image rotation.
  - **Scale Smooth:** Smooths an uneven zoom.

  **Note:** Don't set the Scale Smooth above 0 unless you're positive that the image is being zoomed.

**Borders:** When a clip is stabilized, the resulting transformations that are made to the stabilized image may cause moving black borders to appear around the edges of the clip. This pop-up menu defines how the edges are handled.

- **Normal:** Maintains the size of the stabilized footage. The moving black borders remain around the edges of the clip.
• **Zoom:** Expands the clip to the full size of the Canvas. This prevents black borders from appearing around the edges, but scales up the stabilized clip.

![Zoom Example]

**Direction:** This pop-up menu allows you to specify the dimension to which the recorded movement is applied to the analyzed image: X and Y, only X, or only Y.

**Adjust:** This parameter allows you to choose the transformation to which the stabilization is applied.

- **Position:** When enabled, stabilize is applied to the position of the analyzed image.
- **Scale:** When enabled, stabilize is applied to the scale of the analyzed image.
- **Rotation:** When enabled, stabilize is applied to the rotation of the analyzed image.

**Tracker:** Click the Add button to add trackers to the Stabilize behavior. By default, trackers are added at the center of the Canvas.

Once a tracker is added to a Stabilize behavior, the following occurs:

- The Track Region parameter is no longer available.
- The Reverse checkbox becomes available, allowing you to track a clip backwards.
- The Tracker Preview, Offset Track, Auto-Zoom, Auto-Zoom Mode, Look Ahead Frames, and track list controls become available.

**Note:** When another behavior is used as the source for the stabilization, you cannot add trackers to the Stabilize behavior.

For a description of the Tracker Preview, Offset Track, Auto-Zoom, Auto-Zoom Mode, Look Ahead Frames, and track list parameters, as well as the tracker subparameters, see “Tracker Controls” on page 112.

For information on using the Stabilize behavior, see “Stabilize Workflow” on page 73.
**Unstabilize Controls**
The Unstabilize behavior is used to apply movement tracked in another tracking behavior to an object. This behavior does not perform any tracking analysis. The Unstabilize behavior can be applied to many different object types, including groups, cameras, shapes, particle emitters, and so on.

**Parameters in the HUD**
The Unstabilize HUD contains two controls to load another stabilize track into the behavior: the Source well or the tracking behaviors pop-up menu. These controls are identical to the controls in the Inspector, as described below.

**Parameters in the Inspector**
- **Source**: Drag a Stabilize behavior to this well to load the data into the Unstabilize behavior. To clear a Source well, drag the item away from the well and release the mouse button.
- **Tracking behaviors pop-up menu**: Choose from a list of tracking data (from other tracking behaviors) within the project.

*Note:* The Unstabilize behavior can be converted to keyframes. For more information, see “Converting Tracks to Keyframes” on page 84.

For information on using the Unstabilize behavior, see “Unstabilize Workflow” on page 75.

**Track Points Controls**
The Track Points behavior allows you to link the control points of a shape or mask (including paint strokes) to reference features on a source clip. This behavior also allows you to apply existing tracking data that was recorded by the Analyze Motion, Match Move, or Stabilize tracking behaviors to the control points of a shape or mask.

**Parameters in the HUD**
The Track Points HUD contains controls to load an animated object or tracking behavior into the behavior (via the Source well or the tracking behaviors pop-up menu), to specify how the destination object moves, to start the motion analysis (the Analyze button), to reverse the direction of the track (the Reverse checkbox), and to offset the track (the Offset Track checkbox). The HUD parameters, which also appear in the Inspector, are described below.

**Parameters in the Inspector**
- **Source**: Drag a source object for the track points to this well. The source object can be another tracking behavior, an animated object, or a footage object. To clear a Source well, drag the item away from the well and release the mouse button.
- **Tracking behaviors pop-up menu**: Choose from a list of tracking data (from other tracking behaviors) within the project.
Transform: This pop-up menu allows you to choose how the destination object moves.

- **Attach to Source**: This option “glues” the destination object to the recorded track or animation source. Use Attach to Source when the source object is scaling or rotating, and you want the destination object to “stick” to a particular spot on the source object. Any animation that existed on the destination object prior to applying the track is erased.

  **Note:** Although the destination object is attached to the movement of the source object, the destination object can be offset from the source object.

- **Mimic Source**: This option allows the destination object to “mimic” the recorded track or animation source. Any animation that existed on the foreground object prior to applying the track is added to the track.

  **Note:** As with Attach to Source, the destination object can be offset from the source object.

Align Tangents: When this checkbox is turned off, tangents remain aligned at their original angles. When turned on, the tangents match the transformation of the source animation, and the shape changes its form.

Movement: The Movement parameter contains controls to begin the tracking analysis and to specify the direction of the analysis.

- **Analyze**: Click the Analyze button to begin the motion tracking analysis. Once Analyze is clicked, a status window appears that displays the tracking progress. To stop the analysis, click the Stop button in the status window or press Esc. The start of the track is based on the current playhead position, rather than the start of the behavior in the Timeline.

- **Reverse**: When the Reverse checkbox is turned on, the clip is analyzed from the current playhead position to the first frame of the clip (or the first frame of the tracking behavior).

  **Note:** You must move the playhead to the frame where you want to begin the reverse analysis.

For a description of the Tracker Preview, Offset Track, Auto-Zoom, Auto-Zoom Mode, Look Ahead Frames, and track list parameters, as well as the tracker subparameters, see “Tracker Controls” on page 112.

For information on using the Track Points behavior, see “Track Points Workflow” on page 76.

**Track Parameter Behavior Controls**
The Track Parameter behavior allows you to track a position parameter of a filter to a reference feature of a clip, or to apply existing tracking data to a position parameter of a filter.
Parameters in the HUD
The Track parameter HUD contains controls to load a tracking behavior into the behavior (via the Source Behavior well or the tracking behaviors pop-up menu), to specify how the position parameter moves, to start the motion analysis (the Analyze button), to reverse the direction of the track (the Reverse checkbox), and to offset the track (the Offset Track checkbox). The HUD parameters, which also appear in the Inspector, are described below.

Parameters in the Inspector
Source: Drag the source object for the track to this well. The source object can be another tracking behavior or a footage object. Drag a behavior to the Source well to load that track into the Track Parameter behavior. To clear a Source well, drag the item away from the well and release the mouse button.

Note: An animated object cannot be used as a source for the Track parameter behavior.

- Tracking behaviors pop-up menu: Choose from a list of tracking data (from other tracking behaviors) within the project.

Transform: This pop-up menu allows you to choose how the filter’s position parameter moves.

- Attach to Source: This option “glues” the center of the filter to the recorded track or animation source. Use Attach to Source when the source object is scaling or rotating, and you want the filter’s center to “stick” to a particular spot on the source object. Any animation that existed on the filter’s center prior to applying the track is erased.

Note: Although the filter’s center is attached to the movement of the source object, the center can be offset from the source object.

- Mimic Source: This option allows the filter’s center to “mimic” the recorded track or animation source. Any animation that existed on the filter’s center prior to applying the track is added to the track.

Note: As with Attach to Source, the filter’s center can be offset from the source object.

Movement: The Movement parameter contains controls to begin the tracking analysis and to specify the direction of the analysis.

- Analyze: Click the Analyze button to begin the motion tracking analysis. Once Analyze is clicked, a status window appears that displays the tracking progress. To stop the analysis, click the Stop button in the status window or press Esc. The start of the track is based on the current playhead position, rather than the start of the behavior in the Timeline.

- Reverse: When the Reverse checkbox is turned on, the clip is analyzed from the current playhead position to the first frame of the clip (or the first frame of the tracking behavior).
Note: You must move the playhead to the frame from which you want to begin the reverse analysis.

For a description of the Tracker Preview, Offset Track, Auto-Zoom, Auto-Zoom Mode, Look Ahead Frames, and track list parameters, as well as the tracker subparameters, see “Tracker Controls” on page 112.

For information on using the Track Parameter behavior, see “Track Parameter Workflow” on page 79.

Tracker Controls
All onscreen trackers, regardless of the Motion Tracking behavior, have the following parameters in common:

Tracker Preview: This preview area provides a magnified view of the tracking reference point for the selected tracker. The preview updates as you adjust the position of the tracker in the Canvas. You can also drag in the preview area to adjust the position of the tracker. When dragging in the preview area, the image moves around the red crosshairs in the preview and the tracker moves in the Canvas.

Offset Track: If a tracker’s reference point becomes temporarily hidden or goes off the screen, this parameter allows you to select a different reference point that continues the same tracking path as the original reference point. For more information on offset tracking, see “Tracking Obscured or Off-Frame Points” on page 91.

Auto-Zoom: Choose an option from this pop-up menu to set the magnification level when positioning the tracker in the Canvas. This allows you to zoom in on the Canvas when searching for an ideal tracking reference pattern. There are four choices:

- None: When moving the tracker in the Canvas, there is no magnification (only the tracker appears).
- 2x: When moving the tracker in the Canvas, the magnification around the tracker is two times the normal zoom level.
- 4x: When moving the tracker in the Canvas, the magnification around the tracker is four times the normal zoom level.
- 8x: When moving the tracker in the Canvas, the magnification around the tracker is eight times the normal zoom level.

Auto-Zoom Mode: Choose an option from this pop-up menu to set the display of the auto-zoomed tracker in the Canvas. There are three choices:

- Normal: Displays a normal pattern.
- Contrast: Displays the tracker pattern with contrast detection.
- Edge: Displays the tracker pattern with edge detection.
The Auto-Zoom Mode applies only to the trackers in the Canvas and does not appear in the Tracker Preview in the Behaviors tab of the Inspector.

**Note:** When None is chosen from the Auto-Zoom pop-up menu, the Auto-Zoom Mode setting has no effect.

**Look Ahead Frames:** This slider and value slider allow you to specify the number of “future” frames to be analyzed by the tracker. In other words, you can direct the tracker to look in a specific location for its reference point. This is especially useful for footage that contains fast-moving objects, as the reference point can quickly “get away” from the tracker. For more information on using Look Ahead Frames, see “Giving Motion a Hint” on page 89.

**Track list:** Displays the trackers in the behavior. In the Analyze Motion and Stabilize behaviors, the trackers in this list are called “Track 1, Track 2,” and so on. In the Match Move behavior, the trackers are referred to as “Anchor” and “Rotation-Scale.” When four-point tracking is enabled, the trackers are called “Top Left,” “Top Right,” “Bottom Right,” and “Bottom Left.”

To disable a tracker, turn off its checkbox. To remove a tracker, click the Remove button. A tracker that is turned off is not analyzed with the track.

**Note:** You cannot remove trackers from the Match Move behavior.

Click the disclosure triangle next to the track name to reveal additional parameters:

- **Position:** Displays the X and Y positions of the tracker. The X position is the value slider on the left; the Y position is the value slider on the right. Click the disclosure triangle to display labeled position value sliders.

- **Search Size:** Use this slider or value slider to increase or reduce the tracker’s search area size. In Motion, you do not specify the size of a search area when setting up your trackers in the Canvas. To change the default search size, use the slider or value slider. If Search Size is set to 200 percent, the tracker’s search area is twice the default search area size.

- **Fail Tolerance:** This parameter defines the amount of tolerance for error, or confidence value, of the track. In other words, it defines at what “score” the tracker determines it is able to match a reference feature. When above the score, the tracker accepts the match. When below the score, the tracker rejects the match. Once the match is rejected, the Fail Behavior kicks in.

- **Fail Behavior:** This pop-up menu specifies what happens if the track confidence value falls below the Fail Tolerance amount. The following options are available:
  - **Smart Retry:** The tracker attempts to find the reference pattern in a larger search area. If the pattern cannot be found, the tracker switches to the Predict option. Smart Retry is the default fail behavior.
• **Stop:** Stops the analysis when the tracker loses the reference pattern. You can also click the Stop button in the tracking progress dialog or press Esc to stop an analysis.

• **Predict:** The tracker predicts a new search area without creating keyframes until it finds a match for the reference pattern. This is excellent for tracked objects that pass behind foreground objects.

• **Predict and Key:** If a failure is detected, the tracker predicts the location of the keyframe based on a vector of the last two keyframes, and continues tracking in the new area.

• **Don't Predict:** The tracker remains in its position and searches for subsequent matches as the clip's frames progress. While searching for a match, the tracker does not create keyframes.

• **Use Existing Keyframes:** This allows you to manually create keyframes along your track path. You then return to the start frame and start tracking. The search pattern looks for the motion path created by the existing keyframes.

• **Color:** Click or Control-click the color well to set a new color for the onscreen tracker. You can also click the eyedropper and select a color in the Canvas. The default tracker color is yellow. When a tracker is selected, its center point is white and the search area frame is the color set in the color well. To adjust the individual color channels, including the alpha channel, click the disclosure triangle.