How to create character animations

Inverse Kinematic Poses

Inverse kinematics (IK) is a method for animating an object or set of objects in relation to each other using an articulated structure of bones. Bones allow symbol instances and shape objects to move in complex and naturalistic ways with a minimum of design effort. For example, inverse kinematics lets you easily create character animation, such as arms, legs, and facial expressions.

You can add bones to separate symbol instances or to the interior of a single shape. When one bone moves, the other connected bones move in relation to the bone that initiated the movement. When animating using inverse kinematics you need only specify the start and end positions of objects. Inverse kinematics lets you easily create natural motion.

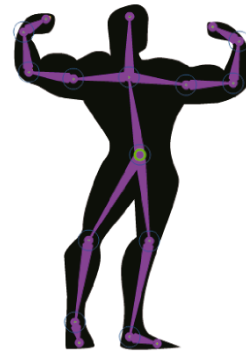**Figure 1** A group of several symbols with IK bones attached   **Figure 2** A shape with an IK armature added

A chain of bones is called an *armature*. The bones in an armature are connected to each other in a parent-child hierarchy. An armature can be linear or branched. Branches of an armature that originate at the same bone are called *siblings*.

You can use IK in Adobe Flash Professional in two ways. The first is to articulate a series of symbol instances by adding a single bone to each instance (**Figure 1**). The bones allow the chain of symbol instances to move together. For example, you might have a set of movie clips that each represents different parts of a human body. By linking the torso, upper arm, lower arm, and hand together, you can create a realistically moving arm. You can create a branched armature to include both arms, both legs, and the head.

The second way to use IK is to add an armature to the interior of a shape object (**Figure 2**). The shape can be created in merge drawing mode or object drawing mode. The bones allow you to move and animate parts of the shape without the need to draw different versions of the shape or create a shape tween. For example, you could add bones to a simple drawing of a snake to enable the snake to move and curve realistically.

You add bones to symbol instances and shapes with the Bone tool. You use the Bind tool to adjust the relationships between individual bones and control points of shape objects.

You can animate armatures and their associated symbols or shapes either in the timeline or with ActionScript 3.0. You animate in the timeline by defining different poses for the armature in different frames. Flash interpolates the positions of the armature in the frames in between. For information about animating armatures with ActionScript, see the fl.ik classes in the ActionScript 3.0 Language and Components Reference.

Note: To use inverse kinematics, your FLA file must specify ActionScript 3.0 as the Script setting in the Flash tab of the Publish Settings dialog box or the document Properties panel.

This document requires Adobe Flash Professional CS6. Technical instructions may differ depending on your version.

Adding bones to symbol instances

When you add bones to symbol instances, Flash moves the instances and the associated armature to a new layer in the Timeline panel. This new layer is called a *pose layer*. Each pose layer can contain only one armature and its associated instances.

To add bones to symbol instances:

1. Start Flash and open a new blank document (ActionScript 3.0).

2. Begin by creating the symbols that make up the moving parts of your character.

   Note: You can import artwork and convert objects to symbols. You can also draw your artwork in Adobe Flash Professional. If you create artwork by drawing shapes, convert each shape to a symbol.

3. Arrange the symbols in a rough spatial configuration of the object you wish to animate using IK (**Figure 3**).

   In this example, basic shapes were converted to symbols and instances of those symbols were arranged on the Stage to form the character.

4. Click an empty part of the Stage to deselect all symbols.

5. Select the Bone tool from the Tools panel.

   You can also press the "M" key to select the Bone tool.

6. With the Bone tool, click the symbol instance that is to be the root or head of the armature. Then drag to a separate symbol instance to link it to the root instance.

   As you drag, a bone appears. The mouse pointer changes to a small bone with a plus symbol (**Figure 4**). When you release, a solid bone exists between the two symbol instances. Each bone has a head (the wide end) and a tail (the narrow end). Each symbol instance can have only one attachment point. You can edit these attachment points later.

   Note: If, when dragging to create bones, the mouse pointer changes to a black bone and a circle with a slash through it, then Flash does not know which symbol instances you are attempting to connect. If this happens, you may be pointing outside the symbol or connecting to a symbol with no fill. To connect to a symbol with no fill, try positioning the pointer over the edge of the symbol instance.
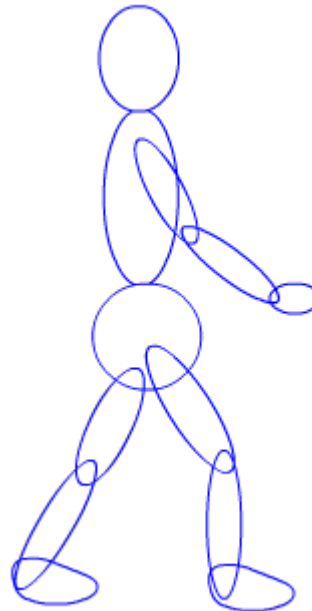

Figure 3 Symbol instances on the Stage

Figure 4 Bone connecting two symbol instances

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7. To add another bone, drag from the tail of the first bone to the next symbol instance you want to add to the armature.

   Note: To make it easier to drag the tail of the new bone to the specific location where you want it, you may want to turn of Snap to Objects (View > Snapping > Snap to Objects).

   Link objects with bones in the order of the parent-child relationships you want to create (**Figure 5**).

8. To create a branched armature, click the head of an existing bone where you want the branch to begin. Then drag to create the first bone of the new branch (**Figure 6**).

   An armature can have as many branches as necessary, but a branch cannot connect to another branch except as its root.
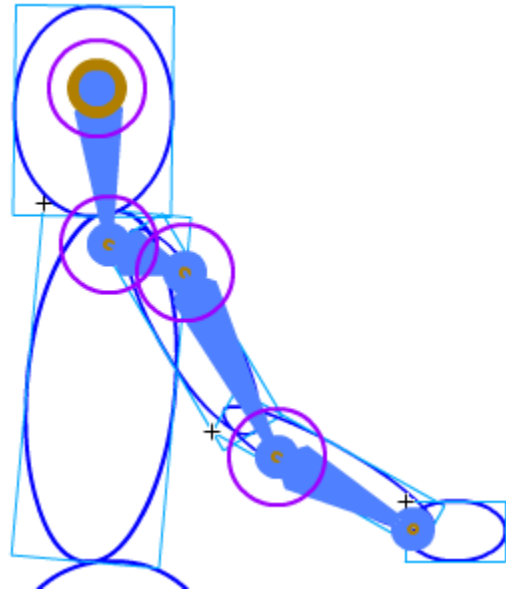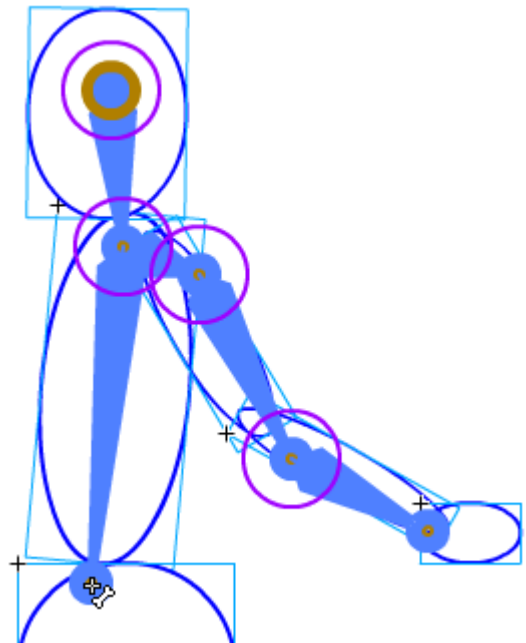

Figure 5 Linking symbols with the Bones tool

Figure 6 Branched armature

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9. Continue to add bones and branches to the armature as needed (**Figure 7**).

As you add bones to instances, Flash moves each instance to a new pose layer named Armature in the Timeline panel (**Figure 8**). You can rename this layer to better describe the armature.

All the bones and symbol instances associated with a given armature reside in the same pose layer. Each pose layer can contain only one armature.

Note: Flash adds the new pose layer to the timeline between existing layers to maintain the previous stacking order of objects on the Stage.

10. To reposition the elements of the armature, use the Selection tool to drag either the bones or the symbol instances themselves.

Note: To rotate a bone with its child bones without moving the parent bone, Shift-drag the bone.

There are many more techniques for manipulating armatures than can be explained in this guide. For detailed instructions on positioning bones and creating poses, refer to Adobe Flash Professional Help.

11. After completing your armature, right-click (Windows) or Control-click (Mac OS) frame 10 in the pose layer and select Insert Pose.

A keyframe appears in frame 10. You can create a new pose of the armature and Flash will interpolate the frames in between, creating the character animation.

12. With frame 10 selected, rearrange the pose as you like.

13. Select Control > Test Movie > In Flash Professional to preview the movie.

The symbols move in relation to each other.
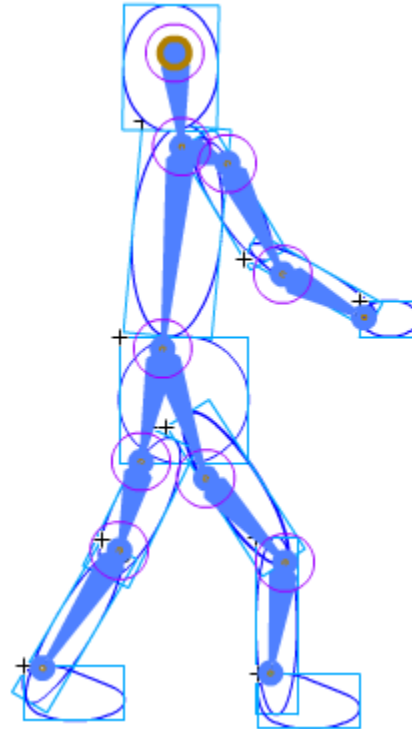
14. Close the preview window.
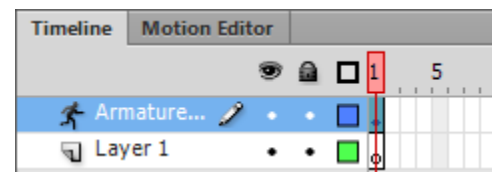

Figure 7 Completed armature

Figure 8 Pose layer

Adding bones to shapes

You add bones to a single shape or to a group of shapes that are on the same layer. In either case, you must select all the shapes before adding the first bone. After you add bones, Flash converts all the shapes and bones into an IK shape object and moves the object to a new pose layer.

After you have added bones to a shape, the shape has the following limitations:

• You cannot merge an IK shape with other shapes outside it.

• You cannot rotate, scale, or skew the shape with the Free Transform tool.

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To add bones to shapes:

1. Start Flash and open a new blank document (ActionScript 3.0).

2. Create a filled shape or shapes on the Stage.

   Note: The shape can contain multiple colors and strokes. Edit the shapes so they are as close to their final form as possible. Once you add bones to a shape, the options for editing the shape become more limited. If the shape is too complex, Flash will prompt you to convert it to a movie clip before adding bones.

3. Select the entire shape on the Stage.

   Note: If the shape contains multiple color areas or strokes, drag a selection rectangle around the shape to ensure that the entire shape is selected.

4. Select the Bone tool from the Tools panel.

   You can also press the "M" key to select the Bone tool.

5. Click inside the shape and drag to another location within the shape.

   As you drag, a bone appears. The mouse pointer changes to a small bone with a plus symbol (**Figure 9**). When you release, a solid bone exists within the interior of the shape. Each bone has a head (the wide end) and a tail (the narrow end).

6. To add another bone, drag from the tail of the first bone to another location in within the shape (**Figure 10**).

   The second bone becomes a child of the root bone.

7. Add new bones to link areas of the shape in the order of the parent-child relationships you want to create. For example, link from shoulder to elbow to wrist.

8. To create a branched armature, click the head of an existing bone where you want the branch to begin. Then drag to create the first bone of the new branch (**Figure 11**).

   An armature can have any number of branches, but a branch cannot connect to another branch except at its root.

   When you add bones to a shape, Flash moves the shape to a new pose layer named Armature (**Figure 12**). You can rename this layer to better describe the armature.
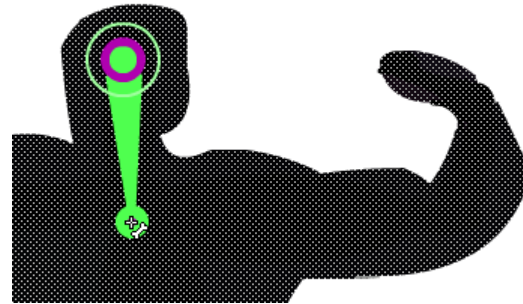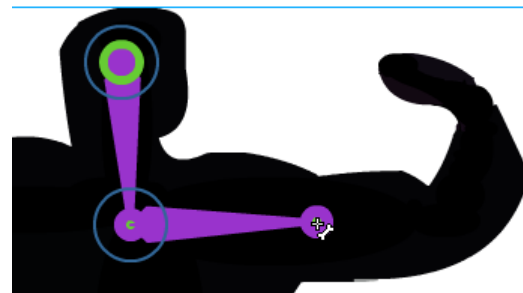

Figure 9 Adding a bone to a shape
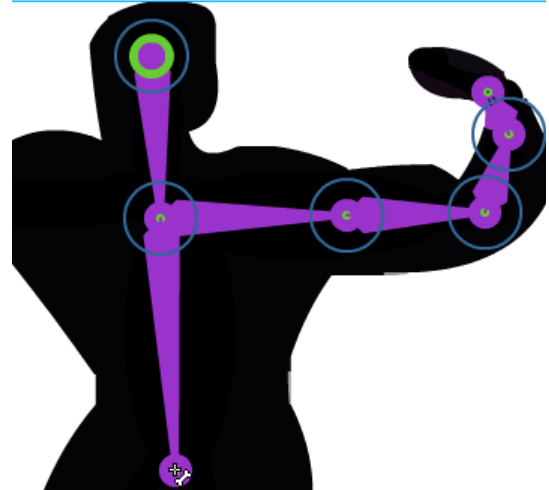

Figure 10 Shape with two bones

Figure 11 Branched armature

Figure 12 Pose layer

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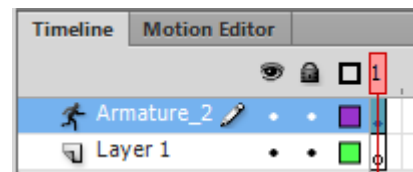9. To rearrange the pose of an armature, select the IK shape object with the Selection tool and then drag any of the bones to move them.

    Note: There many more techniques for manipulating armatures than can be explained in this guide. For detailed instructions on positioning bones and creating poses, refer to Adobe Flash Professional Help.

10. After completing the first pose of your armature, right-click (Windows) or Control-click (Mac OS) frame 10 in the pose layer and select Insert Pose.

    A keyframe appears in frame 10. You can create a new pose of the armature and Flash will interpolate the frames in between, creating the character animation.

11. With frame 10 selected, rearrange the pose as you like.

12. Select Control > Test Movie > In Flash Professional to preview the movie.

    The symbols move in relation to each other. You can fine-tune this movement by shifting the anchor points in the bones.

13. Close the preview window.

Binding bones to shape points

By default, the control points of a shape are connected to the bone that is nearest to them. When moving bones to pose the armature, a shape may become disfigured. One way to prevent this is to change how the bones are bound to the shape. You can use the Bind tool to edit the connections between individual bones and the shape control points. In this way you can control how the stroke distorts when each bone moves. This technique is useful when the stroke of a shape does not change as you want when the armature moves.

You can bind multiple control points to a bone and multiple bones to a control point.

To bind bones to shape points:

1. Select the Bind tool in the Tools panel.

    Note: The Bind tool and Bones tool share the same location in the Tools panel.

2. Click a bone within the shape.

    The control points appear in yellow and the selected bone is red. (**Figure 13**). Control points connected to only one bone appear as squares. Control points connected to more than one bone appear as triangles.

3. To add control points to a selected bone, Shift-click a blue control point (one of the small blue handles that are not highlighted in yellow).

Figure 13 Bone control points within a shape

4. To remove a control point from the bone, Ctrl-click (Windows) or Option-click (Mac OS) a control point that is highlighted in yellow.
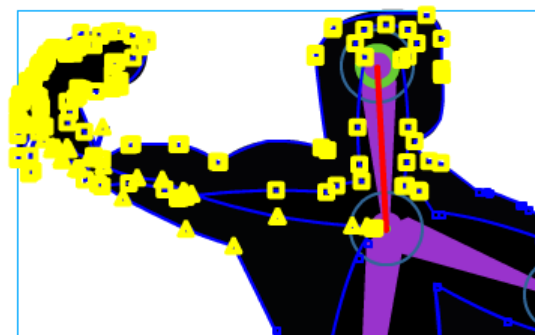
5. To highlight the bones connected to a control point, click the control point with the Bind tool.

   The connected bones are highlighted in yellow while the selected control point is highlighted in red (**Figure 14**).

6. To add other bones to the selected control point, Shift-click a bone.

7. To remove a bone from a selected control point, Ctrl-click (Windows) or Option-click (Mac OS) a bone that is highlighted in yellow.

Figure 14 Selected control point

Changing pose properties

In addition to manually positioning the bones in an armature, you can also use the settings in the Properties panel to control behavior of the bones within each pose.

To change pose properties:

1. Click a pose layer to select it.

2. Using the Selection tool, click a bone to select it (**Figure 15**).

   Note: You can select a bone that connects two symbol instances or bones within a shape.
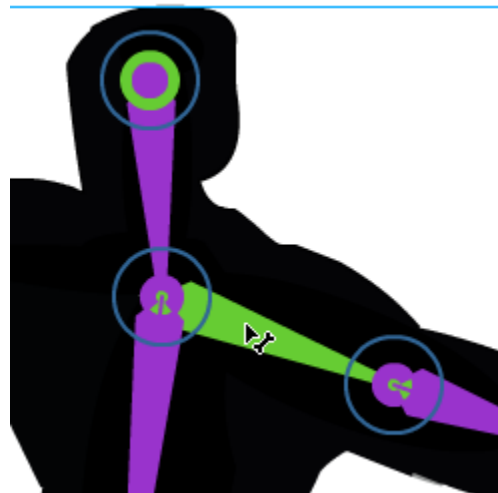

Figure 15 Bone selected

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3. Make sure the Properties panel is open (**Figure 16**).

4. Change one or more of the following properties:

- To enable *springiness*, drag the Strength and Damping scrubbers in the Spring section of the Properties panel. The higher the Strength, the more rigid the spring becomes. Damping determines how fast the spring is reduced: the higher the value, the faster the animation ends.

- To disable *rotation* of the selected bone around the joint, deselect the Enable option in the Joint: Rotation section of the Properties panel. To *constrain* rotation of a bone, select the Constrain option and then change the Min and Max values.

- To disable *translation*, deselect the Enable option in the Joint: X Translation and Joint: Y Translation sections of the Properties panel. Translation refers to how the bone stretches as the joint moves. To limit the amount of motion enabled along the x or y axis, select the respective Enable options and then change the Min and Max values in the respective sections of the Properties panel.

- To *pin* a joint in the armature (the junction between two bones), use the Selection to click on the arm of the bone to select it, and then select the Pin option in the Location section of the Properties panel. Pinning a bone locks the tail of the bone into place so that it does not move when manipulating the pose.
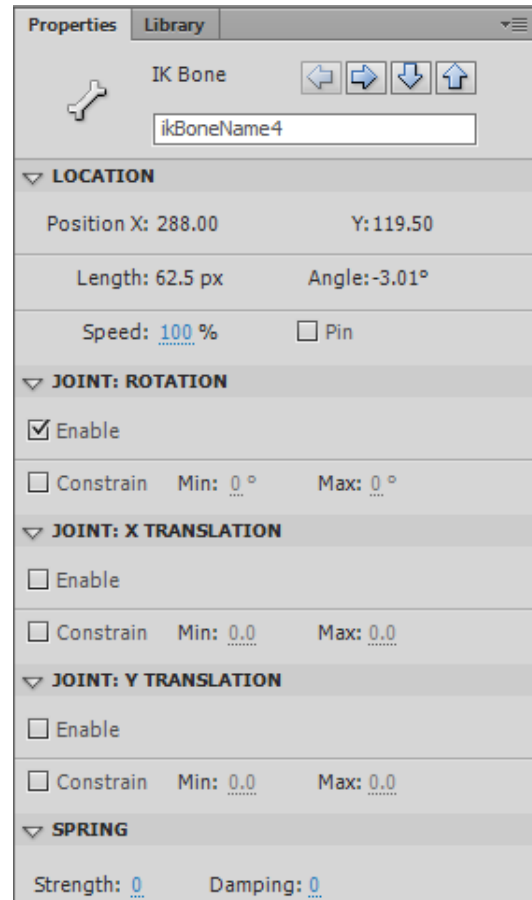
Figure 16 Properties panel

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