Chapter 17
Rigging Characters for Animation

By Erick Miller

When setting up a character for animation, you need to complete several tasks. This chapter discusses those tasks in relation to the *Parking Spot* project outlined in Chapter 3, "Digital Studio Pipeline," and explains why they're important.

Specifically, this chapter explains setting up a character for animation through revealing the step-by-step workflow involved with rigging the following setups in Maya:

- Quadruped spine and hips setup
- Quadruped IK legs and feet
- IK spline tail and ears setup
- Low-res stand-in geometry
- Control boxes hooked up to your character rig
- The advanced biped spine
- Stretchy IK legs and classic reverse foot
- Advanced IK arms and clavicular triangle
- An advanced additive hand and fingers
- Facial controls and blend shape deformers
- Eye controls
- Smooth binding proxy geometry
- Painting of smooth skin weights
- Painting of weights using per vertex selections
- Additional influence objects

Setting Up a Character for Animation

The very first step in creating a character setup rig is to research and gather the animation requirements of your character, including the types of motion the character has to achieve and the types of controls the character must have to fulfill these requirements.

Next, you should analyze the storyboards for the project and get a feel for what the specific shots might need. Also look into what kind of extra controls or capabilities might need to be added for each character or on a shot-by-shot basis.

Note

One important thing to keep in mind while reading this chapter is that the characters in the project are not necessarily supposed to be photorealistic. Instead, they're 3D puppets that an animator will be controlling in both realistic and unrealistic—and perhaps even cartooney—ways to act and tell the story.

Creating Clean Joint Hierarchies for Animation

Now comes the time to actually decide how the joints will be laid out for the characters according to their skeletal structures. This is the experimental time during which you can try out different things for overall joint placement without affecting anything. Joints in Maya are very versatile (see Figure 17.1); they enable you to create and arrange them in whatever form you please.

The next step is to draw the joints in 3D space. The best workflow for drawing your character's joints is to put the 3D view ports into 4-up mode by going to the Panels menu of the 3D view port window and clicking through to the menu item Panels, Layouts, Four Panes. Next, using the Joint tools found under the menu path Skeleton, Joint Tool, begin drawing your joints in one of the orthographic windows (either front or side, but not the Perspective view—it's much more difficult to control where the tool places the joints along a third axis in that view, so it's more difficult to place them accurately by simply clicking in the view window). As you click the first joint, look in the other orthographic windows to see where it appears in relation to your character. Now use the middle mouse button to drag the joint into place in the other orthographic windows.

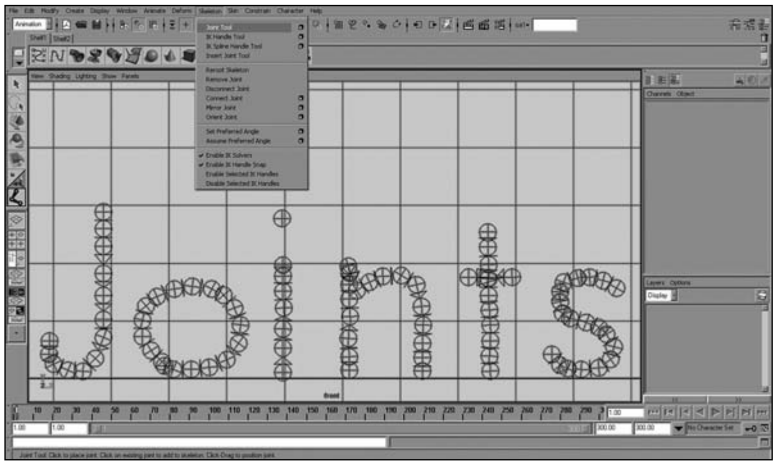


Figure 17.1 Joints are flexible.

After you have built your skeleton, you will need to orient the joints. Do this by selecting all your joints and using the Skeleton, Orient Joint menu command (see Figure 17.2).

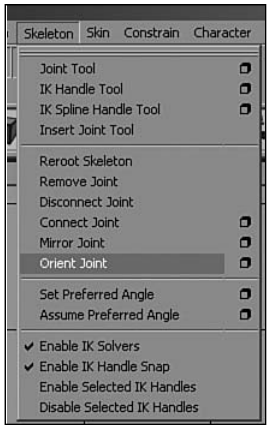


Figure 17.2 Choosing the Orient Joint command.

If you need to move or reposition any of your joints at any point before binding, use the Insert key with the Move tool activated. This enables you to move the joints without moving the children. Be sure to never rotate or scale your joints into place, and always translate them.

After you translate your joints, you need to be sure to rerun the Skeleton, Orient Joint command, or select the root joint of your skeletal hierarchy and execute the following command:

```
joint -e -ch -oj xyz;
```

When your joint positioning is final, select all the joints, go into Component mode by hitting F8, and activate the Local Rotation Axis option. Make sure that you rotate your rotation axis (using the Rotate tool) so that the same axis (probably the X axis) is always pointing down the joint and that the other two axes are pointing in the proper direction for intuitive rotations to take place when it is time to animate the character. Never rotate a local rotation axis on the axis that would cause it to no longer point "down" the bone of the joint. Figure 17.3 shows the local rotation axis while it is being edited.

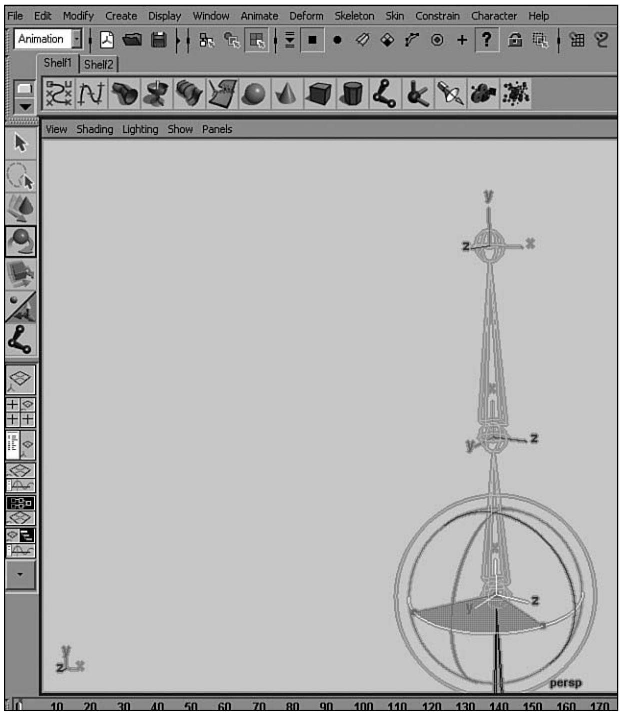


Figure 17.3 Setting local axis rotations.

Finally, after you have moved all your joints into place, oriented them correctly, and modified all their local rotation axes so that the rotations are perfect, you have only one more command to run. Select the top root of the skeleton hierarchies that you have just laid out and oriented, and perform the following command:

```
joint -e -ch -zso;
```

This zeroes out the scale orients and aligns the rest of the transform matrices associated with the joint to match the current orientation that you adjusted it to when you modified the local rotation axis. This is quite an important step, especially if you plan to translate or scale your joints. It is highly recommended that you perform this step when you are finished orienting all of your joints.

Figures 17.4 and 17.5 show the final laid-out skeletal structure of both characters in the *Parking Spot* project.

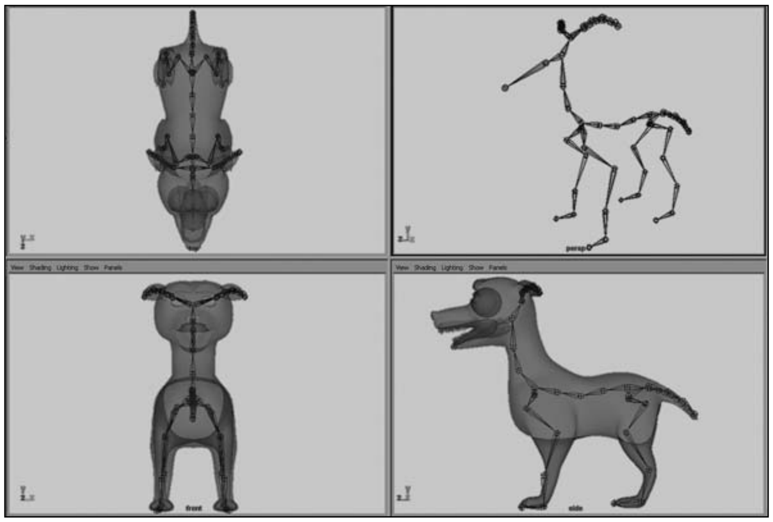


Figure 17.4 The laid-out skeletal structure for Spot.

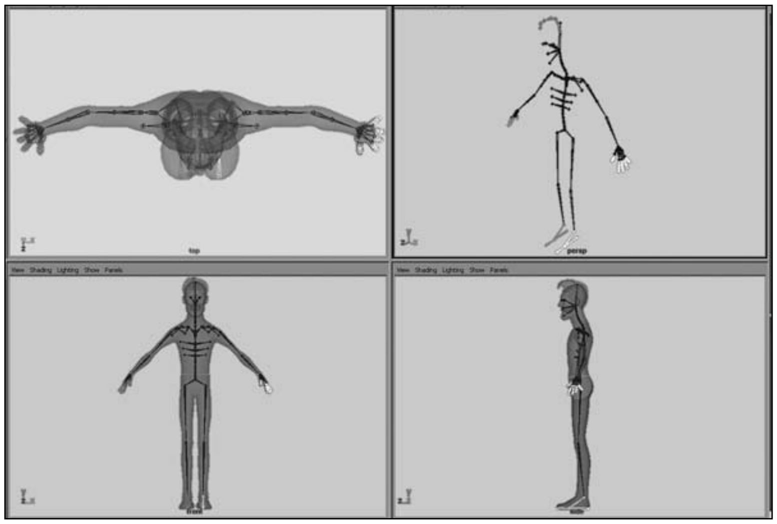


Figure 17.5 The laid-out skeletal structure for The Jerk.

Rigging a Simple Quadruped Character: The Dog

This section covers some simple techniques that you can use to quickly rig a quadruped character for animation, without having to add complex time-consuming or difficult-to-understand controls. Several advanced character setup tutorials later in this chapter go into much more detail on advanced character rigging. The techniques in this section can be used to quickly and easily get a quadruped character set up and ready for character animation.

For many characters, a simple setup is all you will need. As a general rule, it is best to keep your rigs as light and simple as possible so that they are easy to use and maintain throughout the duration of the animated piece. For hero characters whose animation might be the centerpiece of much of the shot or sequence, complex character controls could be necessary. It is the responsibility of the character setup TD to assess with the animators and supervisors of the scene what level of complexity the character's rig should have based on the complexity of the character's motion requirements.

Quadruped Spine and Hips Setup

Here we have built a simple FK spine that can be animated in a very straightforward and traditional fashion by rotating the joints.

As you can see in Figure 17.6, the spine is composed of only six joints, which are pretty much ready to have animation controls hooked up for them.

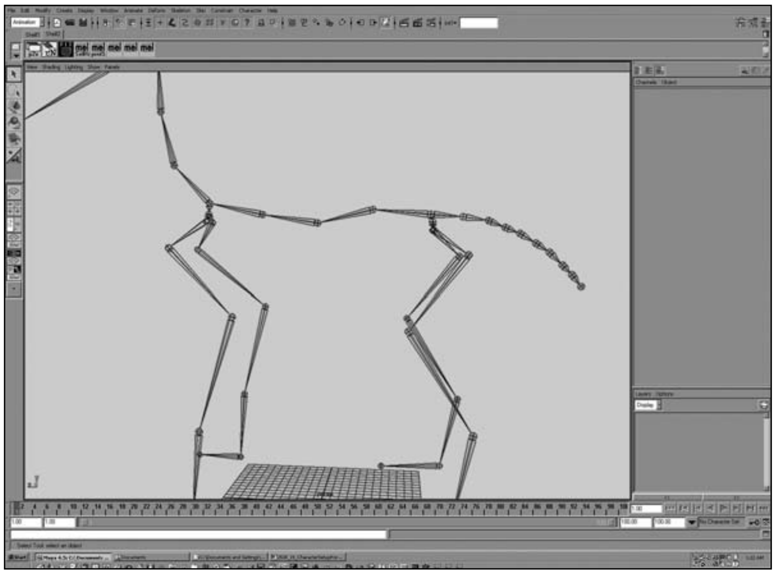


Figure 17.6 The spine is composed of only six joints.

The important part to notice in this portion of the setup is not really the spine itself, but the way the joints that create the spine are parents of the legs. The portion of the character's joints that starts the legs has an extra joint between the parent leg joint and the spine joint it is connected to. In the back of the character, this joint controls extra rotations of the hips. In the front, it controls extra rotations of the chest. Figure 17.7 shows how your spine hierarchy should connect to your legs using the extra hip joint between the hierarchies.

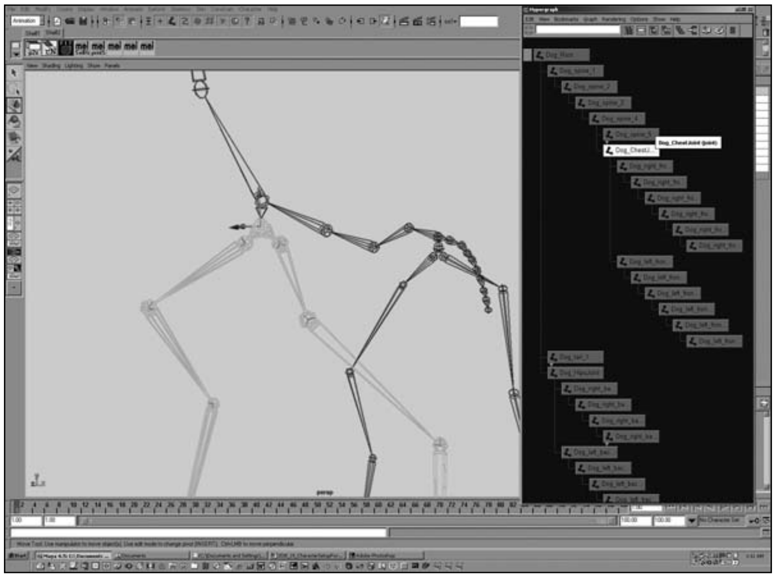


Figure 17.7 The spine hierarchy should connect to the legs using the extra hip joint between the hierarchies.

These joints are parented in this way so that the additional rotation control can hook IK onto all the legs and still rotate the character's hips independently. This concept of having additional parents in a hierarchy will undoubtedly come up many more times when it comes to rigging a character, so be sure to take note.

Quadruped IK Legs and Feet

The legs of the character are composed of four joints, stemming from the hips and the chest. The foot is a single joint that allows for rotation from the ankle (see Figure 17.8). A relatively simple foot control was chosen because our dog character will not need to have individual control over each toe and claw separately.

To make the IK controls for the legs, we created two IK handles for a single leg and hooked up a locator as a constraint to control the rotation of the ankle as well as the position of the IK handle for the foot. Follow along with this step-by-step exercise to see how we set up the first leg (the back right leg). You can quickly and easily set up the character's other three legs using the same technique outlined here.

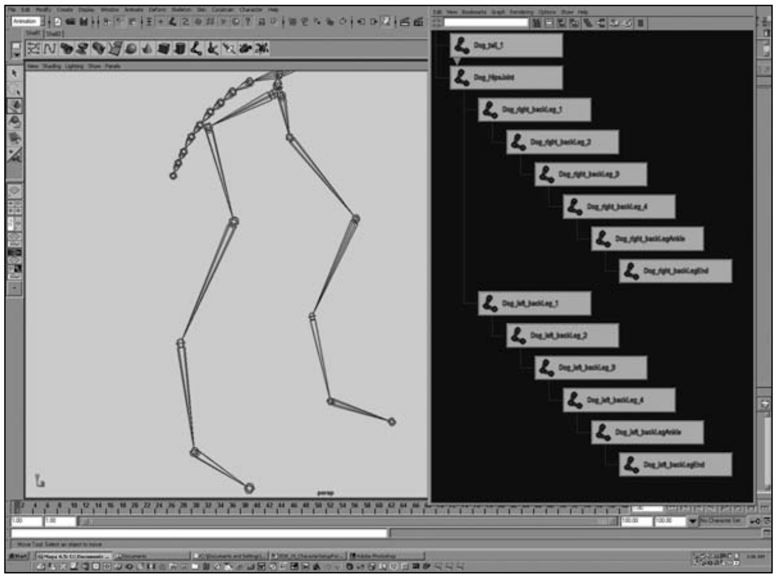


Figure 17.8 The legs of the character are composed of four joints, while the foot is a single joint that allows for rotation from the ankle.

Exercise 17.1 Creating Spot's Hind Right Leg

Begin by creating an IK handle between two joints.

1. Open the file Dog_SkeletalHierarchy.mb from the CD that accompanies this book. Use the IK Handle tool to create an IK handle from the Dog_right_backLeg_1 joint to the Dog_right_backLeg_3 joint. Name the new IK handle thighIkHandle, and freeze its transforms by choosing the menu command Modify, Freeze Transformations while it is selected.
2. Create another IK handle from the Dog_right_backLeg_3 joint to the Dog_right_backLegAnkle joint. Name this IK handle legIkHandle.
3. Create a locator by choosing the menu command Create, Locator. Point-snap it to the legIKHandle by selecting the Move tool, pressing the v key, and, while holding down the middle mouse button, dragging the locator to legIKHandle. Rename it footIkControl.
4. Create a null transform by clicking Ctrl+g with nothing selected. Next, point-snap the null to the legIkHandle using the v key, as before.

Now you will give this null transform the same orientation and transform axis as the Dog_right_backLegAnkle joint.

5. Select the null transform first, and then add to the selection Dog_right_backLegAnkle by holding the Shift key and clicking it (it needs to be last in the selection). Hit the p key to perform the parent operation. Next, perform the menu command Modify, Freeze Transformations. This zeroes out the transforms of the null and puts them into the space of the ankle joint (see Figure 17.9).

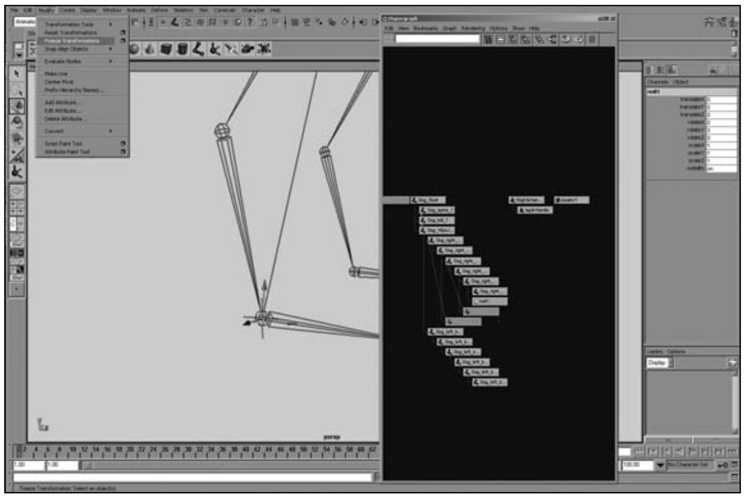


Figure 17.9 Clicking Modify, Freeze Transformations zeroes out the transforms of the null and puts them into the space of the ankle joint.

6. Now unparent this null joint back to the world level by selecting it and clicking the menu command Edit, Unparent.
7. Select and parent the footIkControl locator to the null transform node. Freeze the footIkControl node's transformations. It now has the same orientation as the ankle joint.
8. Next, select footIkControl and use the Shift key to add legIkHandle to the end of the selection list. Click Constrain, Point, select footIkControl and Dog_right_backLegAnkle, in that order, and click Constrain, Orient.

   You have just point-constrained the IK handle to this locator. You've also orient-constrained the foot so that rotating it rotates the foot and translating it moves the IK for the leg.

You are just about finished with the setup for the leg. One last step is to add a pole vector constraint.

9. Create a locator, and name it leg_poleVector. Now move it behind the back of the character's leg, on the side opposite the side of the leg that bends inward.
10. Next, select the leg_poleVector locator and legIkHandle, in that order, and click Constrain, Pole Vector.
11. Now just group the leg_poleVector locator all by itself (to add an additional transform above), and then point-constrain the group node to the Dog_HipsJoint node. Select this new group along with the remaining IK handles in the Hypergraph, as well as the null transform that is a parent of your foot control; group them together using Ctrl+g. Name the new group IkLegControls (see Figure 17.10).

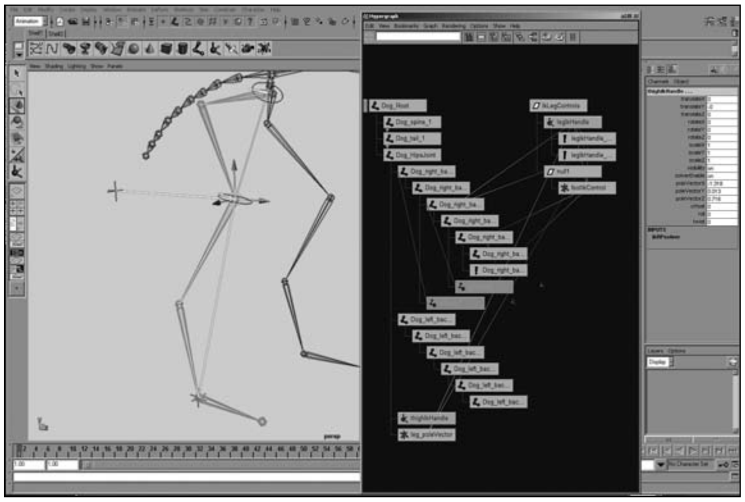


Figure 17.10 The new group, IkLegControls.

12. Repeat the previous steps for each of the other legs. This step-by-step process should go quite quickly when you get the hang of it.
13. When you are finished with all four legs, add prefix hierarchy names for each leg by selecting each node together for a single leg, clicking Modify, Prefix Hierarchy Names, and adding the prefix for that particular leg (for example, frontRightLeg_ and backRightLeg_).

14. Next, select all four of your legs' IkLegControls groups, group them together using Ctrl+g, and rename that group Leg_Controls.
15. Finally, group together the Leg_Controls and Dog_Root joint under a new group, and call it DogMainTransform (see Figure 17.11).

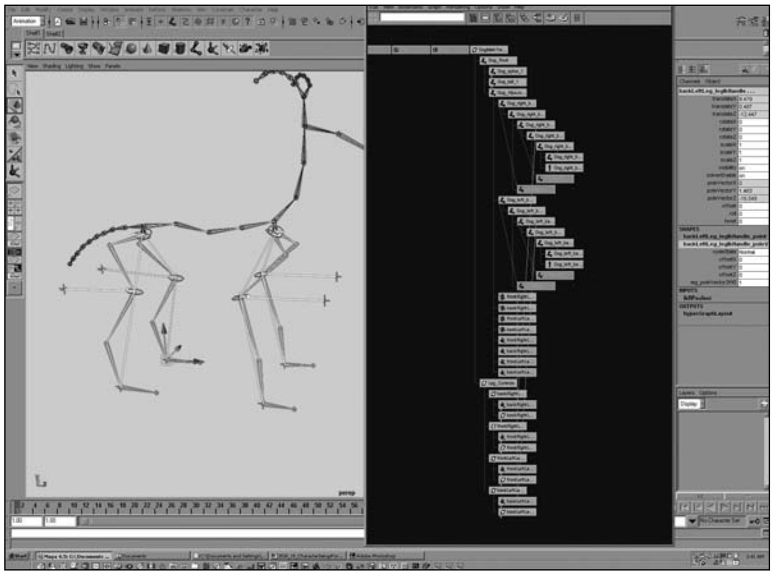


Figure 17.11 The finished legs set up for the dog.

The finished file with all the legs rigged is named Dog_LegsSetup_Finished.mb on the CD.

IK Spline Tail and Ears Setup

The technique used for the IK spline tail and ears setup is a very common combination of IK splines, with some added FK-style control. The technique you will use in the next exercise is basically to create a spline IK for the entire hierarchy of joints and then draw a low-res joint hierarchy right on top of where the IK spline curve was created (usually two to three joints is enough). Next, you'll simply smooth-bind the low-res joints to the IK spline curve. This is a nice way to get some FK feeling control and still have the ability to translate the joints for IK spline-style results.

Exercise 17.2 Character Setup for Spot's Tail and Ears

This exercise again is performed only on the tail. The exact same technique should then be used on the ears as well.

1. Start with the completed file from the last exercise, Dog_LegsSetup_Finished.mb, which you can find on the accompanying CD.
2. Go to the IK Spline tool by clicking the menu item Skeleton, IK Spline Handle Tool, Options Box. Hit the Reset Tool button at the bottom, and then be sure to uncheck the Auto Simplify Curve and Auto Parent Curve options.
3. Draw an IK Spline curve from the root of the hierarchy, all the way to the last joint in the hierarchy. In this case, it is a nine-joint tail; you create the spline handle starting from the Dog_tail_1 joint and ending at the Dog_tail_9 joint.
4. Next, using the Joint tool and holding down the c key to enter Curve Snap mode, draw a low-res four-joint hierarchy directly on top of the spline curve that was just autocreated by the IK spline tool.
5. Translate the new hierarchy upward just enough that it is not right on top of the other joint hierarchy, and rename each joint in the hierarchy TailControlJoint (see Figure 17.12).

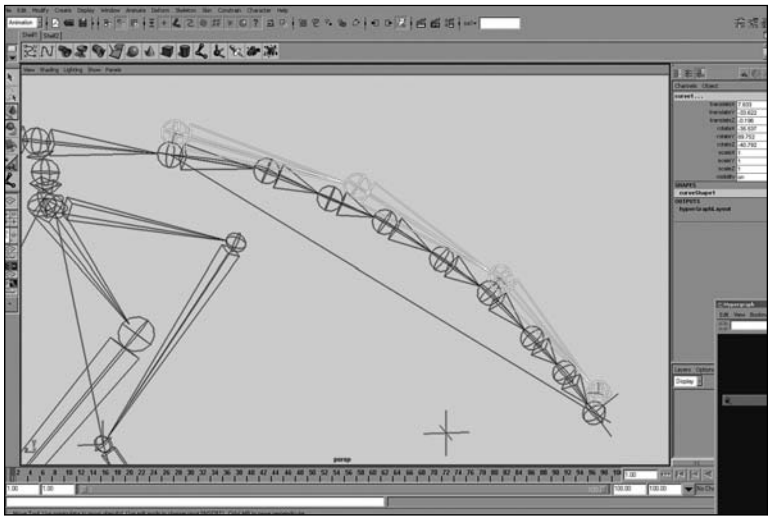


Figure 17.12 Creating a low-res control hierarchy.

6. Next, select the highest parent of the TailControlJoint hierarchy and Shift+select the NURBS curve that was created automatically by the IK spline tool. You might have to use the Hypergraph to select this curve because the joints are in the way.
7. With the current selection, click Skin, Bind Skin, Smooth Bind using the default options.
8. Select the root of the new low-res control hierarchy and parent it to the node that you want to rotate the real tail hierarchy that has the IK spline solver attached to it. In this case, I parented the new TailControlJoint hierarchy to the Dog_HipsJoint node so that when you rotate the hips, the tail wags along with them.
9. Perform these steps for both the ears. The steps are exactly the same.
10. When you are finished, group any ungrouped spline IK handles as well as spline IK curves under a new group node. Then put this group node somewhere in the character's hierarchy that will not have animation applied to it. In this case, I added a new group node to DogMainTransform and called it Dog_character. This group parents anything related to the character that should not be animated as a child of it.
11. Be sure to lock the translates, rotates, and scales of the Dog_character group node. Parent all the leftover IK controls and NURBS curves under the Dog_character group node.

    You can find the completed setup in the file Dog_TailAndEarSetup_Finished.mb on the accompanying CD.

Low-Res Stand-In Geometry

As the following exercise shows, creating stand-in geometry is a very simple process. This geometry is simply a low-resolution version of the actual character geometry, which is then cut up into a separate piece per joint using a combination of the Cut Poly Faces tool and the Poly Separate command. The cut polygon pieces are then simply made a child of the joint that they correspond to. Now, the low-res geometry moves with the joint hierarchy but is not bound or deforming, so it is extremely fast and interactive for the animator to use.

Exercise 17.3 Creating Low-Res Stand-In Geometry

For this exercise, you begin with the finished file from the previous exercise, Dog_TailAndEarSetup_Finished.mb, which you can find on the accompanying CD.

1. Import into the Dog_TailAndEarSetup_Finished.mb file the low-res dog file, called Dog_lowResPolyStandIn.mb, which you'll find on the accompanying CD (see Figure 17.13).

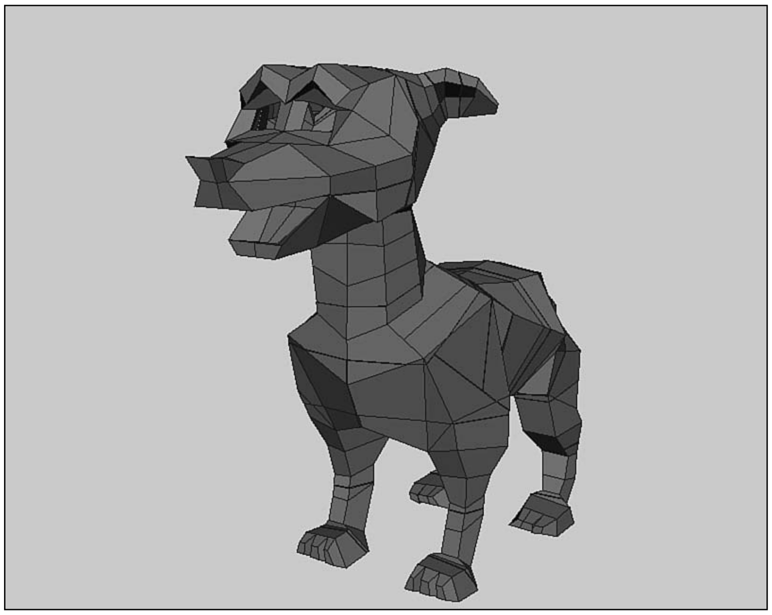
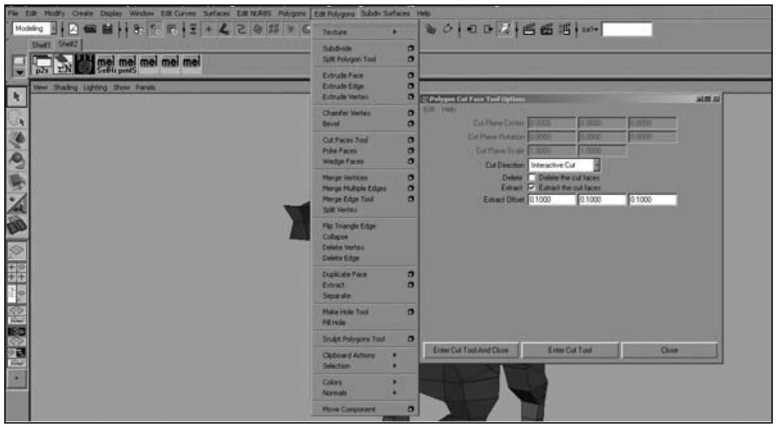


Figure 17.13 A low-res version of the character model is used for the low-res stand-in geometry.

2. Take a look at the joint hierarchy of the dog, and start to figure out where you want to cut your low-res poly object into separate pieces. A general rule is that you will need to cut your character in any place that it will need to bend, or any child that will need to rotate independently from its parent to achieve the articulation of the character's pose.
3. Select the low-res polygon character. Activate the Cut Poly Faces tool by clicking Edit Polygons, Cut Faces Tool (it might say just Cut Faces, depending on your tool settings) Option Box (see Figure 17.14).



Polygon Cut Face Tool Options

Cut Plane Center 0.0000 0.0000 0.0000
Cut Plane Rotation 0.0000 0.0000 0.0000
Cut Plane Scale 1.0000 1.0000
Cut Direction Interactive Cut
Delete ☐ Delete the cut faces
Extract ☑ Extract the cut faces
Extract Offset 0.1000 0.1000 0.1000

Figure 17.14 Select the low-res polygon character, and activate the Cut Poly Faces tool.

4. Now, with the options from the previous figure, drag your mouse across the geometry and watch as the Cut Faces tool creates a straight line across your geometry. This is where the polygons will be cut when you release the tool. Cut the polygons. Experiment with where you are cutting the geometry and how well it lines up with the location of the joint.
5. Next, after you have cut the polygon, perform the menu commands Edit Polygons, Separate and then Edit, Delete by Type, History.
6. Cut the geometry into a separate piece for each joint, trying not to cut across other parts of the geometry that shouldn't be split yet. Then, each time you cut, separate the polygons and delete the history. Eventually, you will be finished cutting up the entire geometry.
7. Next, one by one, select each polygon piece that you cut, and Shift+select the closest joint that you cut that piece for. Hit the p key on your keyboard to parent the geometry to the joint. Do this for each separate piece that you cut for the character.

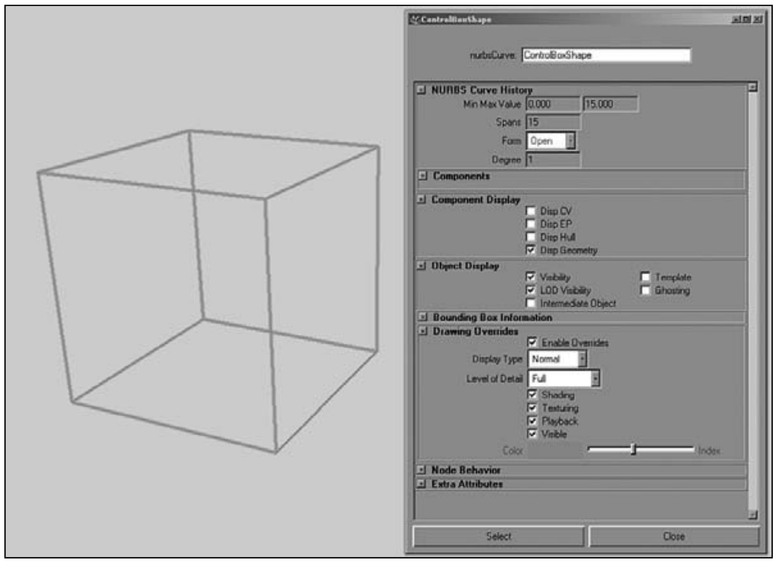
   You can find the finished file with the low-resolution stand-in character properly cut and parented in the file Dog_LowResStandIn_Finished.mb on the accompanying CD.

Hooking Up Control Boxes to Your Character Rig

Control boxes are the visual handles that the character animator uses to animate the character. The control boxes are an extra layer of setup hooked up to your skeleton's joints, IK, and hierarchical controls to give the animator a simple and intuitive way to see and select all the controls for your character that are meant to be animated. All the translation and rotation of your character should happen on character control boxes, not on random locators or selection handles that are difficult to see or select.

Control boxes can be made of NURBS curves or of polygon objects that have been disconnected from a shader. NURBS curves are the most common choice because you can isolate them for selection while animating using the NURBS Curve option in the Object Mode Pick Mask menu. You can also quickly view them on or off with the Show NURBS Curve option of the Show menu of your current 3D view port window (or from the HotBox).

Open the file CharacterControlBox.mb on the accompanying CD to see exactly what a control box is. As you can see, it is just a NURBS curve that has been shaped so that it creates a cubelike box shape—hence the name control box (see Figure 17.15). Control boxes can, of course, be any shape and size (because they are just NURBS curves), and the CVs of the curve itself can always be hand-tweaked to produce the correct shape.


ControlBoxShape

nurbsCurve: ControlBoxShape

NURBS Curve History
Min Max Value: 0.000 15.000
Spans: 15
Form: Open
Degree: 1

Components

Component Display
☐ Disp CV
☐ Disp EP
☐ Disp Hull
☑ Disp Geometry

Object Display
☑ Visibility ☐ Template
☑ LOD Visibility ☐ Ghosting
☐ Intermediate Object

Bounding Box Information

Drawing Overrides
☑ Enable Overrides
Display Type: Normal
Level of Detail: Full
☑ Shading
☑ Texturing
☑ Playback
☑ Visible
Color Index

Node Behavior

Extra Attributes

Figure 17.15 A control box.

You can hook up a control box to a rigged character in several ways. Basically, the main goal is to in some way connect the transformation controls of the control box into the transformation controls of the character rig. You can achieve this through expressions, complex node networks, or just simple constraints or parenting relationships.

The most common and straightforward methods for hooking up control boxes to your character are the following:

- **Transform (object) parenting**—Simply parent your control as a child of your control box. This works easily and efficiently for things such as IK handles and constrained locators, as well as groups that are meant to control translation or rotation.
- **Shape parenting**—You do this by parenting the NURBS curves' shape nodes (not the transform, but the shape, which you have to load into the Hypergraph and graph input and output connections to see and select). Making the NURBS curve shape a child of the actual transform that you are trying to hook up the control box for enables you to use the curve as a selection handle for the actual joint or hierarchical animation control.

  You can do this by first point-snapping the NURBS curve to the joint that you want to hook it onto. Next, parent the NURBS curve transform to the joint and click Modify, Freeze Transformations on the NURBS curve. Select the NURBS curve shape. (Make sure the node says Shape at the end, in Hypergraph, Graph, Input and Output Connections. Also be sure you have the shape selected, not the transform.) Then Shift+select to add to the current selection the joint (or any other transform node) that you want to hook up the NURBS curve as a selection handle for. Then perform this MEL command:

  ```
  parent -r -shape;
  ```

  This parents the NURBS curve shape node under the transform for the joint. Now you should be able to select the curve in the view port window, but in actuality you are selecting the transform of the object that you just parented the NURBS curve shape onto.
- **Grouped control boxes with constraints**—Create a group node that has the same orientation and translation space as the joint or node that you are hooking up the control box. Then make this node the parent of your control box. You then freeze transforms on the control box and point-constrain it to the

joint that you are hooking up to. Orient-constrain the joint to the control box so that it controls the rotations.

You can create a group node that has the same orientation and translation space as the joint or node that you are hooking up the control box to in two different ways. First, you can create a null transform by selecting nothing and then hitting Ctrl+g. Next, you can give the null the same transform pivots as the joint or node you are trying to hook up to. You do that in two ways:

  - Point-, orient-, and scale-constrain the null transform node to the joint. Then immediately delete the constraint nodes to give the null transform node the same transform space as the joint.
  - Point-snap the null transform node directly on top of the joint. Then temporarily parent the null to the joint, freeze transforms on the null, and unparent it back into its original hierarchy to give the null transform node the same transform space as the joint.

- **Grouped control boxes with direct connections**—Create a null group node, and point- and orient-constrain it to the parent node of the actual joint or transform that you are trying to hook the control box onto. Next, create a group node that has the same orientation and translation space as the joint or node that you are hooking the control box up to; make this node the parent of your control box. Parent your control box group node under the constrained null. Then freeze transforms on the control box and open the Connection Editor. Load the NURBS curve's rotates on the left side and the joint's rotates on the right, and directly connect them to one another so that the control box is driving the rotations of the joint. Even though they are directly connected, they will always move together properly because the parents are linked with constraints and the nodes are both in the same transform space.

Connecting your control boxes is really a crucial element of rigging your character because it is one of the last steps before your character is ready for animation testing. treat the process of hooking them up to your character accordingly. One thing to remember, though, is that it really doesn't matter how you get your control boxes hooked up to control your character, as long they work correctly and move the correct nodes around. Sometimes on simple characters you can get away with purely parenting techniques or direct connections alone (which is perfectly acceptable). Another good idea when it comes to hooking up your control boxes is to keep the translates and rotates of the control boxes transforms capable of going back to zero as the default attribute state. Therefore, if you need to move, scale, or position your control box, simply enter Component mode and shape it using the control vertices. This also usually means freezing the transforms before actually going through the process of connecting the box to control a joint or other transform node.

Also remember that control boxes are simply used to select animation controls for your character and to move the character around. The goal of these controls is that they be immediately accessible and selectable from any view. Sometimes it is difficult, but do whatever you can to make the controls easy to see and select from most angles. This includes making controls somewhat uneven in shape or asymmetrical, as well as color-coding so that if one is right on top of the other, it is still quite intuitive to differentiate between the two control boxes.

Here are a few easy ways to color-code your control boxes in Maya:

- By clicking Display, Wireframe Color with the object selected, you can easily change the color of just about any object without modifying attributes that other parts of Maya directly use to change the color of the node as well (such as the Layer Editor).
- Open the Attribute Editor of the node and expand the Object Display frame layout. Then expand the Display Overrides subsection of the Object Display layout. Next, turn on the check box that reads Enable Overrides. Now the lower section that reads Color becomes enabled, and you can drag the slider and choose any color that you want.
- Simply make a layer and assign your objects to that layer. Then just change the layer color. This is the least preferred method because you really don't want to have to make a layer for every single object whose wireframe color you want to change.

Note

Changing the wireframe display color affects only the OpenGL display of the node, not any look or color attributes of the shader or the software-rendered elements. However, it affects the "hardware"-rendered wireframe color.

Figures 17.16 and 17.17 show the control boxes for The Jerk and Spot models, respectively.

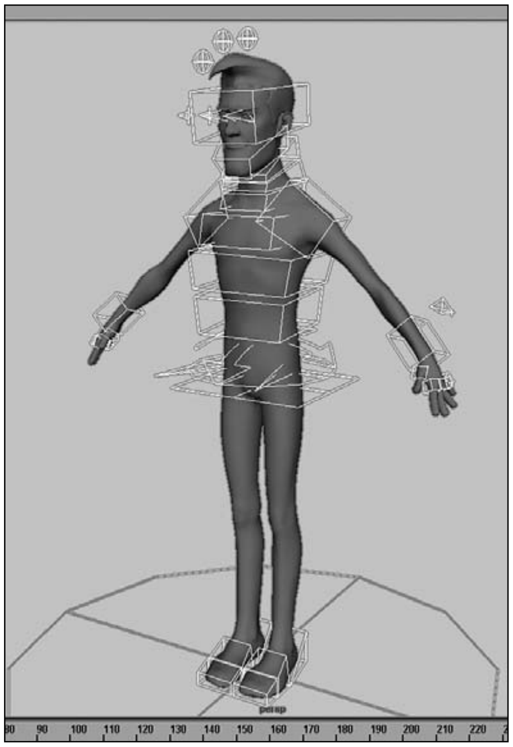


Figure 17.16 The control boxes for The Jerk.

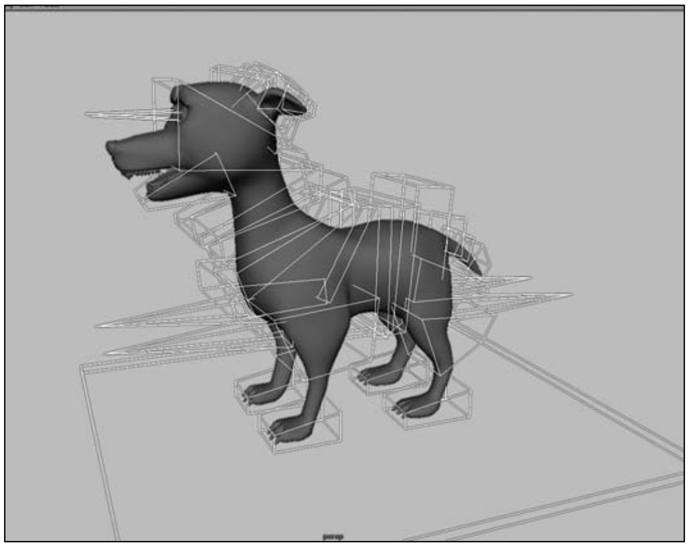


Figure 17.17 The control boxes for Spot.

Creating Advanced Bipedal Character Controls

This section covers several more advanced approaches, some that lend themselves very nicely to the stretching characters into any pose needed by the animators. We know that our human character will need to stand on two feet, sit down and drive a car, get sprayed by a fire hydrant, get knocked down, and interact with several objects and props in his environment. The fact that the character might need to be animated with a touch of cartooned style, per his character design, is also a consideration for the design of the controls. A special type of rig involving a stretchy spline IK setup that reacts with the intuitive controls of an FK hierarchy will be used for the back (spine) of The Jerk. It will give him the ability to stretch his back evenly, similar to the real stretching ability of a spine. It will also allow normal, traditional FK-style rotations of the controls for certain poses that should not be controlled by an IK rotational element. The ability to stretch more than would be anatomically correct will exist, and it will be the animator's job to decide how much the back will stretch, bend, and so on.

The legs of the character will be rigged using IK because The Jerk will need to stick mostly to the ground for walking. The arms will also be rigged using IK, but a simple IK parenting technique will be used to allow for FK-style rotation of the shoulders, as well as IK-style translation placement for The Jerk's clavicle and hand. This will give the character animator full control to pose the characters. Both the arms and the legs of The Jerk will have automatic stretching built into their IK rigs as well. This adds another level of control for the animators, especially when sticking the feet or hands onto objects, because the legs and arms will actually stretch to any length to meet the placement of the hands or feet.

The Advanced Biped Spine

Let's start the first advanced character setup exercise with creating what I have coined "the Divine Spine." There has been much talk about spine controls over the years, and several techniques in Maya lend themselves to achieving promising results, but these techniques are missing key elements from other styles of rigging that many animators and riggers prefer. Thus arises the basic dilemma of character rigging: How do you really manipulate the transformation space to achieve the ultimate combination of motion capabilities, while still successfully maintaining straightforward ease of use and production-level stability?

This advanced spine setup solves many, if not all, of the problems that certain preexisting techniques for spine setups contain. It also combines the best of both FK controls and IK controls, which enabling the animator to operate in both FK and IK seamlessly at the same time while animating the character. No uncomfortable or unintuitive switching on and off of weighted attributes is required. I designed the Divine Spine setup with these requirements:

1. Be able to move the hips of the character without changing the location or moving the shoulders, and be able to move the shoulders without changing the position of the hips.
2. Still be able to grab a control and rotate it in any direction. It should intuitively rotate the character's back hierarchically as if it were a simple FK joint hierarchy.
3. Be able to grab the same character control and translate it, and intuitively translate the character's spine like a spline IK setup.
4. Be able to compress and stretch uniformly between vertebrae when the controls are animated.
5. Be controlled by a minimal number of control joints, yet still allow for a large number of actual spine joints.
6. Be stable, predictable, and production-worthy. It should not use some forced mathematical function to compute secondary motion that will make the animator "fight" with the motion.

This spine setup is a versatile approach and can be used effectively to rig extremely realistic spine controls as well as cartooney ones.

Without further ado, let's begin.

Exercise 17.4 The Divine Spine Setup

1. First, create your joint hierarchy and orient the joints. I usually use a total of 12 to 18 joints for the base hierarchy of the spinal column, but you can use more or less, depending on your character's requirements. For this setup to work properly, you must be sure of the following things:

- Scale Compensate is turned on in the Joint tool options before you draw your joints.
- All your joints have been properly oriented before proceeding, with the Scale option checked on in the Orient Joint options window before you perform the Orient Joint operation (see Figure 17.18).

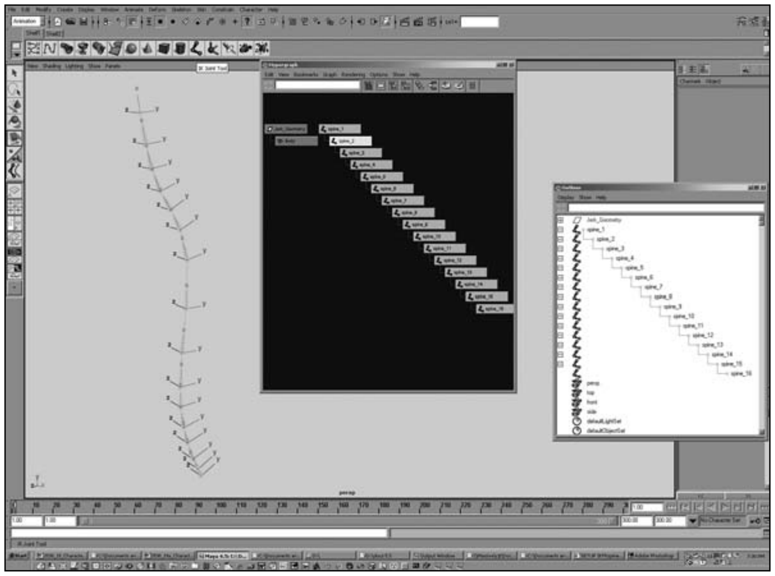


Figure 17.18 Make sure Scale Compensate is turned on and that you properly orient all your joints before proceeding.

Note

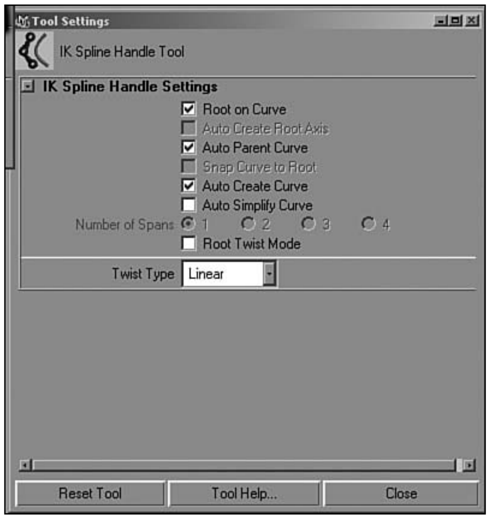
If you prefer to start with a precreated joint hierarchy, you can open the file Jerk_DivineSpine_Begin.mb on the CD that comes with this book.

2. Create a spline IK handle from the first to the last joints in the hierarchy using the Skeleton IK Spline Handle Tool options. Make sure that Auto Simplify Curve is turned off in the spline IK options (see Figure 17.19).
3. Select the spline IK curve that the IK Spline Handle Tool created for you automatically. Then create a curve info node by executing the following MEL command in the command line (by all probability, your curve might actually be named curve1):

   ```
   arclen -ch on;
   ```

4. Select the Spline IK curve, open the Hypergraph, and select the menu item Graph, Input and Output Connections to view upstream in the Hypergraph.

   You should see a node attached to your curve called curveInfo. This node contains the length of your curve (see Figure 17.20).



[✓] Root on Curve
[ ] Auto Create Root Axis
[✓] Auto Parent Curve
[ ] Snap Curve to Root
[✓] Auto Create Curve
[ ] Auto Simplify Curve
Number of Spans [✓ 1] 2 3 4
[ ] Root Twist Mode
Twist Type: Linear

Figure 17.19 Make sure that Auto Simplify Curve is turned off in the spline IK options.

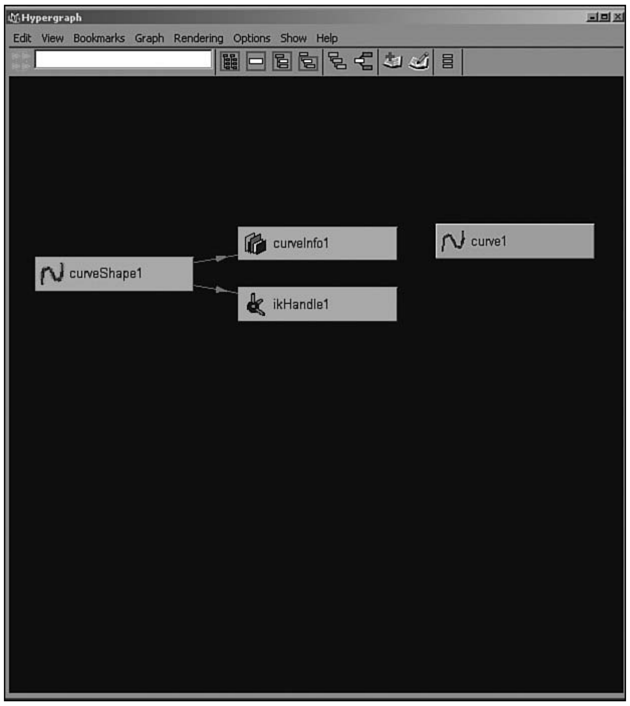


Figure 17.20 The curveInfo node contains the length of your curve.

5. From the Utilities tab of the createRenderNode window (accessible from the menu path Create, Create New Node in the Hypershade), create a multiplyDivide node.
6. Double-click the multiplyDivide node to display the Attribute Editor and set Operation to Divide. Open the Hypergraph and display the input and output connections along with the spline IK's NURBS curve (see Figure 17.21).

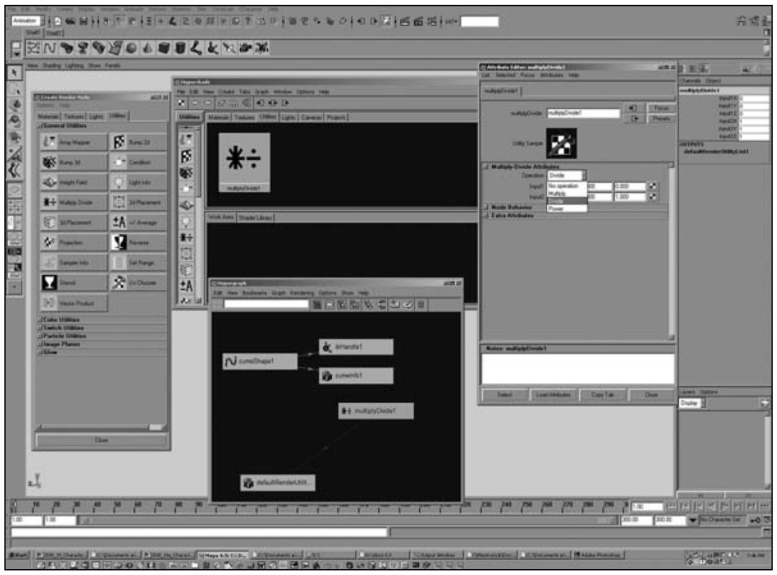


Figure 17.21 Switching the multiplyDivide node's Operation attribute to Divide mode in the Attribute Editor.

Note

If at any time you lose sight of your utility node (such as multiplyDivide) and you can't seem to find it for selection, you can usually find it in the Hypershade window's Utilities tab. If this fails (because the node isn't connected to the defaultRenderUtilityList), you can always select all the nodes of that type or with that name, and then find the one you want by using MEL and either node type or wildcard name using the `select` command.

To select by node type, execute this MEL command:

```
select -add `ls -type multiplyDivide`;
```

To select by wildcard name, execute this MEL command:

```
select -add "*multiplyDivide*";
```

You can then click Graph, Input and Output Connections and see all the nodes you are looking for. This easy technique works for any node type or node name in your Maya scene, by the way.

7. Next, open the Connection Editor, load the curveInfo node in the left side, and load the multiplyDivide node on the right.

8. Figure out which axis is pointing down your joint hierarchy so that when you scale your joints, they scale along the axis that is pointing toward the next child joint. This determines which attributes you connect in the next step. For this example, if you used the default xyz for the Orient Joint command, the axis you need to use to connect will be the X axis (see Figure 17.22).

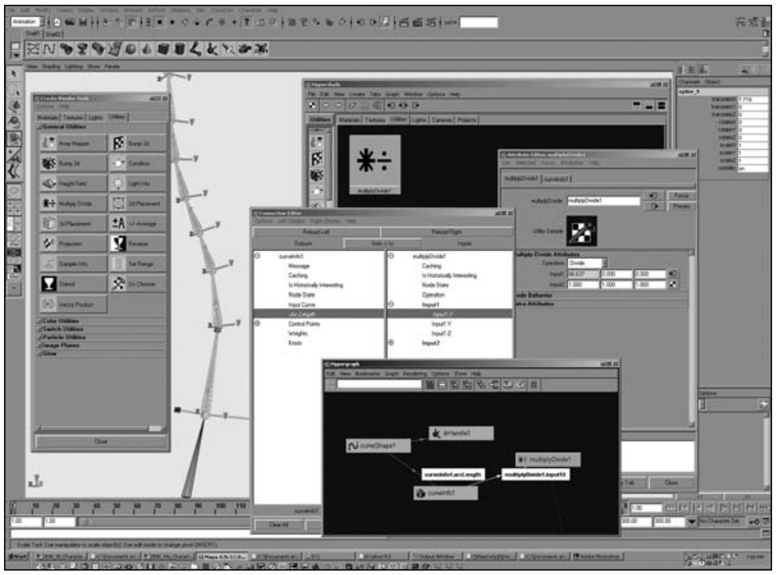


Figure 17.22 Connecting the curveInfo node with the Orient Joint command.

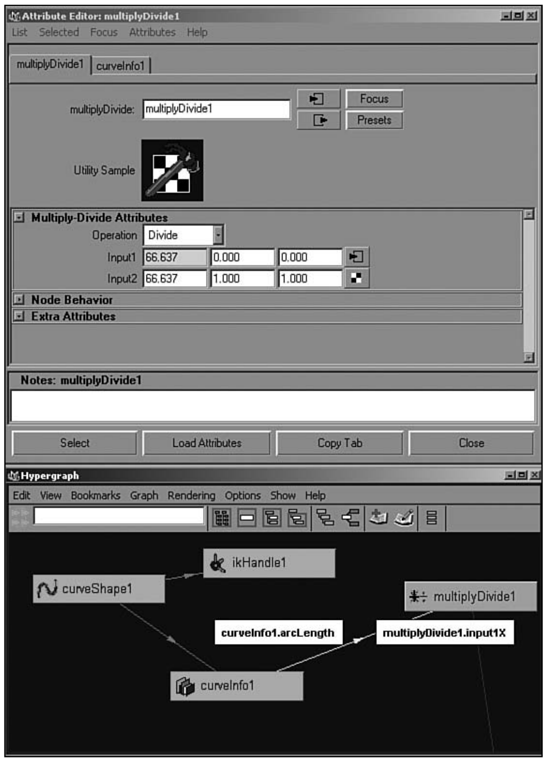
9. Connect the arcLength attribute of the curveInfo node to the multiplyDivide node's input1 attribute. Be sure to use the axis (X, Y, or Z) that your joint should scale along—you took note of this in the last step. For this example, use input1X.

10. Now look at the number that is in the multiplyDivide node's input1 attribute (by looking at the yellowed number in the Attribute Editor). In this case, it is 66.637. This is the output value of the arcLength, which returns the current length of your spline IK curve's length. If the spline's curve length changes (by pulling CVs or deforming it in some way), this arclen node will continue to update the curve length and feed the current new distance into the multiplyDivide node.

Now you want to create a normalized ratio that represents the amount that the curve length is scaling (if a CV of the curve gets moved) to drive the scale attribute of each joint in the hierarchy. This is easily achieved by dividing the current distance (the yellow one) by the initial distance before the deforming took place. So, as common sense would dictate, the output at the default state always equals a scale of 1. The curve has not yet been deformed, so the current distance just happens to also be exactly what you need for the initial distance.

11. Copy/paste the attributes from the yellow input attribute of your multiplyDivide node (the curve's current length) into the corresponding input2 channel directly below in the Attribute Editor for the correct division action to take place.

This results in a value that will represent the amount by which the joint's length should be changed to approximate the curve's current length. You can then simply use this to drive the scaleX attribute of each joint (see Figure 17.23).



multiplyDivide: multiplyDivide1

Operation Divide

Input1 66.637 0.000 0.000

Input2 66.637 1.000 1.000

Notes: multiplyDivide1

Figure 17.23 Resulting value that represents the length that the joints will be changed to.

12. Open the Connection Editor again, load the multiplyDivide node on the left and the joints on the right, and then connect the multiplyDivide node's division outputX attribute into each joint's scaleX. Skip the very last joint in the hierarchy (the bottommost child at the tip). Because it is the very last end joint, it doesn't need to have any scale attached (see Figure 17.24).

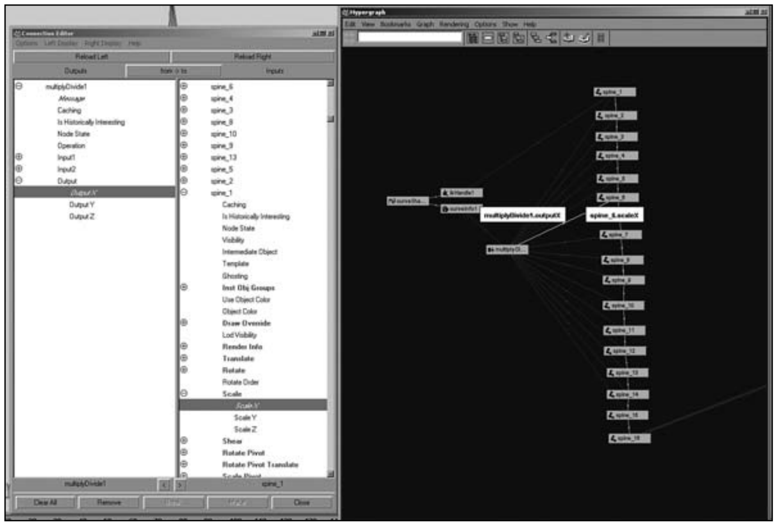


Figure 17.24 In the Connection Editor, connect the multiplyDivide node's division outputX attribute into each joint's scaleX.

Now you will create a second skeleton hierarchy. This will be the low-res, control joint hierarchy that controls all the high-res spine's motion through a series of binding and weighted pole vector constraints. Usually about four to six joints will do just fine for this low-res hierarchy.

13. Create the joints, and make sure they are spaced evenly and are placed in the locations that you want the back to pivot and bend from. Also make sure that they are placed directly on top of the spline IK curve by using the Joint tool with holding down the c key; this activates Curve Snapping mode while drawing your joints directly on top of the spline IK curve. Make sure that the new low joint count hierarchy that you just built has the same start position as the spline IK's root and has a similar end position as the very last child joint in the spline IK hierarchy.

14. Make sure you are happy with the orientation and placement of your new low-res joint hierarchy; reorient these new low-res spine joints, if necessary. Click Modify, Prefix Hierarchy Names to rename this new joint hierarchy with the prefix lowRes_Control_ (see Figure 17.25).

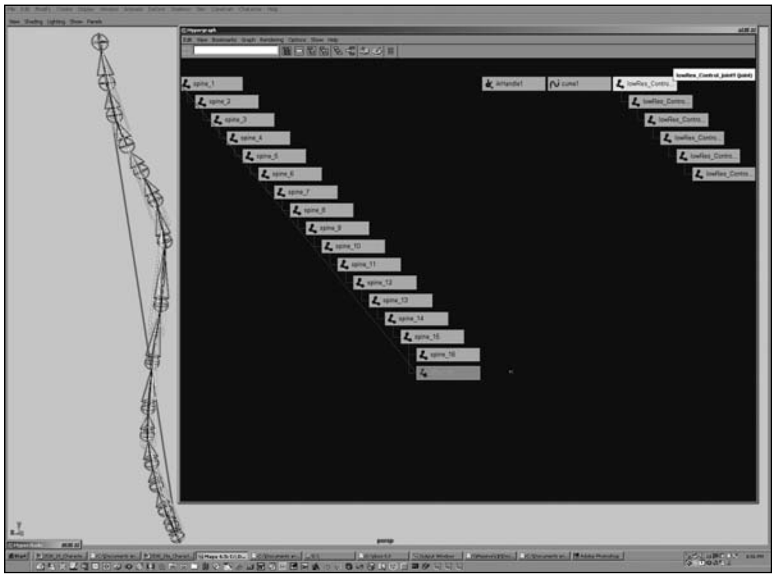
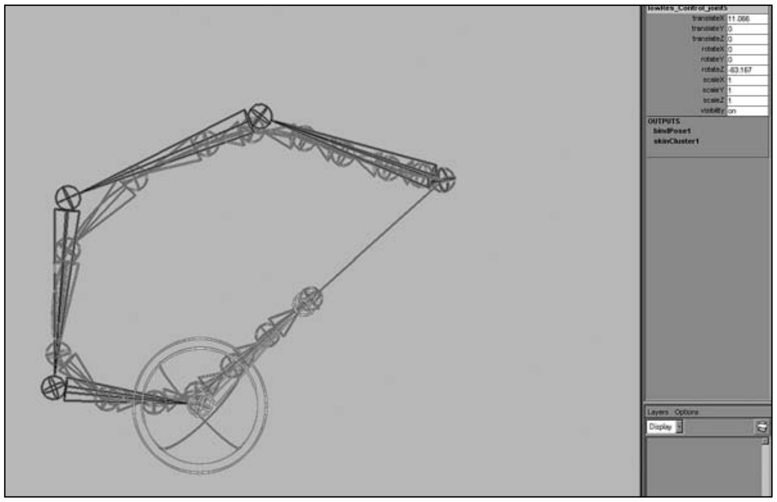


Figure 17.25 Rename the low-res joint hierarchy.

15. Now select the spline curve and Shift+select the lowRes joint hierarchy's root. Smooth-bind the curve to the lowRes joint hierarchy.

16. Test how the low-res joint hierarchy bends your spline IK setup so far. If you are unhappy with the arc or curve of the bend, hit Undo (the z key) a few times until you are back to the point where you can start rebuilding your low-res joint hierarchy. Do this test a few times until you get the right placement and number of joints for your low-res joint hierarchy (see Figure 17.26).

17. Next, even out the weighting of your smooth bound curve by distributing the curve's CV weights more evenly across the joints. Do this by selecting the CVs of the curve and using the Smooth Skins tab under General Editors, Component Editor. Modify the weights by changing some of the values at 1 to .5, or .75, depending on how close they are to the neighboring joint (see Figure 17.27).

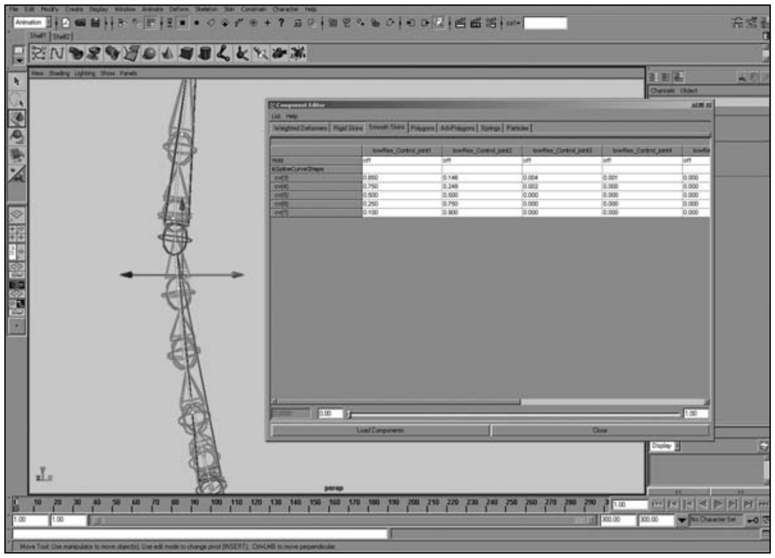


lowRes_Control_joint5

translateX	11.066
translateY	0
translateZ	0
rotateX	0
rotateY	0
rotateZ	-63.167
scaleX	1
scaleY	1
scaleZ	1
visibility	on

OUTPUTS
bindPose1
skinCluster1

Figure 17.26 Testing the low-res joint hierarchy on the spline IK setup.



Component Editor

	lowRes_Control_joint1	lowRes_Control_joint2	lowRes_Control_joint3	lowRes_Control_joint4	lowRe
Hold	off	off	off	off	off
ikSplineCurveShape					
cv[3]	0.850	0.146	0.004	0.001	0.000
cv[4]	0.750	0.248	0.002	0.000	0.000
cv[5]	0.500	0.500	0.000	0.000	0.000
cv[6]	0.250	0.750	0.000	0.000	0.000
cv[7]	0.100	0.900	0.000	0.000	0.000

Figure 17.27 Using the Component Editor to modify the weights.

Now the problem you have is that the spline IK hierarchy bends and compresses really nicely, but it doesn't twist (due to the nature of the spline IK solver's pole vector). Although the spline IK solver has a rotation plane implemented and is controllable by using the twist attribute, you don't want to use this attribute to drive the twisting of the spine—it will violate the intuitive control that an animator expects to have when he rotates one of the single joint controls of the low-res skeleton. At this point you really need a rotate plane at every single joint, which has a weighted average to control the twisting of the spine based on the twisting of the low-res control joints. Unfortunately, the spline IK allows only a single rotate plane that is distributed evenly over the entire hierarchy.

So, in the following steps you will create yet one more hierarchy of joints. This time it will be an exact duplicate of the spline IK hierarchy—but *without* the spline IK and *with* a weighted pole vector–constrained ikRPsolver IK handle at every single joint.

18. Select the root joint of the original spine's spline IK joint hierarchy and duplicate it using the default duplicate options. Delete the unused effector node in the new duplicated hierarchy, which got duplicated from the other spline hierarchy. (Make sure you delete only the effectors of the duplicated hierarchy, not the effector that the IK spline solver is connected to.)

19. Click Modify, Prefix Hierarchy Names to rename this duplicated hierarchy to have a new prefix of Ik_Bind_Spine_. This is the spine that the character mesh eventually will be bound onto (see Figure 17.28).

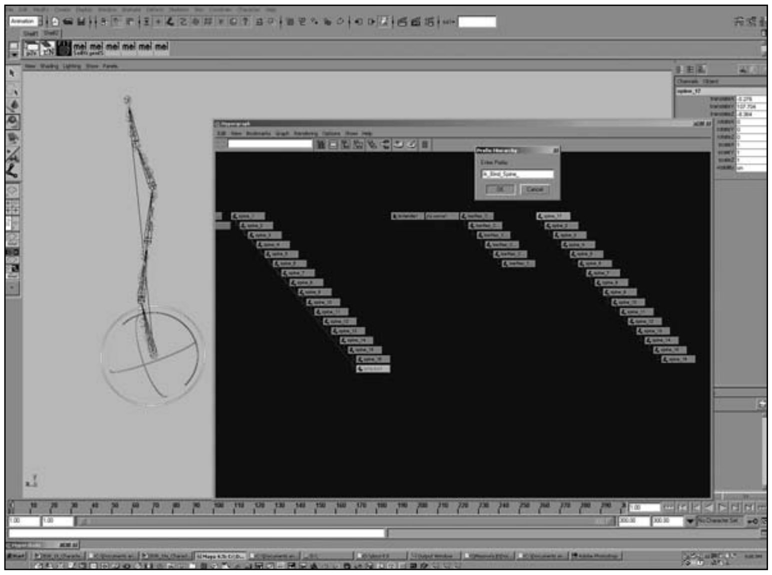


Figure 17.28 This is the spine that the character mesh eventually will be bound onto.

Note

This situation will result in the creation of three hierarchies in the end. One of them (the one you just duplicated) will have the character's skin bound to it and will be partially controlled by the original stretchy spine splineIk hierarchy. These two hierarchies will need to stay unparented from any group that will transform with the character because these two hierarchies will be entirely controlled by the lowRes spine that is currently smooth-skinned to the spine's spline curve. If you transform the bound IK spline hierarchy as well as the low-res control spine, you get double transforms. I discuss this later, but hopefully this helps enlighten things a little bit more for now.

20. Translate this duplicated Ik_Bind_Spine_ hierarchy's root node away from the spline IK hierarchy so that this whole situation isn't completely confusing when you try to select and rig up your joints in the 3D view window.

You now want to create rotate plane IK handles at each joint of the new Ik_Bind_Spine_ hierarchy by starting with the root and then making an IK handle that is *a single joint long* using the IK Handle tool.

21. Select the first joint and then the very next joint in the hierarchy going up the spine. Then start the next IK handle's base at the end location of the previous IK handle that was just created; continue this process until the end of the spine hierarchy is reached (see Figure 17.29). This procedure should exactly result in the same number of IK handles as there are joints in your hierarchy, minus one—the only joint that does not have an IK handle stuck directly on top of it should be the root (which will later be point-constrained).

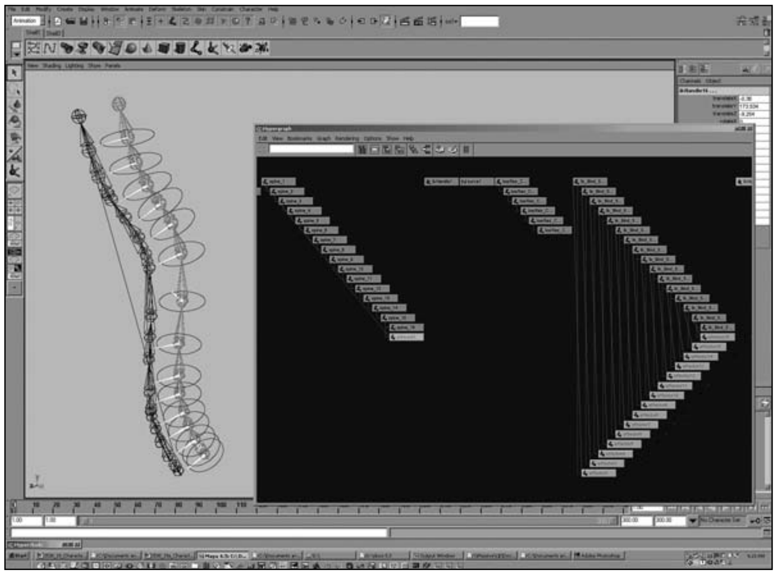


Figure 17.29 Creating rotate plane IK handles at each joint of the new Ik_Bind_Spine_ hierarchy.

Now you will perform a few steps to perfectly line up the rpIk spine with the spline IK spine.

22. First, point-constrain each one of the rpIk handles to the corresponding joint that is part of the spline IK hierarchy. Then point-constrain the root of the Ik_Bind_Spine_ rpIk hierarchy directly to the root of the spline IK hierarchy (see Figures 17.30 and 17.31).

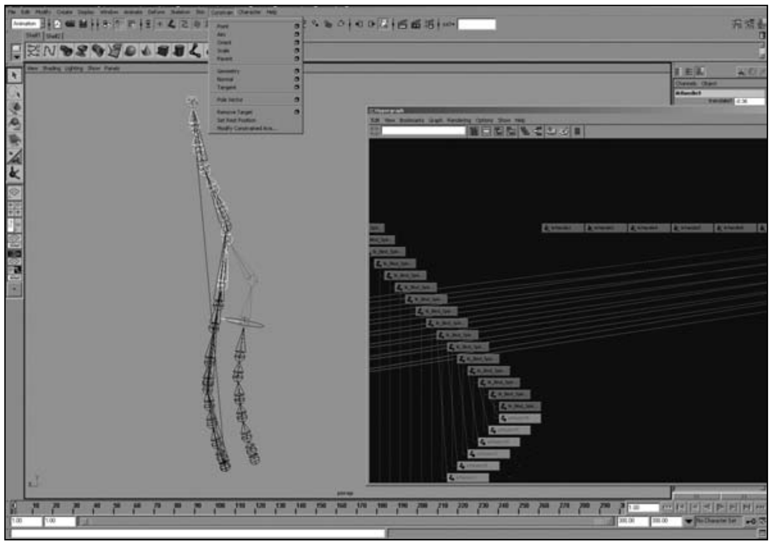


Figure 17.30 This image shows half of the IK handles as they are being point-constrained to the corresponding splineIk spine joints.

23. Next, connect the scale attributes from each original joint in the spline IK hierarchy to the scale attributes of the corresponding duplicate joint in the Ik_Bind_Spine_ rpIk joint hierarchy.

Because these two hierarchies are right on top of each other in the 3D view, the easiest way to select them is by looking at the two hierarchies side by side in the Hypergraph's Graph, Scene Graph mode. Then hit the Toggle Free Form Layout button and move the hierarchies side by side. By doing this, you can see exactly which nodes you need to connect to each other because each node in the hierarchy is right next to the corresponding one. Because the hierarchies are exactly the same, you simply need to open the Connection Editor, select a single spine joint first, and load it into the left side. Select the corresponding duplicate Ik_Bind_Spine_ joint second, and load it into the right side. Then quickly connect the scale attribute of the spine to the scale attribute of the corresponding IK_Bind_Spine.

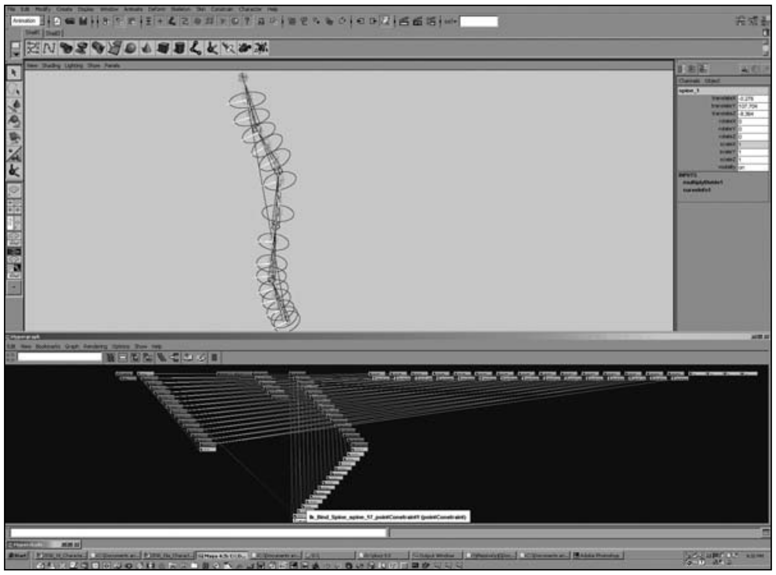


Figure 17.31 This image shows all of the IK handles after they have been point-constrained to the corresponding splineIk spine joints. The root of the Ik_Bind_Spine_ has been point-constrained to the root of the splineIk's spine joint root.

24. Next, group all the rpIk handles under one node by selecting them all and hitting Ctrl+g (see Figure 17.32).

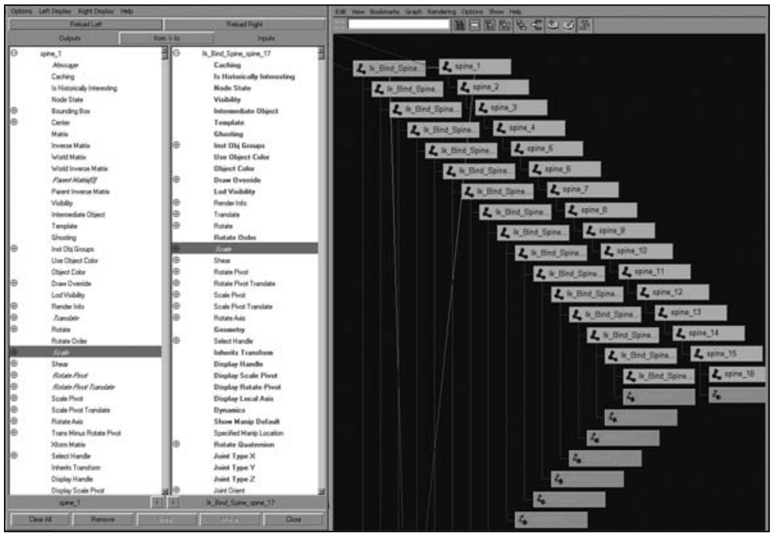


Figure 17.32 Group all the rpIk handles under one node.

You should now have three joint hierarchies that, for the most part, all move together and are controlled by the low-res control hierarchy. They have the capability of stretching and compressing, as well as rotating using an FK approach and translating using an IK approach. The only part missing is the FK capability to actually twist the low-res joint hierarchy and have the joints in the high-res joint hierarchy get the separate portions driven by the twist.

To achieve the desired twisting capability, you will create locators to serve as weighed poleVector constraints for each rotate plane IK handle in the rpIk Ik_Bind_Spine_ hierarchy.

25. Before beginning, hide the lowRes control hierarchy temporarily so that it doesn't confuse things in the 3D view. Do this by selecting the root of the lowRes hierarchy and hitting Ctrl+h.

26. Start by creating a single locator, and name it poleVector1. Next, activate the Move tool, and with the middle mouse button on your mouse, and the v key on your keyboard depressed, drag your mouse to snap the locator directly on top of the root joint of the high-res hierarchies. When the locator is directly on top of the root joint, translate it along the Z-axis direction that moves it backward so that it is directly behind the character's back. Be sure that it is moving only on a single axis and that you are moving it behind the character.

27. Next, hit Ctrl+d to duplicate the locator and snap this new duplicated locator to the next joint, which should also have an IK handle right on top of it. Perform the exact same step, moving the locator backward about the same distance on the same axis as the first locator that you just moved behind the character. Repeat this step for each joint in the hierarchy except for the very last one.

28. When you are finished duplicating, snapping, and moving all the locators behind the character, check that you have the correct number of locators. You should have a single locator for each rpIk handle, and each locator should be located directly behind each one of the character's spine joints, with a single IK handle for each joint except the root. Your locators should be situated something like the ones shown in Figure 17.33.

29. Next, unhide the low-res control joints by setting the root node's visibility attribute to on. Parent each one of the poleVector# locators to the nearest low-res control joint (see Figure 17.34).

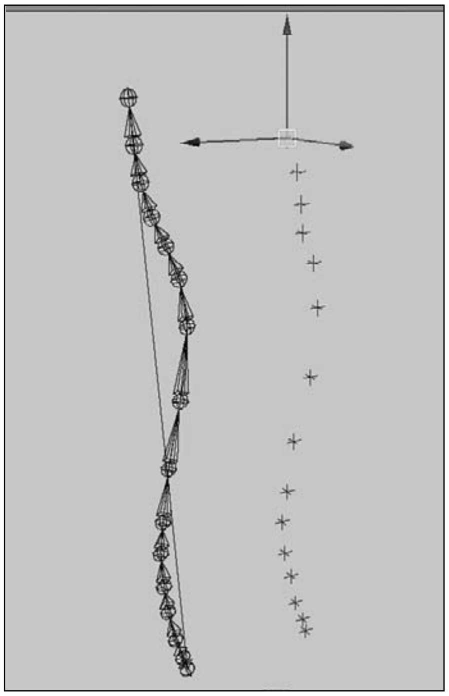


Figure 17.33 Your locators should be situated something like this.

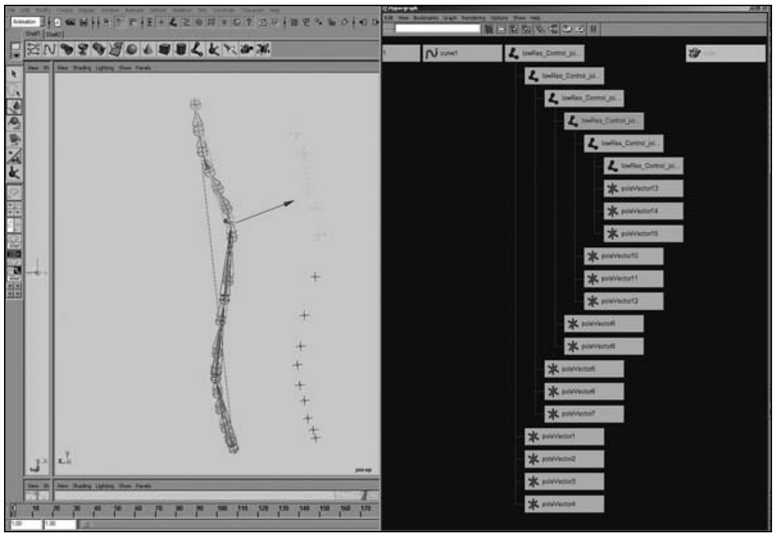


Figure 17.34 Parenting each poleVector locator to the nearest low-res control joint.

30. Now pole vector–constrain each rpIk handle so that it is constrained to all of the locators. Do this by first selecting all the locators that you have situated and parented behind your character's back; then add to the last selection the rpik handle and perform the command Constrain, Pole Vector.

    This creates a single weighted pole vector constraint with weight attributes for each locator, which constrains the IK handle onto all the locators situated behind your character.

31. Perform Step 31 for each IK handle on your character's back: Select all the locators and then select a single IK handle, and perform Constrain, Pole Vector. When you are finished, you should have each one of your IK handles pole vector–constrained to all of the locators behind your character, as in Figure 17.35.

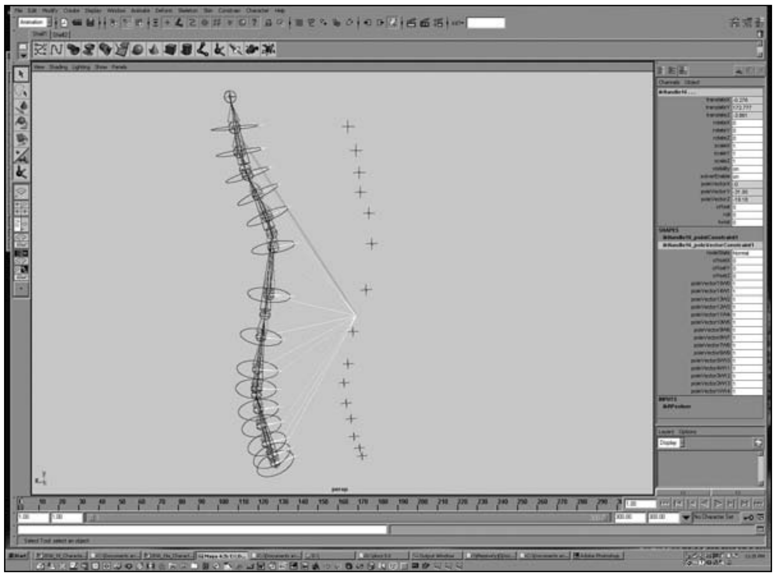


Figure 17.35 Each rotate plane IK handle pole vector is constrained to all the locators that have been placed behind the back.

Now it's time to manually change each of the pole vector constraint weights to weight them with a nice fall-off toward the corresponding low-res joints that the locators are parented onto.

32. To do this, select each IK handle and click the pole vector constraint in the Channel box to modify the pole vector constraint weight attributes (or, just select the pole vector constraint that is a child of your IK handle).

Now look at the weight values that show up in the Channel box. Each weight represents how much the current IK handle's twisting is controlled by each locator that it is constrained to (the locators are children of the low-res back).

33. Set each weight value to a number that will distribute the rotation of the pole vector to be controlled evenly by two to four of the locators.

Rotating a low-res joint causes the pole vector constraint locator that is a child to orbit around the pivot of the low-res joint you are rotating. This, in turn, causes any of the IK handles that are constrained to the locator to twist or rotate along the IK handle's rotate plane. The idea is to determine which low-res joint's rotations you want to have affect the twisting of the high-res joints.

Determining which joints should receive weighting is quite simple: If the joint is at the top of the hierarchy, weight it toward the locators that are children of the top low-res joint. The best part about all this is that the poleVector constraint has weights, so it can have weights that are falling off from one locator to the next, across multiple joints. If one of your rpIk handles is in between the top low-res joint and one of the middle low-res joints, give it weights that are averaged between locators that are children of these two hierarchies. For example, if you are distributing the weights across four locators, choose weights that are falling off from low values to higher values, such as .1, .35, .75, and 1; the rest of the weights should be set to 0. The only rule for which constraint weights you should give higher weights to is this: Set the weights of the pole vector constraints so that when you twist the low-res hierarchy, the high-res joints rotate with an appealing and desirable fall-off between them.

Figure 17.36 shows what your pole vector constraints should look like when you are finished changing their weights.

34. Next, group all of your IK handles and curves together. Then group both of your high-res IK hierarchies under the same group and name it spineRigIkNodes. Keep your low-res hierarchy outside of this spineRigIkNodes group because this group will never be moved or translated. The lowRes hierarchy will be the joints that are hooked up to control boxes and that are used to animate the character.

35. Point-constrain the root of the lowRes hierarchy to the root of the character, and group and constrain the rest of the lowRes hierarchy to control boxes so that it is kept free from the translations of the root.

This keeps the hips free from moving with the shoulders, and vice versa. An additional parent of both hierarchies should eventually also be used when the rest of the character controls are built, to move both the root and the upper spine together.

You can find a completed file, titled Jerk_DivineSpine_Finished.mb, on the accompanying CD for this chapter.

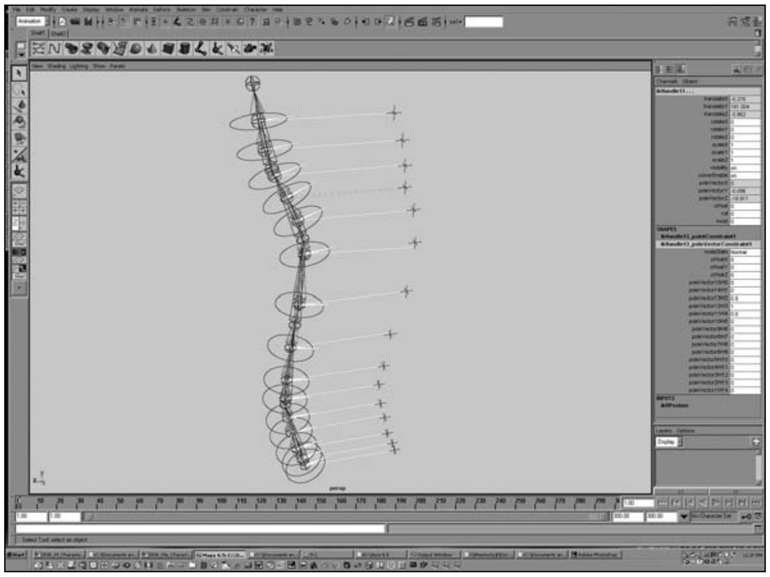


Figure 17.36 When you are finished changing their weights, your pole vector constraints should look like this.

Advanced Stretchy IK Legs and Classic Reverse Foot

The Jerk's legs will be rigged up in a similar way to the spine: They will be capable of stretching when the distance between the foot and the hips becomes larger. This is an interesting setup because it causes the foot to stay stuck to the ground, even if the character's root is causing the leg to stretch just a small amount. This capability allows for the animator to hit nice key poses in a walk, or any other pose that involves planting one foot and moving another, without having to worry too much about the terrible "IK snapping" of joints as the IK handle moves too far away from the joint and it can no longer bend to achieve the pose.

In the next exercise, you set up the leg joints so that they will stretch and the animator will never have to worry about this problem.

Exercise 17.5 Classic Reverse Foot Setup

The foot will be set up using a classic reverse foot setup. This simple technique allows the foot to be rotated from all three pivots that a real foot's weight lands upon while walking: the heel, the ball, and the toe. This makes for a very straightforward time when animating the feet for a walk cycle of a character.

1. Start by opening the file Jerk_IkLegs_Begin.mb on the CD for this chapter.
2. Next, activate the rotate plane IK Handle tool by going to Skeleton, IK Handle Options and hitting the Reset Tool button. Using the IK Handle tool, create an IK handle from the leg joint to the ankle joint, then from the ankle joint to the ball joint, and finally from the ball joint to the toe joint. Your result should look like Figure 17.37.

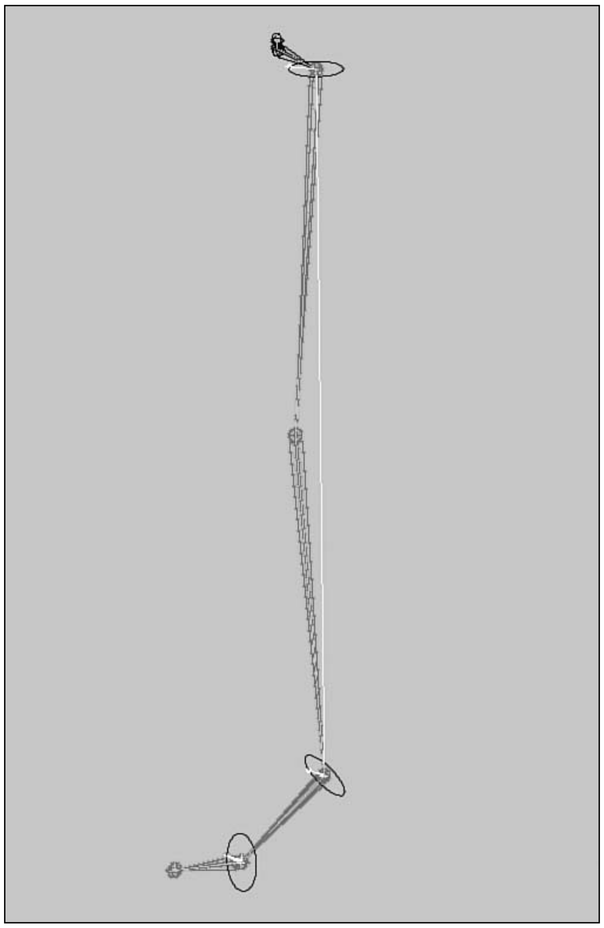


Figure 17.37 The leg after creating the necessary IK handles.

3. Next, rename all your IK handles to match the portions of the leg and foot that they correspond to—ankle_ikHandle, ball_ikHandle, and toe_ikHandle.
4. Now create the reverse foot. Start by drawing a backward foot joint hierarchy. The root of this new joint hierarchy should start at the base of the heel and then move to the toe, the ball, and the ankle. Name your hierarchy reverseHeel, reverseToe, reverseBall, and reverseAnkle, accordingly. Your result should look like Figure 17.38.

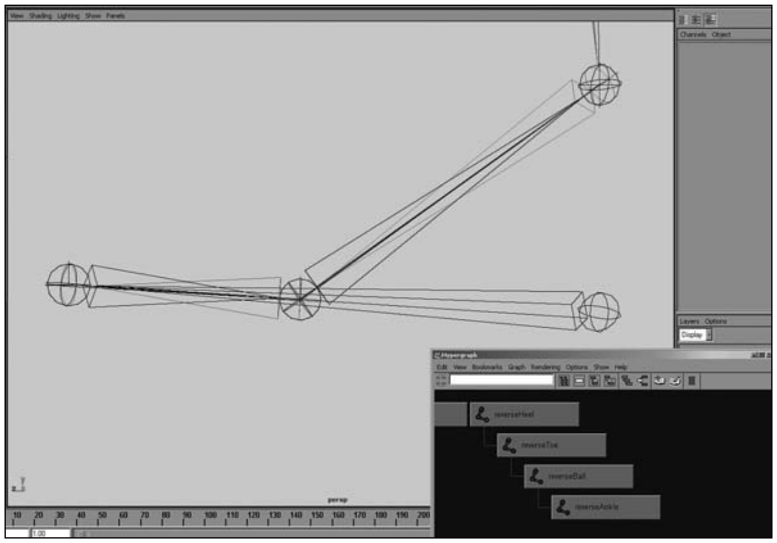


Figure 17.38 The reverse foot joint hierarchy.

5. Next, parent the ankle IK handle to the reverseAnkle joint. Parent the ball IK handle to the reverseBall joint, and parent the toe IK handle to the reverseToe joint, as in Figure 17.39.
6. Create three locators that will be pole vector constraints for the leg and feet IK handles. Name the first locator ballPoleVector. Keeping the v key pressed down and using the middle mouse button with the Move tool, point-snap this locator to the reverseAnkle node and make it a child of reverseAnkle. Next, select the ballPoleVector locator that you just parented, Shift+select the ball_ikHandle, and perform Constrain, Pole Vector. Move the locator so that it is off to the side of the foot, not right on top of the ankle joint.

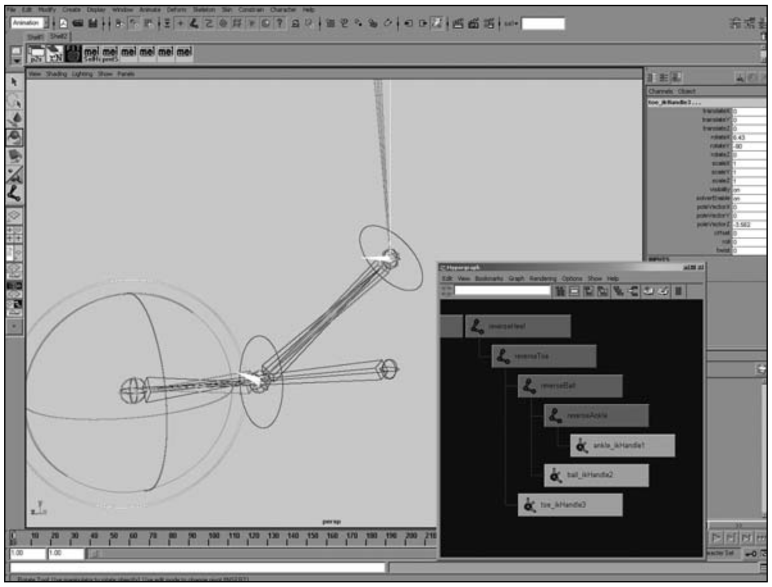


Figure 17.39 IK handle relationship in the reverse foot joint hierarchy.

7. Name the second locator toePoleVector, and point-snap and parent it to the reverseBall joint. Next, select it along with the toe_ikHandle and perform Constrain, Pole Vector. Also move this locator so that it is off to the side of the foot, not right on top of the ball joint.
8. Finally, name the third locator legPoleVector, and point-snap it to the legJoint; then move it out in front of the knee joint. Parent this locator to the Hips joint. Select this locator, and Shift+select the ankleIk handle and again perform Constrain, Pole Vector. Your result should look like Figure 17.40

   The reverse foot setup is completed, and is ready to be animated.
9. You can animate the reverseHeel, reverseToe, and reverseBall joints to make the character's foot roll as it is walking. Also hide the locators and IK handles that are children of the reverse foot hierarchy so that they aren't accidentally animated or selected.

   Now you can create your stretchy legs setup.

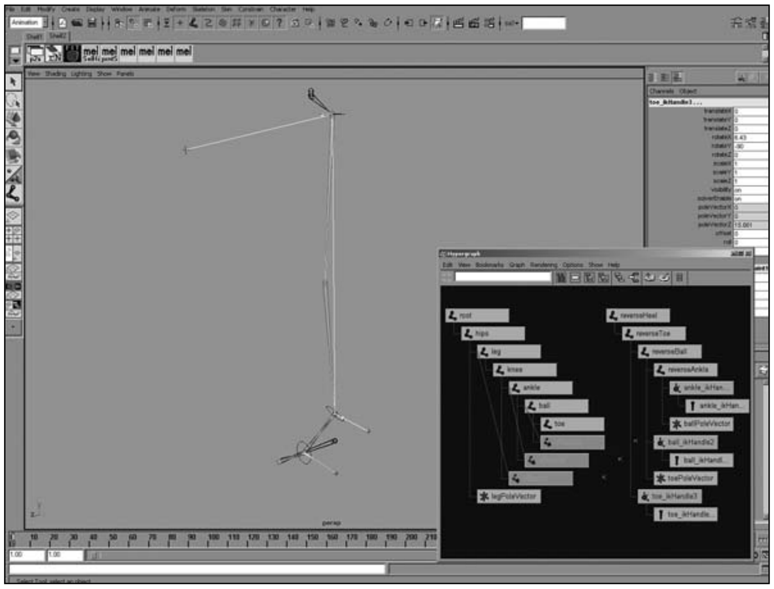


Figure 17.40 Pole vector constraint for the leg.

10. Create a distance dimension node from the leg to the ankle with the measuring tool by using the menu command Create, Measuring Tools, Distance Tool. Click first on the leg joint and then on the ankle joint. Now point-constrain the first locator of the distance tool to the leg joint; point-constrain the second locator of the distance tool to the ankle_ikHandle, which spans from the leg joint to the ankle joint, using Constrain, Point (see Figure 17.41).

11. Next, open the Create Render Node window from the Hypershade window under Create, Create New Node, and create the following utility nodes:

    - Three multiplyDivide nodes
    - Two plusMinusAverage nodes
    - One condition node

    Figure 17.42 shows the result.

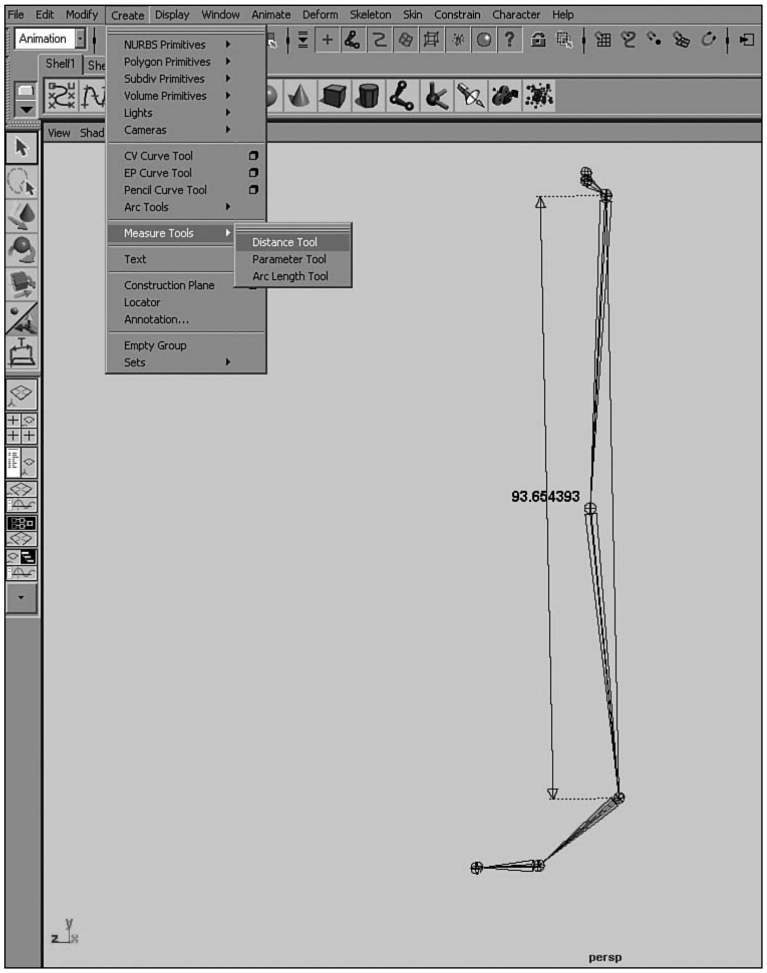


Figure 17.41 Creating a distance dimension node for the leg.

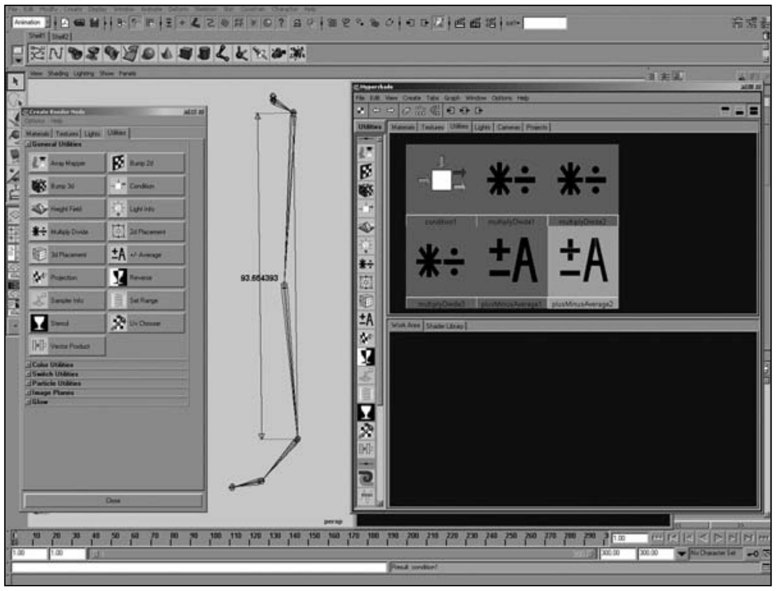


Figure 17.42 Creating utility nodes for the leg.

Next, you'll hook up a node network that will allow the legs to stretch as the distance between the ankle's IK handle and the leg joint becomes greater.

To start, you'll create some attributes that can be used to easily control the stretching capabilities of the leg.

12. Select the reverseHeel joint. This will be the node that you add the additional attributes onto because this is also the joint that you can use to animate the position of the foot. Go to the menu item Modify, Add Attributes and add the following attributes:

autoStretch min: 0, max: 1—This is so that the automatic stretching can be blended on and off.

shortenTolerance min: 0, max: 1—This attribute will control how short the leg gets before it starts to bend.

legScale min: 0, max: 10—This is an extra control that allows the leg to scale on top of the automatic scale.

Figure 17.43 shows the result.

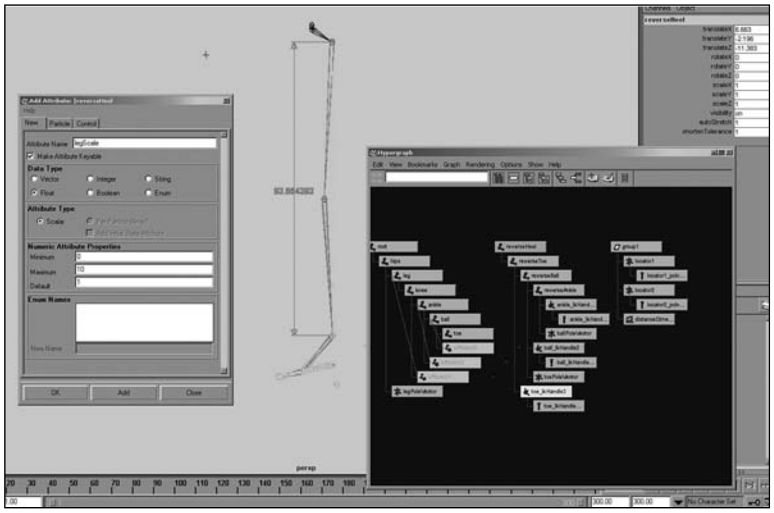

Attribute Name: legScale
Make Attribute Keyable [✓]
Data Type: [✓ Float]
Attribute Type: [✓ Scalar]
Numeric Attribute Properties
Minimum: 0
Maximum: 10
Default: 1

Figure 17.43 The new leg attributes are ready to be connected.

Now you'll connect all the nodes and attributes that you just created to get the controllable automatic stretchy reaction that you want from the leg.

13. Connect the distanceDimensionShape.distance attribute to the multiplyDivide1.input1Y attribute. Set the operation mode of multiplyDivide1 node to Divide. Next, copy and paste the number from input1Y (using Ctrl+c and Ctrl+v) into the input2Y attribute of the multiplyDivide1 node.

14. Next, connect the multiplyDivide1 outputY to the plusMinusAverage1 input1D[0] attribute. Make sure that the plusMinusAverage1 node's operation is set to Subtract. Also make sure that the multipyDivide1 node's input2Z attribute is set to 1. Then connect it to the plusMinusAverate input1D[1] attribute (to subtract 1 from the output).

15. Connect the plusMinusAverage1 node's output1D to the multiplyDivide2 node's input2Y. Connect the reverseHeel's autoStretch attribute into the input1Y attribute of the multiplyDivide2 node.

16. Connect the multiplyDivide node's outputY attribute to the plusMinusAverage node's input1D[0]. Then set the multiplyDivide2 node's input2z attribute to 1 and connect it to the input1D[1] attribute of the plusMinusAverage2 node.

17. Set the operation mode of the condition1 node to Less Than, and connect the plusMinusAverage2 node's output1D attribute to the condition node's colorIfFalseG attribute. Then connect the plusMinusAverage2 node's output1D attribute to the condition node's firstTerm attribute. Next, connect reverseHeel's shortenTolerance attribute to the condition node's secondTerm attribute, and also connect reverseHeel's shortenTolerance attribute to the condition node's colorIfTrueG attribute.
18. Next, connect the condition1 node's outColorG to the last multiplyDivide3 node's input1Y attribute. Connect reverseHeel's attribute legScale to multiplyDivide3's input2Y attribute.
19. Finally, connect the outputY attribute of the multiplyDivide3 node into the scaleX attributes of the leg and the knee joint nodes.

    Your final node network should look similar to Figure 17.44.

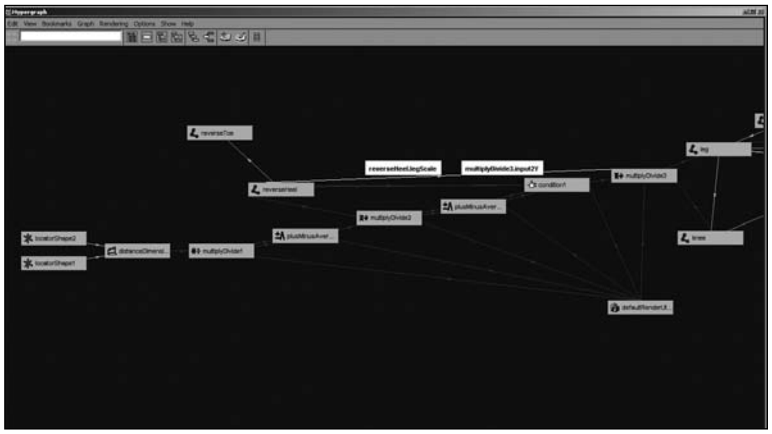


Figure 17.44 The final node network for the stretchy leg.

You can now animate the reverse feet, and the leg will actually stretch to compensate for the overextension of the foot. The attributes to control this reaction are right on the reverseHeel, so you can keyframe this behavior on and off and scale the legs on top of it. The completed scene file appears on the accompanying CD as Jerk_IkLegs_Finished.mb.

Advanced IK Arms and Clavicular Triangle

In the next exercise, you will see how I chose to rig The Jerk's shoulders and arms. The technique used enables the arms to stretch and the shoulder to rotate as if it were an FK arm. Separate controls exist for posing the arm using IK from the scapula, the clavicle, and the shoulder, as well as the traditional IK handle at the wrist. Two locators both have the wrist's IK handle constrained to them, adding the capability to plant the character's hand any place we choose. Two extra joints were inserted as children of the shoulder and elbow but were not connected (not made parents) with the rest of the hierarchy of the arm. These unparented children joints were used for better deformations on the twisting of the shoulder and the wrist, to avoid the painful washboard effect.

Exercise 17.6 Advanced Stretchy IK Arms and the Clavicular Triangle

Begin by opening the file Jerk_ArmSetup_Begin.mb, which you'll find on the accompanying CD. Take a look at how the arm joints are laid out to create the hierarchy.

Examine this file closely: It contains the joint placement for the entire skeletal hierarchy that will create the final arm for The Jerk. The only thing missing is the controls, which you will add to the rig now. You begin with the shoulder area of the character, which I refer to as "the clavicular triangle." Then you tackle the advanced stretchy IK arm controls that will allow the character's arms to stretch to any length. You'll also transition the hand to be stuck on any object and stay there while the rest of the body is animated. So, let's get started with the clavicular triangle.

1. Beginning with the file Jerk_ArmSetup_Begin.mb from the CD, create an IK handle from the clavicularTriangle joint node to the scapulaJoint node. Do this by clicking Skeleton, IK Handle Tool Options; first hit the Reset Tool button and then select the nodes in order from the 3D view port window. Rename the newly created IK handle scapulaClavicle_IkControl.
2. Next, select the scapulaJoint and use the Ctrl+h key combination to temporarily hide it so that you can select the correct node in the view port window. Now, using the same settings in the IK Handle tool from above, create another IK handle from the clavicleJoint node to the clavToShoulder joint node. Rename the newly created IK handle clavicleStretch_IkHandle.
3. Next, use the Ctrl+Shift+h keyboard combination to unhide the last hidden node (the scapulaJoint node). Then select the clavicleJoint node and use Ctrl+h to temporarily hide it.

4. Using the same settings, create an IK handle from the scapulaJoint node to the shoulderJoint node. Rename this newly created IK handle clavicleShoulder_IkControl.
5. Create one last IK handle from the shoulderJoint node all the way down to the bottom of the arm to the wristJoint node. Rename the newly created IK handle armWrist_IkControl. Now Ctrl+Shift+h to unhide the previously hidden clavicleJoint.
6. Next, parent the clavicleShoulder_IkControl under the scapulaClavicle_IkControl node. Then parent the clavicleStretch_IkHandle and the armWrist_IkControl nodes to the clavicleShoulder_IkControl. Finally, parent the entire group of the scapulaClavicle_IkControl node to the connectToSpine joint node. Your hierarchy so far should look like Figure 17.45.

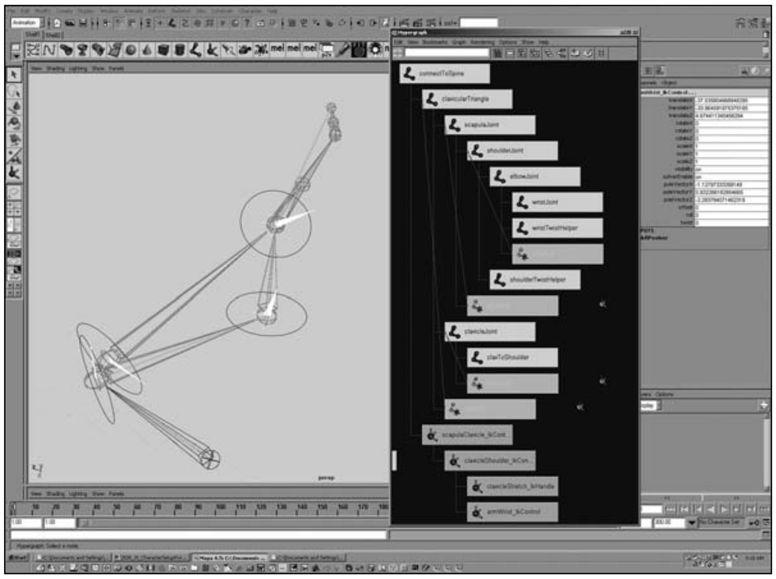


Figure 17.45 Hierarchy for the clavicle shoulder setup.

7. Now that you've parented all your IK appropriately, select all four IK handles and perform the Modify, Freeze Transformations menu command. Next, with all the IK still selected, highlight the poleVectorX, poleVectorY, and poleVectorZ attributes in the Channel box and set them all to 0 (zero).

8. Next, click Create, Measure Tools, Distance Tool. While holding down the v key on your keyboard (Snap mode), snap a distance locator from the clavicleJoint to the clavToShoulder joint. Rename each locator appropriately: clavicleJointPoint and clavToShoulderPoint. Also rename the distanceDimension node that was created to clavToShoulder_distanceDimension.
9. Select the shoulderJoint and the clavToShoulderPoint and perform the Constrain, Point menu command. Next, select clavicleJoint and then clavicleJointPoint, and again perform the Constrain, Point menu command. Now select the two locators and the distance dimension, and hit the Ctrl+g keyboard combination to group them. Rename the group clavicleDistanceGroup and make it a child of the connectToSpine joint node. Your hierarchy so far should look like Figure 17.46.

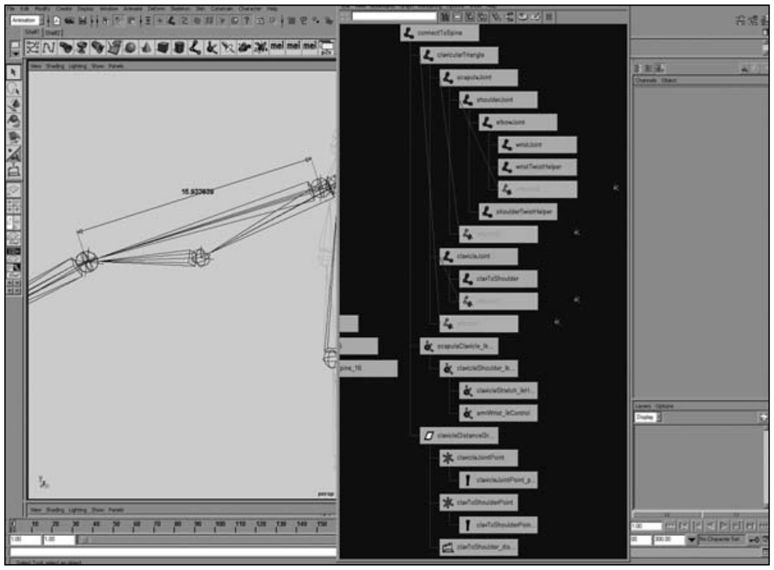


Figure 17.46 IK handles for the clavicle shoulder setup.

10. Next, execute this command:

```
createNode multiplyDivide;
```

11. Be sure to hold down the Shift key, and Shift+click, selecting the clavToShoulder_distanceDimension node. Open the Hypergraph window and click Graph, Input and Output Connections.

    Your screen should look like Figure 17.47.

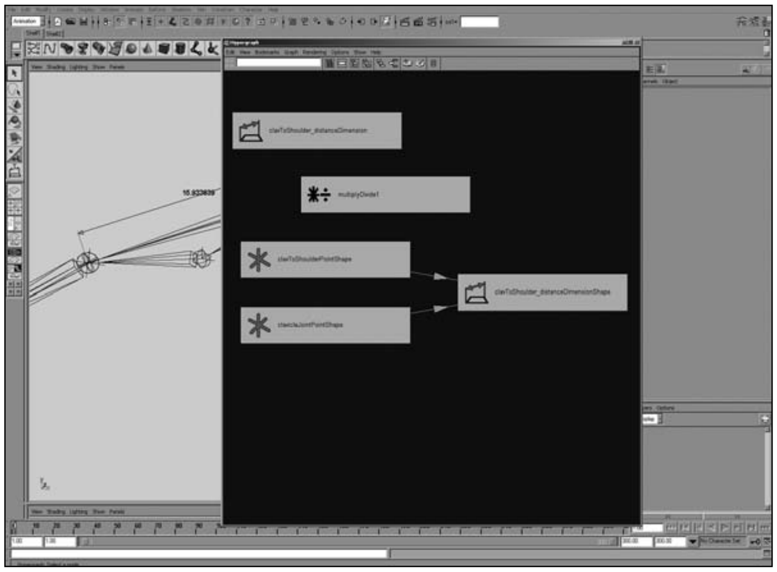


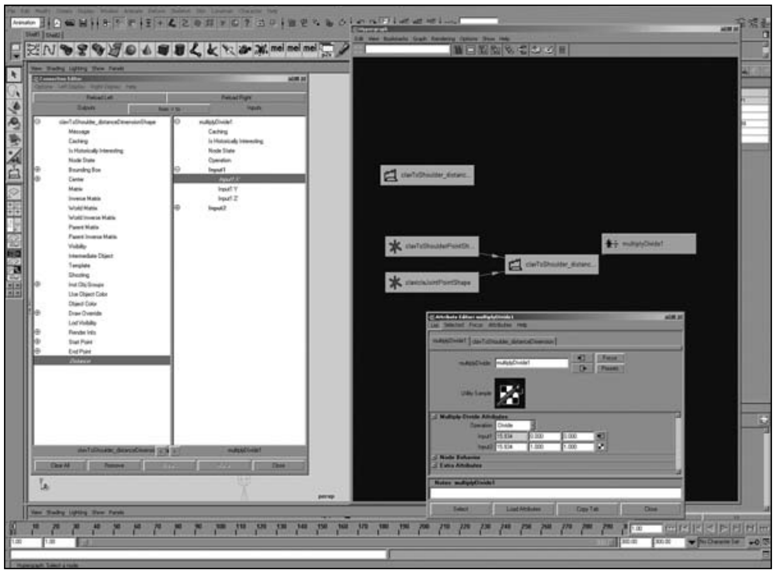
Figure 17.47 Connecting the distanceDimension node.

12. Next, using Shift plus the middle mouse button, drag and drop the clavToShoulder_distanceDimensionShape onto the multiplyDivide1 node. This should bring up the Connection Editor window. Inside the Connection Editor, connect the distance attribute from the clavToShoulder_distanceDimensionShape into the Input1X attribute of the multiplyDivide node.

13. Next, select the multiplyDivide node and open the Attribute Editor. Change Operation to Divide, and copy the yellow input1X attribute (using the Ctrl+c keyboard combination) and paste it into the input2X field so that you are dividing the current distance by the initial distance. This creates a ratio that you can use to scale the clavicle joint down its axis. Your hierarchy so far should look like Figure 17.48.

14. Select the multiplyDivide node and Shift+select the clavicleJoint. Open the Hypergraph window and click Graph, Input and Output Connections. Using Shift and the middle mouse button, drag and drop the multiplyDivide node onto the clavicleJoint node. Again, this opens the Connection Editor for you to connect the appropriate attributes.

15. In the Connection Editor, highlight the OutputX attribute from the multiplyDivide node, and connect it with the scaleX attribute of the clavicleJoint node. This should appear to do nothing because the outputX attribute should be currently equal to 1.



multiplyDivide: multiplyDivide1
Operation: Divide
Input1: 15.534 0.000 0.000
Input2: 15.534 1.000 1.000

Figure 17.48 Connecting the multiplyDivide node.

16. Finally, select the shoulderJoint, Shift+select the clavicleStretch_IkHandle, and perform Constrain, Point.

That is about it for the clavicle setup. If you move or rotate the clavicleShoulder_IkControl IK handle, you will see that the clavicleJoint actually scales to keep its length between the shoulder and its point of origin at the clavicle. Although this is not anatomically correct, it can prove very helpful for achieving appealing deformations in this area when the character points his arm forward in front of his body, reaches his hand across his chest, or lifts his arm above his head. The key is to spread the weighting of this joint smoothly and sparingly across certain portions of the frontal geometry.

In the next exercise, you will set up some of the controls for the entire arm itself.

Exercise 17.7 Arm Twist Setup

Begin by connecting the joints that will help the arm's twisting deformations look more believable.

1. Using the Connection Editor, connect the wristJoint.rotateX attribute to control the wristTwistHelper.rotateX attribute (highlighting in the Connection Editor, just like in the last example). Then connect the shoulderJoint.rotateX attribute to control the shoulderTwistHelper.rotateX attribute using the same method (see Figure 17.49).

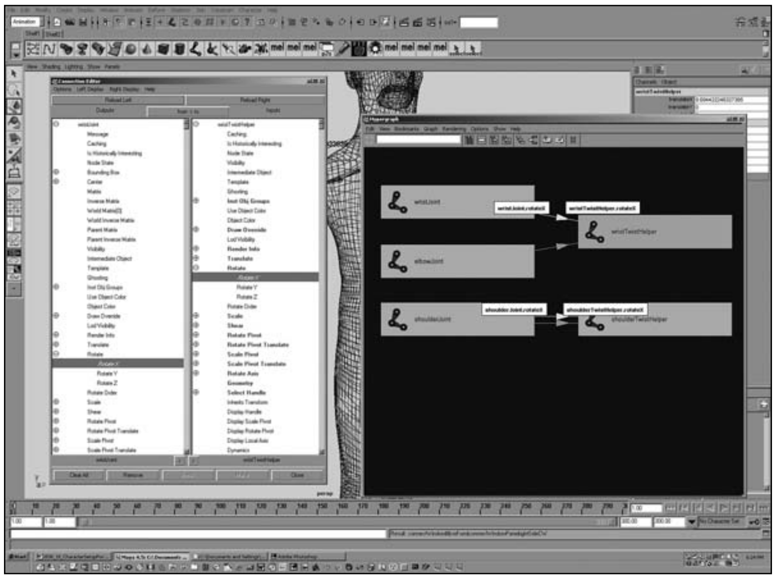


Figure 17.49 Connecting the joints that will help the arm's twisting deformations.

Next, you will create a standard IK control for the arm, which will enable the animator to control the twisting of the shoulder and the orientation that the elbow is pointing. You will pole vector–constrain the wrist's IK handle onto a locator that is situated behind the character, which can be grabbed and translated around to control the arm's orientation.

2. Create a locator (click Create, Locator) and rename it armPoleVectorConstraint. Now, with the Move tool activated, hold down the v key (Point Snap mode) on the keyboard and, holding down the middle mouse button, click and drag the locator toward the shoulderJoint until it snaps into place on top of the shoulderJoint. Then, no longer holding the v key, translate it backward a few units behind the character.

3. Make the armPoleVectorConstraint locator a child of the connectToSpine node by selecting the armPoleVectorConstraint and then the connectToSpine; then hit the p key on your keyboard.
4. Select the armPoleVectorConstraint locator and Shift-click the armWrist_IkControl node to add it to the selection. Create a pole vector constraint by using the menu command Constrain, Pole Vector.
5. Select the armPoleVectorConstraint locator and perform Modify, Freeze Transformations to zero the locator's transforms.

   Next, you will create the extra controls that will allow the hand to be "planted" or stuck on any object. For example, if the character needs to lean his hand against the wall, grab onto a pole and swing around on it, or even just hold on to a steering wheel, this setup will easily allow for it.

   The way you'll accomplish this is very simple indeed. First, you'll create two locators and parent them under the same group as the armWrist_IkControl. Then you will create weighted point and orient constraints from these two locators onto the armWrist_IkControl node. Finally, you will add an attribute that will control the weight of the constraints that were added, to determine which locator the IK handle gets constrained onto. Let's get started.
6. First, create two locators. Rename one locator plantIkHand. Rename the other locator freeIkHand.
7. With the Move tool activated, hold down the v key (Point Snap mode) on the keyboard and, holding down the middle mouse button, click and drag both locators toward the wrist's armWrist_IkControl in the 3D view port until they snap into place directly on top of the armWrist_IkControl.
8. Next, parent both the plantIkHand and freeIkHand locators under the same parent as the armWrist_IkControl node (the scapulaClavicle_IkControl) by selecting the two locators and Shift+selecting the scapulaClavicle_IkControl to add it to the selection last; then hit the p key on your keyboard.

   Next, you will create an empty "null" transform node that you'll use to parent the IK handle and both locators under so that they are in the same orientation and position as the wristJoint node. You can then orient-constrain the wrist to the IK handle without changing the current orientation of the wrist.
9. Create the null transform by first being sure that nothing is selected and then hitting the Ctrl+g keyboard combination.

10. With the new null node created, point-snap it to the wristJoint node using the Snap mode of the Move tool by holding down the v key while clicking and dragging with the middle mouse button held down. Zero the null node's transforms by selecting it and performing Modify, Freeze Transformations.

To put this null node into the same orientation as the wristJoint, you will point- and orient-constrain it and immediately delete these constraints by executing a single line of MEL code supplied in the next step.

11. A quick and easy way to do this is to execute the following MEL command in the command line (first select the wristJoint node and Shift+select the null node to add to the selection). Now execute the following bit of tricky code (which actually creates constraints for you and then automatically deletes them immediately afterward so that they will line up your nodes but not keep them controlled via a constraint relationship—all at the same time):

```
delete 'orientConstraint';  delete 'pointConstraint';
```

12. Rename the null node to be called wristTransformCompensation. Parent it under the same node as the armWrist_IkControl IK handle and plantIkHand and freeIkHand locators by first selecting the wristTransformCompensation, Shift+selecting the clavicleShoulder_IkControl node, and hitting the p key on the keyboard.

The null transform is now in the same orientation space as the wristJoint, but it will travel correctly under the clavicleShoulder_IkControl IK handle node. You will now make this new wristTransformCompensation null node the parent of the armWrist_IkControl IK handle and plantIkHand and freeIkHand locators.

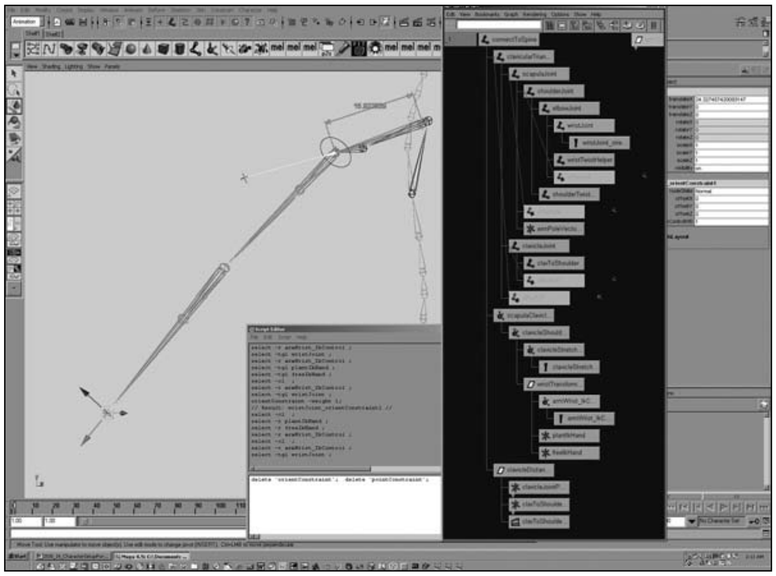
13. Select all three of these nodes (armWrist_IkControl, plantIkHand, and freeIkHand), and Shift+select the wristTransformCompensation null node to add it to the selection last. Hit the p key to parent the IK and locators to this null node.

Note

If the wrist and elbow seem to pop into a different spot when you parent the armWrist_IkControl IK handle, you can correct this. Simply select the armPoleVectorConstraint, highlight all its translate channels in the Channel box, and then hit 0 and the Enter key. This update problem occurs because of the nature of Maya's lazy dependency graph evaluations.

14. Now select the armWrist_IkControl, plantIkHand, and freeIkHand nodes; perform Modify, Freeze Transformations to zero out the IK handle and locator's transforms; and put them in the same transformation space as the wristTransformCompensation null node. You should remember that this is also in the same orientation space as the wristJoint node. This whole step is important because you will next orient-constrain the wrist to the armWrist_IkControl IK handle node.

15. Select the armWrist_IkControl, Shift+select the wristJoint node, and perform the menu command Constrain, Orient. So far, your nodes should look like Figure 17.50 in the Hypergraph window.



```
select -r armWrist_IkControl ;
select -tgl wristJoint ;
select -r armWrist_IkControl ;
select -tgl plantIkHand ;
select -tgl freeIkHand ;
select -cl ;
select -r armWrist_IkControl ;
select -tgl wristJoint ;
orientConstraint -weight 1;
// Result: wristJoint_orientConstraint1 //
select -cl ;
select -r plantIkHand ;
select -r freeIkHand ;
select -r armWrist_IkControl ;
select -cl ;
select -r armWrist_IkControl ;
select -tgl wristJoint ;
```

```
delete `orientConstraint`; delete `pointConstraint`;
```

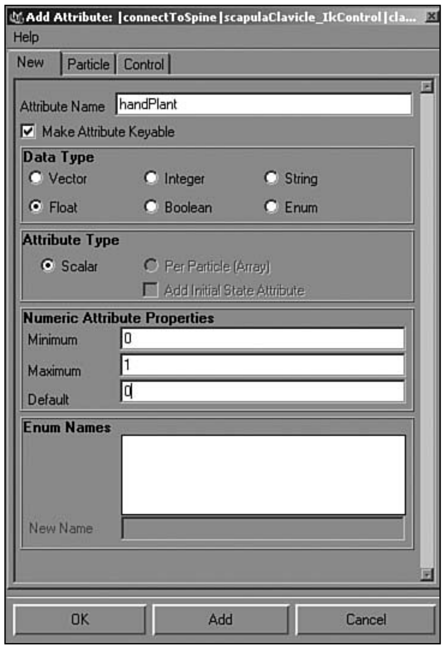
Figure 17.50 Arm and wrist IK control hierarchy.

Now that you have all your controls in the proper transformation space, you will finally create the constraints that enable you to animate the hand freely and then plant it so that it sticks somewhere. Again, you'll do this by using the weights of orient and point constraints.

16. Select the plantIkHand and freeIkHand nodes, and Shift+select the armWrist_IkControl to add it to the selection last. Now perform the two menu commands Constrain, Point and Constrain, Orient.

So far, if everything was done properly, you should have your wristJoint orient constrained to your arm's IK handle. The IK handle, in turn, is point- and orient-constrained to both plantIkHand and freeIkHand locators, which both currently constrain it with a weighted average of 1.

17. Next, select the armWrist_IkControl and use Modify, Add Attribute to create a float attribute. Name that float attribute handPlant, and give it a min of 0, max of 1, and default of 0. The settings should look like those in Figure 17.51.


Add Attribute: |connectToSpine|scapulaClavicle_IkControl|cla...

Attribute Name: handPlant
[✓] Make Attribute Keyable
Data Type: Vector, Integer, String, [✓ Float], Boolean, Enum
Attribute Type: [✓ Scalar], Per Particle (Array)
[ ] Add Initial State Attribute
Numeric Attribute Properties
Minimum: 0
Maximum: 1
Default: 0

Figure 17.51 Adding attributes to the armWrist_IkControl.

Now that you have created the handPlant attribute on the armWrist_IkControl IK handle, you want to make it control the weights of the constraints between the plantIkHand and freeIkHand locators. This is achieved using set-driven keys.

18. Go to the menu item Animate, Set-Driven Key, Set option box to bring up the UI for creating set-driven keys.

19. Next, select the armWrist_IkControl IK handle and click the Load Driver button. Be sure to highlight the handPlant attribute in the upper-left section of the window.

20. Open the Hypergraph and select the two bottom constraints that are children of the armWrist_IkControl node (the point and orient constraints that you just finished creating in Step 16). These should be named armWrist_IkControl_pointConstraint1 and armWrist_IkControl_orientConstraint1. Hold the Shift key and add to the selection the plantIkHand and freeIkHand nodes. Next, in the Set-Driven Key window, click Load Driven. Your window should look like Figure 17.52.

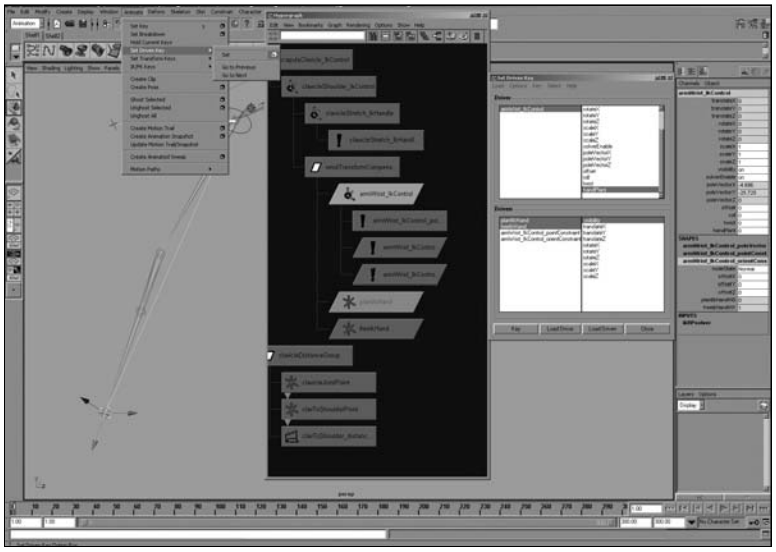


Figure 17.52 Preparing to use the Set-Driven Key window.

The next few steps are very important for applying the set-driven keys correctly.

21. First, be sure that the armWrist_IkControl IK handle's handPlant attribute is set to 0 and is loaded as the driver node/attribute. Also be sure that the node name armWrist_IkControl is highlighted on the upper left and that the attribute name handPlant is highlighted on the upper right of the Set-Driven Key window.

22. Now set the attributes on your nodes to the following values:

Driver attribute:

armWrist_IkControl.handPlant: 0

Driven attributes:

freeIkHand.visibility: on

plantIkHand.visibility: off

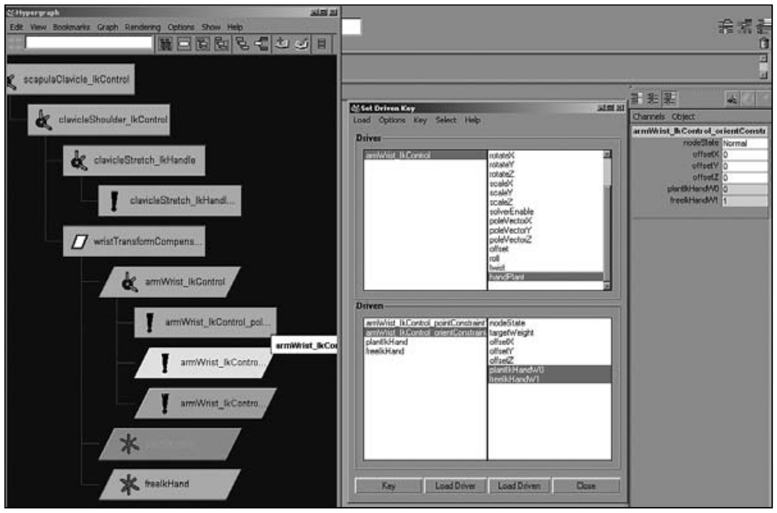
armWrist_IkControl_pointConstraint1.plantIkHandW0: 0

armWrist_IkControl_pointConstraint1.freeIkHandW1: 1

armWrist_IkControl_orientConstraint1.plantIkHandW0: 0

armWrist_IkControl_orientConstraint1.freeIkHandW1: 1

23. Now that your attributes are set exactly from the previous list, with your driver node actively highlighted, go through the driven nodes in the Set-Driven Key window and, one by one, click each node/attribute in the Driven section. Highlight each name on the lower left, highlight the attribute that you just set on the lower right, and hit the Key button. For example, the first node to highlight on the bottom left is the freeIkHand; on the bottom right, it is the attribute visibility. With both highlighted, hit the Key button. Do this for each node's attribute that you previously loaded and set, including each constraint separately (see Figure 17.53).



armWrist_IkControl_orientConstr

nodeState Normal
offsetX 0
offsetY 0
offsetZ 0
plantIkHandW0 0
freeIkHandW1 1

Figure 17.53 Using the Set-Driven Key window.

Now that you have hit the Key button for each driven attribute value when the driver is set to 0, you will set the values for the driven attributes when the driver is set to 1.

24. Set the following node attribute's values:

Driver attribute:

armWrist_IkControl.handPlant: 1

Driven attributes:

freeIkHand.visibility: off

plantIkHand.visibility: on

armWrist_IkControl_pointConstraint1.plantIkHandW0: 1

armWrist_IkControl_pointConstraint1.freeIkHandW1: 0

armWrist_IkControl_orientConstraint1.plantIkHandW0: 1

armWrist_IkControl_orientConstraint1.freeIkHandW1: 0

25. Finally, repeat the previous step, but using the current values, and set a driven key on each one of your driven node/attributes. One by one, highlight them in the Driven section of the Set-Driven Key window; one by one, highlight their attributes. Then hit the Key button to set the driven node's attribute key at the current driver node's attribute value.

Two locators control the location of the arm's IK handle as well as the orientation of the wrist. For the most part, the freeIkHand locator can be used to animate the hand when it does not need to be planted on something. But now there's an extra node to use to plant and orient the hand on a shot-by-shot basis, without ever needing to add extra controls to the character. When you need the hand to transition from being free moving to being planted somewhere, simply parent or point-constrain the plantIkHand onto the object that the hand needs to be stuck to and then animate the .handPlant attribute over a couple of frames, from 0 to 1. This hides the freeIkHand locator, which you no longer need to animate, and makes visible the plantIkHand locator, which you have stuck onto something.

In the next exercise, you will tackle the stretchy arm setup, which includes creating all the controls, attributes, and node networks involved to make an automatically stretchy IK arm that will stretch to maintain the distance between the IK handle and the shoulder. Regardless of whether the location of the shoulder or the location of the IK handle causes this distance to become greater, the arm will still stretch automatically. You will also add all the controls needed by an animator to animate this behavior blended on and off, while still exposing manual controls to scale the length on top of these controls.

Exercise 17.8 Stretchy Arm Setup

Begin by creating a distance dimension node for the arm. You will do this the same way you created the distance dimension for the clav to shoulder. This begins the controls that cause the arm to stretch.

1. Go to Create, Measure Tools, Distance Tool to activate the Distance tool.

2. Now click with the mouse once in the general area of the shoulder and again in the general area of the wrist. You will get two locators, most likely named locator1 and locator2. Rename these locators shoulderPoint for the locator near the shoulder, and wristPoint for the locator near the wrist. Also rename the distanceDimension node armDistance_distanceDimension.

3. Select the shoulderJoint node, Shift+select the shoulderPoint locator, and point-constrain the locator to the shoulder by using Constrain, Point. Next, point-constrain the wristPoint locator to the armWrist_IkControl by selecting the armWrist_IkControl, Shift+selecting the wristPoint locator, and again performing the menu command Constrain, Point. Finally, select the two locators and the distanceDimension node, and group them using the Ctrl+g keyboard combination. Name this new group armDistanceGroup (see Figure 17.54).

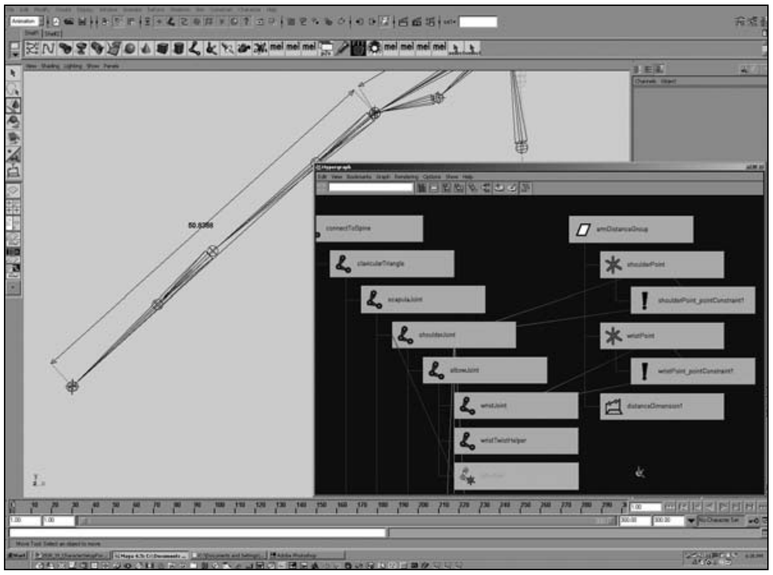


Figure 17.54 Setting up the constraints for the stretchy arm.

4. Parent the armDistanceGroup node under the connectToSpine joint node so that it is part of the hierarchy that will comprise the arm.

   Next, you will create a bunch of math utility nodes to create a node-based expression network. These nodes were built in Maya traditionally for rendering, but they are more commonly being used for character rigging as well.

5. Open the Hypershade window by clicking Window, Rendering Editors, Hypershade, and go to the Create, Create New Node menu. This launches the Create Render Node window. Next, click the tab labeled Utilities and create the following series of nodes (you will create four total utility nodes—see Figure 17.55):

   Create three multiplyDivide nodes and rename them armScaleRatio, autoStretchMultiplier, and armScaleMultiplier.

   Create one Condition node and rename it shortenToleranceCondition.

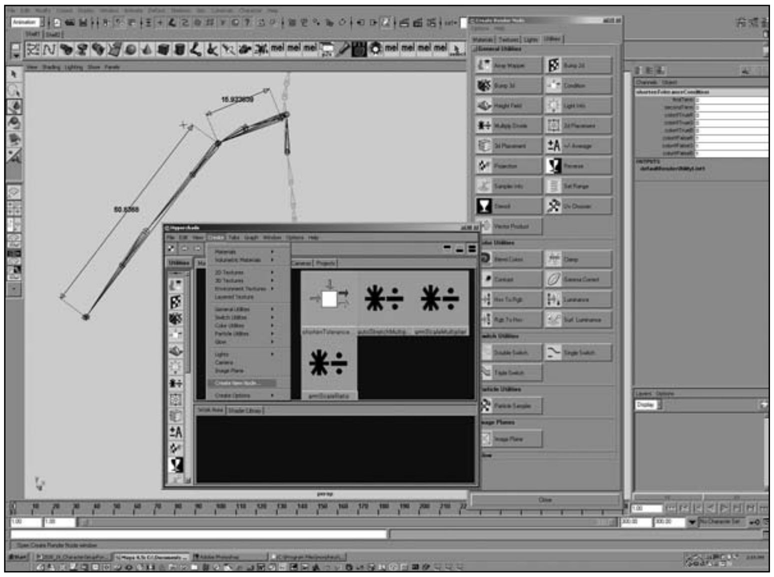


Figure 17.55 Setting up the utility nodes for the stretchy arm.

Next, you will create a few attributes that an animator can use to control the stretchiness of the character's arms.

6. Select the armWrist_IkControl and load up the Add Attribute window by going to Modify, Add Attribute.
7. In the Add Attribute window, create three float data type attributes with the following names and settings:

   autoStretch (min 0, max 1, default 1)

   shortenTolerance (min 0, max 1, default 1)

   armScale (min 0, max 10, default 1)

Now it is time to get started connecting some attributes to create our stretchy IK arm.

Because you already have the Hypershade window open, you will use it (instead of the Hypergraph) to make all of your node connections.

8. Choose the Utilities tab from the Hypershade, and select all four of the new utility nodes that you just created. Shift+add to the selection the armDistance_distanceDimension node and the armWrist_IkControl node from either the Hypergraph or the 3D view port. Now, with the current active selection in the Hypershade, click the menu item Graph, Input and Output Connections. You get a somewhat disorganized display of nodes. Organize the nodes in your window so that they are visually lined up similar to the order pictured, to make it easier to connect the appropriate attributes (see Figure 17.56).

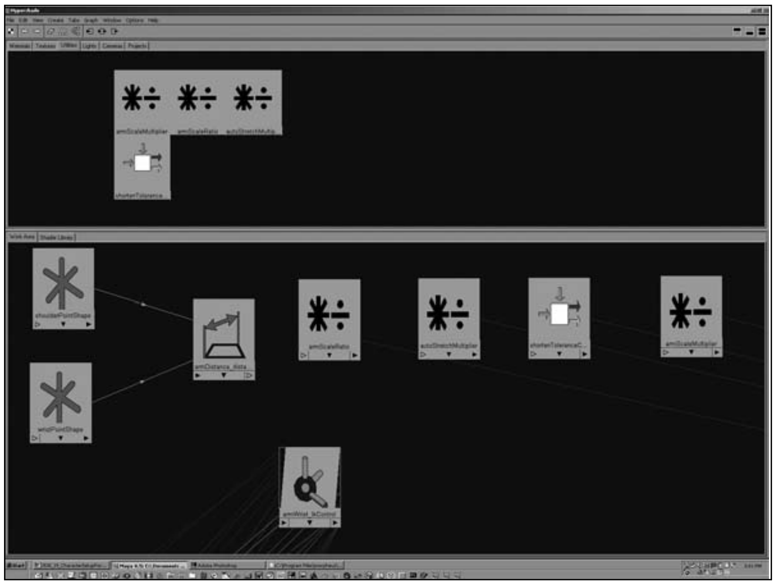


Figure 17.56 Preparing the utility nodes for the stretchy arm.

9. Holding down the Shift key and the middle mouse button, drag and drop the distanceDimensionShape node onto the armScaleRatio multiplyDivide node. Using the Connection Editor, connect the distance attribute to the input1X attribute of the multiplyDivide node.

10. Now select the armScaleRatio multiplyDivide node that you just connected to, and hit Ctrl+a to launch the Attribute Editor. Change the multiplyDivide node's operation mode from Multiply to Divide. Now copy the number from the input1X channel and paste it into the input2X channel so that you are dividing the current distance by the original distance.

The node's output should currently equal 1; as the distance grows, the output will be a normalized ratio equal to how much the initial distance has scaled (starting from 1). This output will eventually be the number that you use to drive the scale of the arm joints, but you will set up a few extra nodes to add a small amount of logic and control over the stretchiness.

11. Using the Connection Editor window, connect the following attributes to create an expression-based node network:

The armWrist_IkControl.autoStretch attribute into the autoStretchMultiplier.input1X attribute

The armScaleRatio.outputX attribute into the autoStretchMultiplier.input2X attribute (The output of this autoStretchMultiplier node enables you to blend the stretchy behavior from on to off, and vice versa.)

The autoStretchMultiplier.outputX attribute into the shortenToleranceCondition.firstTerm attribute

The autoStretchMultiplier.outputX attribute also into the shortenToleranceCondition.colorIfFalseR attribute

The armWrist_IkControl.shortenTolerance attribute into the shortenToleranceCondition.secondTerm attribute

The armWrist_IkControl.shortenTolerance also into the shortenToleranceCondition.colorIfTrueR attribute (The output of the shortenToleranceCondition node's outColorR attribute now keeps the arm from shrinking shorter than the shortenTolerance attribute specifies.)

The shortenToleranceCondition.outColorR attribute into the armScaleMultiplier.input1X attribute

The armWrist_IkControl.armScale attribute into the armScaleMultiplier.input2X attribute

12. Next, select the shortenToleranceCondition node and open the Attribute Editor by hitting Ctrl+a. Change the operation mode of this condition node to Less Than.

This condition node keeps the arm from scaling any shorter than what the armWrist_IkControl.shortenTolerance attribute is set to by making a decision for you. The logic behind how the condition node works is as follows: If the First Term is Less Than the Second Term, use Color If True; otherwise, use Color If False. This output, which goes into the armScaleMultiplier, enables you to manually stretch the arm longer or shorter by changing this attribute.

All that is left is to connect the output of this scale multiplier to each of the arm joints (the shoulder and the elbow).

13. Again, using the Connection Editor, connect the armScaleMultiplier.outputX attribute into both the shoulderJoint.scaleX and elbowJoint.scaleX attributes. Figure 17.57 shows a Hypershade and Hypergraph Input and Output Connections view of what your final node network should look like.

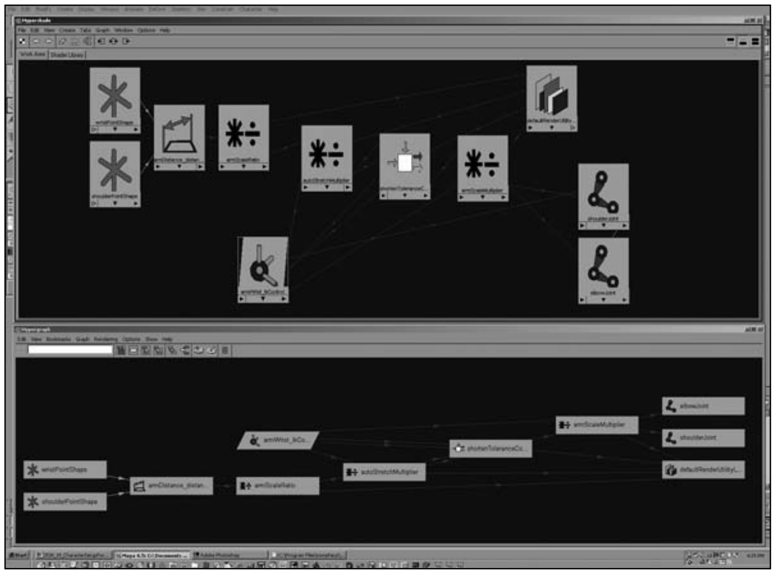


Figure 17.57 A Hypershade and Hypergraph Input and Output Connections view of what your final node network should look like.

Figure 17.58 shows a Hypergraph Scene Hierarchy view of what your node's groupings should look like.

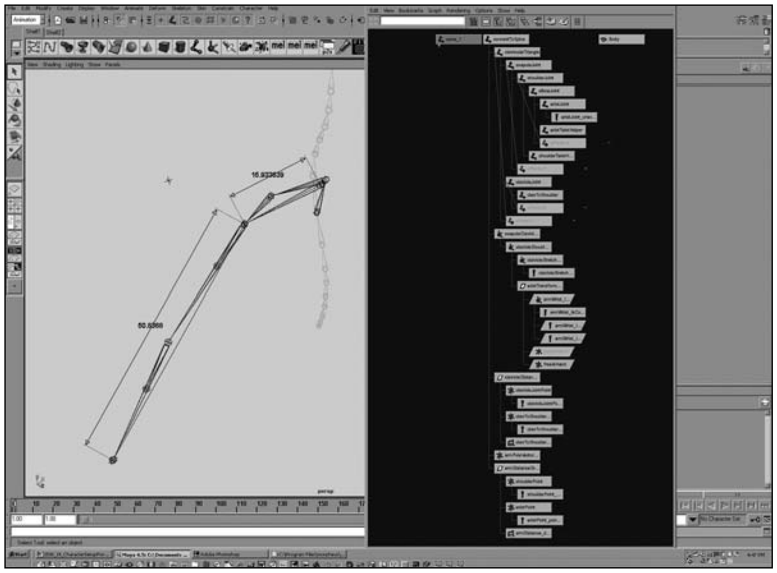


Figure 17.58 A Hypergraph Scene Hierarchy view of what your node's groupings should look like.

Now spend a few minutes testing the controls and attributes that you just created. Try moving around the freeIkHand locator while the handPlant attribute on the IK handle is set to 0. Experiment with your controls to make sure you didn't miss a step and that everything is functioning properly. If something seems to be working incorrectly, go back and retrace your steps to troubleshoot what might have gone wrong. This completed exercise with all the rigging finished is found in the file Jerk_ArmSetup_Finished.mb in the CD folder for this chapter.

In the next exercise, you will add the hand to the arm setup and, finally, put in all the control boxes that the character animator will ultimately use to animate the entire arm and hand.

Exercise 17.9 Rigging an Advanced Additive Hand and Fingers

Before you start this exercise, take a moment to examine the hierarchy of the hands for this setup, as in the file Jerk_HandJoints.mb in this chapter's folder on the CD. Note that at each knuckle there is an additional joint that is directly on top of the child knuckle joint. This technique allows for two things. It zeroes out the transforms of the children knuckles (which will be directly animated), and it also allows for layered animation on the parent knuckles if this becomes necessary for later shot requirements.

Also note that the knuckles have control boxes around them. The technique of using control boxes for the animators to set keys on is a great idea when setting up a character. Control boxes can be added to a character in many ways; this is covered later in this chapter. For now, you should know that these control boxes are actually NURBS curves shape nodes that were made children of the joint's transform by selecting the curve shape and then the joint, and using the –shape flag with the parent MEL command. (See the section in this chapter, " Hooking Up Control Boxes to Your Character Rig," for more information.)

For the hand setup, you want it to be super-easy for an animator to use, as well as have all the extra controls needed for the animator to hit any hand pose necessary. You will set up a hand control that will allow the animator to rotate the fingers individually or together, add a full-finger curl, and add individual controls for each knuckle. You will use added attributes that are connected to plusMinusAverage nodes, which add together the attributes that control the rotations of the knuckles.

1. Start by opening the completed previous exercise, which is found in the file Jerk_ArmSetup_Finished.mb (or, you can start from your own completed file). With the arm setup file open, import the file Jerk_HandJoints.mb that is on the CD for this chapter.
2. Select each parent joint node that makes up the fingers and thumb hierarchies. They are the thumb_1, index_DoubleKnuckle, middle_DoubleKnuckle, ring_DoubleKnuckle, and pinkyFinger_1 nodes. Parent them directly to the wristJoint node, and delete the empty handGroup group node that is left.
3. Now select each knuckle control box from the 3D view port, and go to Modify, Add Attribute. Add the following float data type attributes (just leave the min, max, and default options blank):

    fingerFullCurl

    fingerMidBend

    fingerTipBend

    Figure 17.59 shows the result.

    You will use the double-jointed knuckle, along with the addition operation of the plusMinusAverage nodes, to allow the fingerCurl attribute to make the whole finger bend each joint. This also will cause the finger to flex closed, while still providing individual control over each joint in each finger so that the animator can pose the hand very explicitly. For each of the four fingers, you will create two plusMinusAverage nodes and then connect the same attributes on each finger. The following steps go through one finger; you should repeat the steps for the rest of the fingers in the exact same fashion (except for the thumb, which is slightly different and is covered separately).

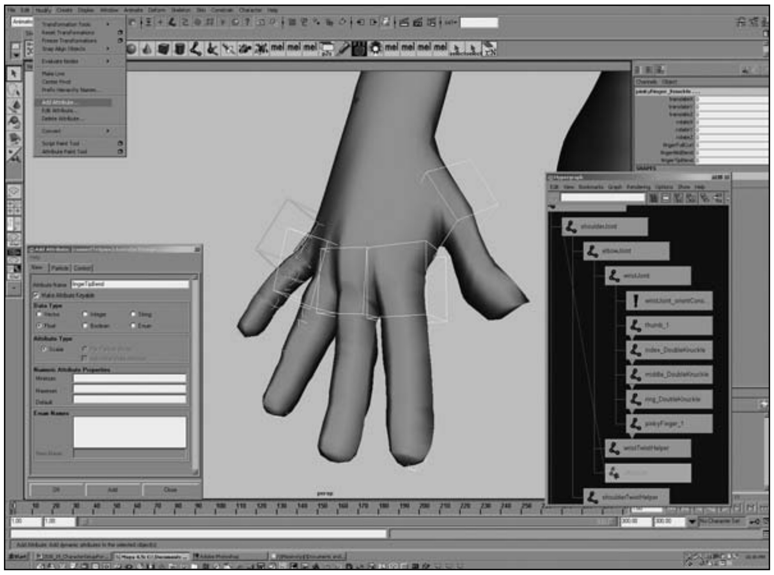


Figure 17.59 Knuckle control boxes.

4. Create two plusMinusAverage nodes by opening the Hypershade window and going to Create, General Utilities, Plus Minus Average.
5. Select the two new plusMinusAverage nodes that you just created, as well as the pinkyFinger_Knuckle node. Open the Hypergraph window and select Graph, Input and Output Connections.
6. Use the Hypergraph and Connection Editor to connect the fingerFullCurl attribute of the pinkyFinger_Knuckle node into the input1D[0] attributes of both plusMinusAverage nodes. Also connect the fingerFullCurl attribute to the pinky_DoubleKnuckle rotateX attribute.
7. Next, connect the fingerMidBend attribute of the pinkyFinger_Knuckle node to the input1D[1] attribute of one of the plusMinusAverage nodes. Now connect the output1D of this node into the rotateX attribute of the pinkyFinger_2 joint.

Tip

Sometimes array attributes can be tricky to connect to because the Connection Editor doesn't always show you the next available element. To connect an output attribute to the input1D[1] attribute, try selecting and loading both nodes into the Inputs and Outputs view of the Hypergraph. Next, right-click and hold down the mouse on the very rightmost side of the output node. A pop-up menu should appear that displays at the very top Connect Output Of and that gives you a list of attributes. Continuing to hold down the mouse button, highlight the appropriate attribute from the list and then let go of the mouse button. The mouse turns into an active dragging line with a little square icon at the end.

Now right-click on top of the node that contains the input array attribute, and hold down the mouse button. You should see a menu labeled Connect Input Of. While still holding down the right mouse button on top of your input node, select the appropriate input array attribute. That's it—you just made a connection. This technique takes a little practice, but it is really fast once you get the hang of it. And it takes less effort because you don't need to load the Connection Editor just to connect a few attributes.

8. Connect the fingerTipBend attribute of the pinkyFinger_Knuckle node to the input1D[1] attribute of the other plusMinusAverage node. Now connect the output1D of this node into the rotateX attribute of the pinkyFinger_3 joint.

   Figure 17.60 is an example of what the node network looks like for the finger.

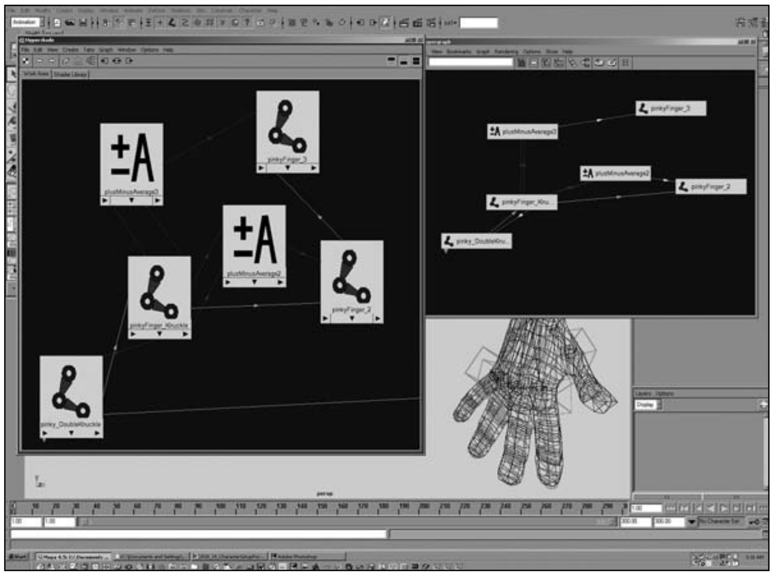


Figure 17.60 This is what the node network looks like for the finger.

Perform steps 2 through 8 for each of the other four fingers.

9. For the thumb, create three plusMinusAverage nodes. Select them along with the thumb_Knuckle joint, and load them in the Input Output Connections view of the Hypergraph.

10. Connect (using the Hypergraph and the Connection Editor) the thumb_Knuckle rotateY and rotateZ attributes directly to control the thumb_1 rotateY and rotateZ attributes.

11. Connect the fingerFullCurl attribute of the thumb_Knuckle to the input1D[0] attribute of one of the unused plusMinusAverage nodes. Then connect the fingerMidBend attribute to the input1D[1] attribute of the same plusMinusAverage node. Now connect the output1D of this plusMinusAverage into thumb_DoubleKnuckle rotateX.
12. Connect the fingerFullCurl attribute of the thumb_Knuckle to the input1D[0] attribute of one of the other unused plusMinusAverage nodes. Then connect the thumb_Knuckle rotateX attribute to the input1D[1] attribute of the same plusMinusAverage node; connect its output1D into the rotateX of the thumb_1 node.
13. Connect the fingerFullCurl attribute of the thumb_Knuckle to the input1D[0] attribute of the last unused plusMinusAverage node. Then connect the fingerTipBend attribute to the input1D[1] attribute of the same plusMinusAverage node. Now connect the output1D of this plusMinusAverage into the thumb_2 rotateX attribute. Your result should look like Figure 17.61.

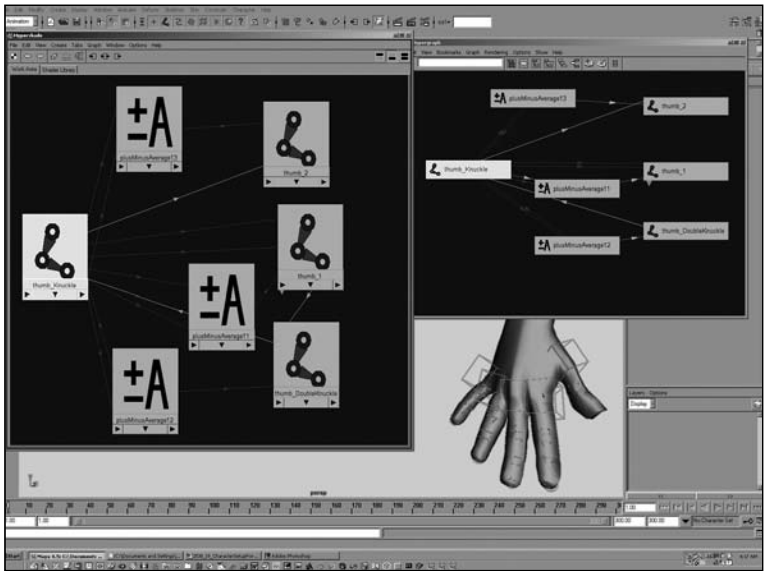


Figure 17.61 Utility nodes set up for the hand.

This completes the hand setup. For a finished example file of this rig, open the scene file Jerk_HandSetup_Finished.mb, which is included in this chapter's folder of the CD.

Hooking Up the Head Skeletal Hierarchy

For the head of a character, you can create a separate hierarchy that is point-constrained to a locator that is a child of the spine or neck. This leaves the rotational controls free from the hierarchy and enables the animator to animate them by hand (see Figure 17.62). You will do this in the next exercise.

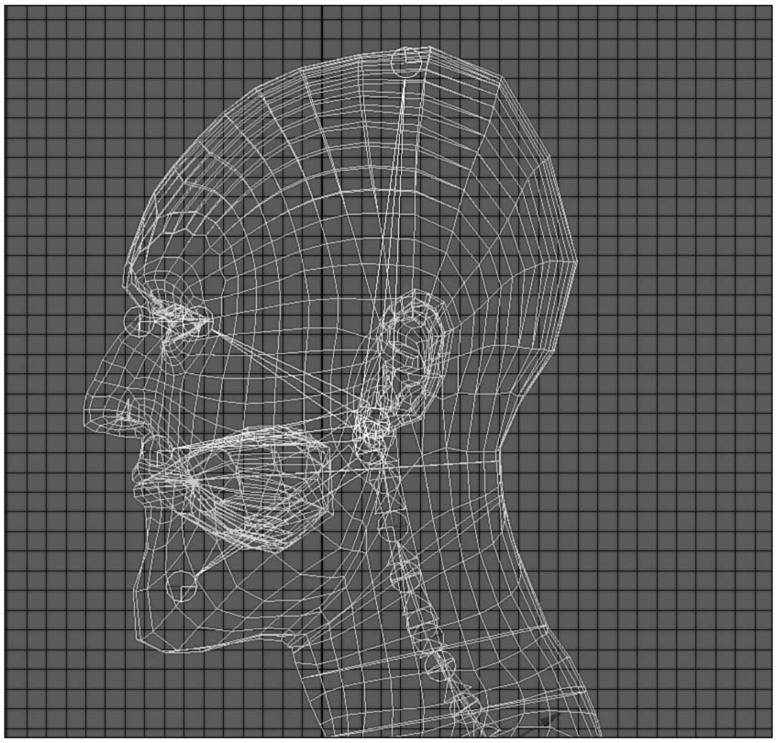


Figure 17.62 IK layout for the head.

Exercise 17.10 Attaching the Head Setup

This is a short exercise that goes through a few simple steps to create a joint hierarchy for the head. The head is created first. Then it is connected to the neck using a combination of constraints that allow for additional freedom when animation occurs, giving the character's head extra flexibility later.

1. Create the head joints for your character using a similar joint layout as shown in Figure 17.62.

   It is a good idea to place the jaw's point of rotation slightly in front of and below the side view of the ear lobe. Usually you should include a few extra joints that stem from the jaw, as well as a joint that goes up to the top of the head of your character, for extra weighting of the facial geometry.

2. Next, create a locator and point-snap it to the root of the head skeleton that you just created. Make this locator a child of the nearest neck joint.

3. Point-constrain the head's root to this new child locator by selecting the locator and then the head's root joint, and performing Constrain, Point (see Figure 17.63).

   This setup allows the character's head to rotate freely from the spine and neck, but it still translates around with the neck and spine appropriately. If you need to translate the neck by any small amount, the ability is there by moving the locator that the head is constrained onto.

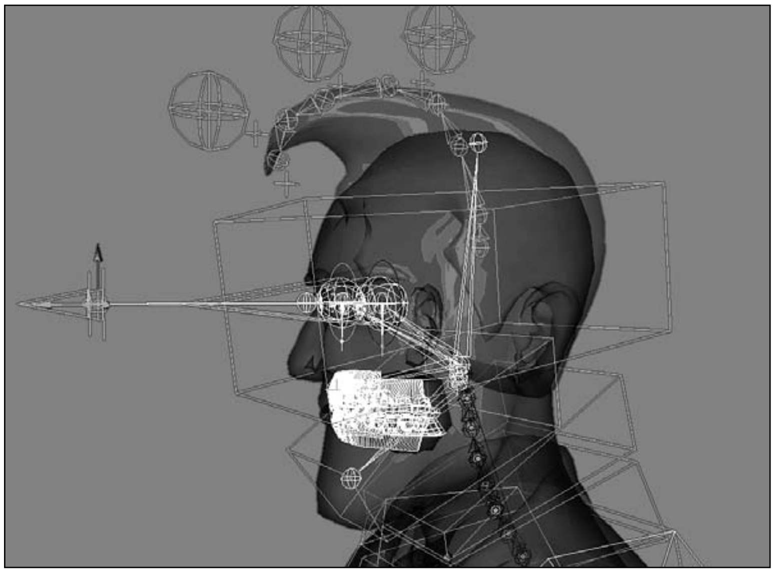


Figure 17.63 Full head setup with control boxes.

Facial Controls and Blend Shape Deformers

Although facial rigging was a smaller portion of the setup for this project, the way that the rigging was accomplished can also be used for complex scenarios of lip-synching and high-range emotional facial animation. All facial expression controls can be successfully implemented in a very traditional way. You first model them as separate models and apply them as blend shapes targets. Then you rig each attribute of your blend shape into a single faceController node simply and quickly by adding attributes. Then you use the Connection Editor to quickly hook them all into the single faceController node so that they are easily accessible to the animator.

Eye blinks can also be modeled as blend shapes and hooked up using set-driven key onto attributes of a driver. Each eye should have a separate blink control so that the eyes can blink at an offset of each other (see Figure 17.64).

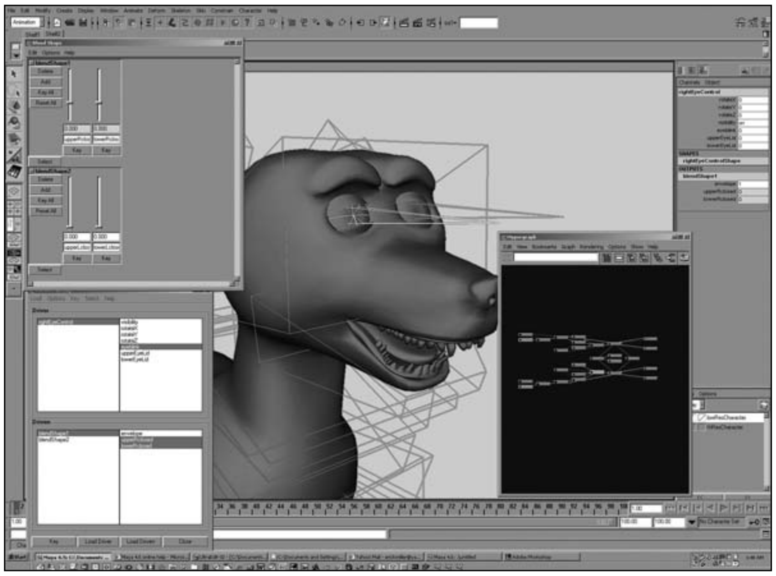


Figure 17.64 Blend shape setup for eye blinks.

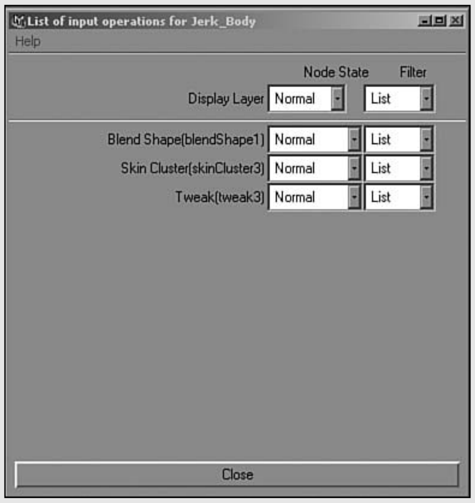
The opening and closing of the jaw can be achieved using joints and painting the smooth bind weights to achieve an appropriate and appealing opening and closing of the mouth corners.

It is important to note that all the blend shapes for the lips must be modeled with the geometry in the default pose, with the mouth closed, to avoid double transformations of the jaw being double deformed while opening.

Tip

To create blend shapes for a character that has already been bound to a skeleton, you will want to be sure of two things:

- Be sure that you are using an exact duplicate of the character's geometry before it was bound to the skeleton to begin modeling your blend shapes.
- When you create the blend shape, go into the Advanced tab in the Create Blend Shape options box and choose the Front of Chain options in the deformation order pull-down menu. Or, after you create the blend shape, choose Inputs, All Inputs and use the middle mouse button to drag your blend shape to the bottom of the deformation order list (just above any tweak nodes there—see Figure 17.65).



List of input operations for Jerk_Body

	Node State	Filter
Display Layer	Normal	List
Blend Shape(blendShape1)	Normal	List
Skin Cluster(skinCluster3)	Normal	List
Tweak(tweak3)	Normal	List

Figure 17.65 List of history operations window.

Creating Eye Controls

The eye's "look at" controls were set up simply with two joints for each eye. RPK IK handles were point- and pole vector–constrained to a locator that is a child of the "look at" control.

The next exercise takes you through this process. Start with a new scene and create two spheres, evenly placed as your eyeball objects.

Exercise 17.11 Eye Setup

Begin by creating the joints for the eyes.

1. Create two joints for each eye.

   The crucial aspect of where these joints get placed is that the parent joint (the one that will control the rotations of the eye) has its location in the exact same location of the eye geometry's pivot. Therefore, it is also extremely important that the eye be capable of rotating around its own pivot without visibly intersecting any of the face's external geometry. In other words, make sure the eyes can look around correctly by simply rotating around. If the eyes are perfect spheres and are carefully placed inside the head, and if the head is modeled correctly around the eyes, centering the pivot of the eyes should work just fine.

   An easy way to make sure your parent joint is in the exact same place as your eyeball joint is to turn on handles for the node that should rotate the eyes. You can do this by selecting the joint and going to Display, Component Display, Selection Handles. Then use the v key to point-snap the joint directly on top of the location during creation and layout of the joint.

2. Create two locators, and place each locator directly in front of each eye.

3. Name the joints and the two children locators appropriately according to which eye they are in front of: leftEyeJoints and leftEyeAim.

4. Next, create an IK handle from the parent joint to the end joint at the end of the eye.

5. Now select the "look at" locator first and the IK handle second; click Constrain, Point to point-constrain the IK handle onto the locator.

6. With the same selection active, click Constrain, Pole Vector to pole vector–constrain the IK handle to the same target.

7. Select the eyeball geometry group. Shift+select the parent eyeball joint, and hit p to parent the eyeball geometry to the joint (see Figure 17.66).

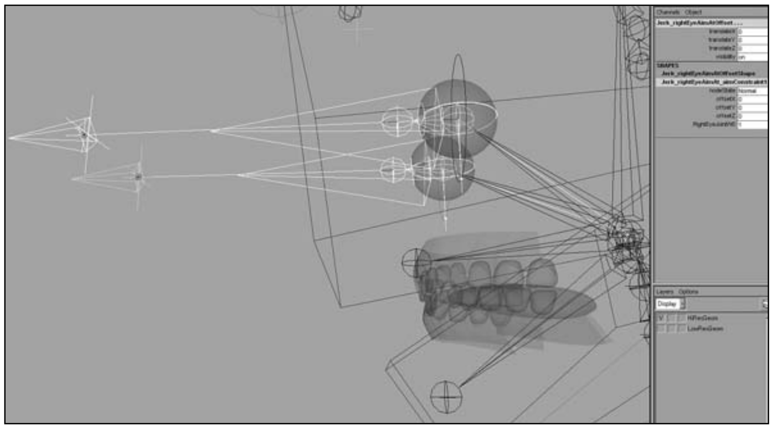


Figure 17.66 Parenting the eyeball to the eyeball joint hierarchy.

You can now hook up some parented control boxes to make the eyes look around. You can add an additional parent to the aim locator that is point-constrained to the location of the eyes. An animator can use this to have FK-style rotations and then actually translate the locator to have the IK style look at control as well.

This technique involves several really cool things. First, you will not get flipping because you will have control over the IK handle's rotate plane much better than a mere aim constrain could provide. Second, you can actually bind those joints that are rotating the eyes to the face geometry. When you weight the character, you will want to carefully distribute the weighting of the eye joints just around the lids of the character, somewhere between .2 and .4, so that the fleshy area around the eyes actually deforms subtlety enough when his eyes look around.

The Hair of the Jerk

For the hair of The Jerk, the overlapping action rig setup was used (loaded straight from the finished example file from Chapter 13, "Making Advanced Connections"). This was simply imported from the completed file from Chapter 13, chapter13_OverlappingAction_finished.mb, and then was translated, rotated, and scaled into place using the TRANS_ROTATE_SCALE_MATRIX node. Then the mainAttachNode was constrained to the end of the head hierarchy to attach it to the main skeleton. See Chapter 13 for a detailed step-by-step tutorial on how to create this dynamically driven floppy IK setup.

Note

If you do not want the dynamics mode of this rig during actual animation testing, you can turn the dynamicFlopOnOff and addMoreFlopiness attributes found on the FloppyChainContoller locator node to 0 until the actual playblasted animation occurs. Then you can begin testing how high you want to set these attributes. Note that because this portion of the rig is using soft body particle dynamics, it is necessary to start the animation at least 10 to 15 frames earlier so that the dynamics get a chance to calculate their initial position correctly.

Smooth Binding Proxy Geometry

The characters were modeled using subdivision surfaces in Maya, but when it came to production, we chose to convert our properly modeled sub-d meshes into medium-resolution polygon meshes for the purposes of our rendering pipeline going out to Mental Ray. We were also fortunate enough to not need to deal with the hassle of binding Maya's sub-d surfaces or doing any deformations on sub-d geometry at all because we had a pure polygon conversion before skinning occurred. I strongly recommend doing things this way, unless there is a strong reason to not to. The level of simplification on a geometric level becomes a real time saver and improves the quality of your final result.

This might not be the case for some productions using Maya, though. Because subdivision surfaces are going for a full-blown implementation in Maya, I have included the workflow that is involved with rigging a character that is actually built from Maya's native subdiv mesh node. The following exercise was not necessarily used for our production, but it is an important step to take if you are planning to skin a subdivision mesh in Maya.

The basic premise for the workflow is this: We do not want to bind the Maya subdivision surface itself to the joint's skinCluster because it will be much too slow to deform or to paint weights onto. The difficulty of working with the model is truly overwhelming when compared with simply binding the polygon control mesh shape node. You will bind only the joints that need to deform the character by implicitly selecting them and then selecting the polygon control mesh shape node, instead of binding directly the subdivision surface.

Exercise 17.12 How to Bind a Subdiv Mesh's Polygon Proxy Control Mesh

This exercise was written to work with any character as a general workflow tutorial. Therefore, it is not file-specific. You will simply need to start with a scene that contains any Maya subdivision surface geometry and some joints to bound the geometry onto.

1. Go to your current 3D view panel. Under the Show menu, turn off everything except joints. This makes it easier to see and select only joints.
2. Carefully select only the joints that are important for the character to deform.

   This means that anywhere there are overlapping or point-constrained joints, select only the single joint that should be causing the deformations. Never select two joints that are overlapping (double joints). You also usually don't need to select the tips of the joint hierarchies. Keep the Hypergraph open to make sure you are selecting only the joints you need. The fewer joints you select, the fewer you will have to paint weights for later.
3. When you have made sure your selection is correct, save a quick-select set by going to Create, Sets, Quick Select Set. Call your new set bindJoints. This is just a way of saving a selection so that you can go back and select it again later.
4. Now select the subdivision character and open the Hypergraph window. To select the polygon control mesh, you must be in Scene Hierarchy mode of the Hypergraph. Turn on Options, Display, Shape Nodes by making sure there is a check box next to it in the menu window.
5. Next, you should see two shape nodes. One is a subdiv shape that is being fed its data by a polyToSubdiv node (which you can see if you select it and click Graph, Input and Output Connections). Below it is another shape node, which is a polygon mesh shape. The polygon mesh shape node is your poly control cage (as seen in Figure 17.67).

   You can select the polygon proxy control mesh of your native Maya subdivision geometry by viewing the shape nodes, as previously stated. Or, you can find it in the tangled node network that shows up in the Input/Output Connections view of the Hypergraph. Or, you can use a quick MEL command by selecting it in the View window and executing the following line in the Script Editor window:

   ```
   select -r 'listRelatives -c -type mesh';
   ```

Note

If your subdiv surface is not in polyProxy mode, you will need to switch it to this mode before any of this will appear. Select your surface and go to Subdiv Surfaces, Polygon Proxy Mode.

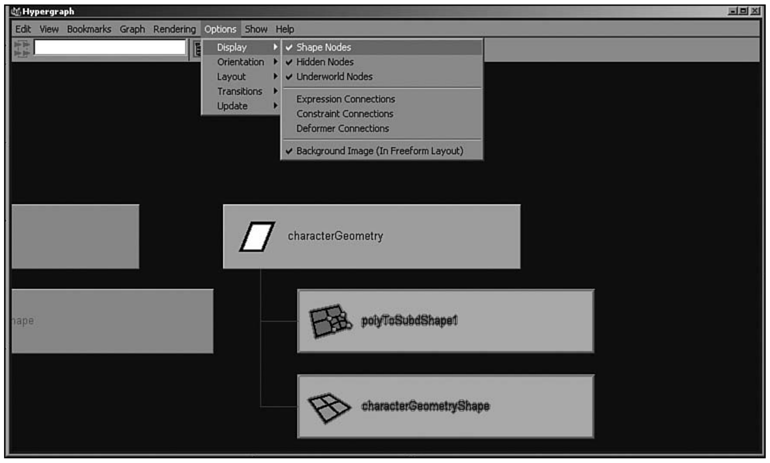


Figure 17.67 Viewing geometry shapes with the Hypergraph.

6. With the polygon shape node visible in the Hypergraph, select your bind joint selection set by going to Edit, Quick Select Sets, bindJoints.
7. Hold down the Shift key and select the polygon shape node in the Hypergraph.
8. Go to the options for Skin, Bind Skin, Smooth Bind Options Box, change the Bind To options to Selected Joints, and hit the Bind Skin button.
9. Before you can paint weights, you must assign a shader to the poly proxy mesh. Select the poly proxy control mesh again. Open the multilister, right-click the initialShadingGroup, and choose Edit, Assign.
10. Under your current 3D view, go to the Show menu and turn off Subdiv Surfaces. This makes it easier to deform your character and visibly see what is going on.

Painting Smooth Skin Weights

Painting weights is one of the single most important stages for your character's deformations to look believable and appealing. The process of painting weights basically involves using the Artisan paint brush architecture in Maya to paint on a value somewhere between 0 and 1. This will tell your skin cluster which joints will have an influence on the movement of which vertices.

The following text describes the process I use to paint weights on a smooth bound character. Then following exercise elaborates on the specifics involved to achieve good character weighting.

First, just as if you were doing a painting, rough in your general values by blocking out your weights, going through groups of vertices as well as each joint, and flooding them with either 0 or 1 values. Next, paint with a medium-size brush around the edges of your weights so that all the influences are at a value of 0 or 1. When you are finished and you have painted every single joint at either 1 or 0, you set the Artisan value to 1 but turn the opacity down to about .33.

Then go through and lightly soften the edges of all your weights by painting with this partially opaque brush. Every once in a while, use the smooth brush at this stage to also soften the edges. The last stage is to go through and use the smooth brush exclusively to really soften the weights on the joints that you want to have a lot of fall-off to their weighting. During this entire process, you should be testing your character's deformations by bending the joints and testing the controls. When you get things looking pretty good, you should do major motion and extreme poses for your character; test the weighting on an animated character that is hitting really exaggerated poses (with hands way up in the air, bending over and touching the head to the toes, and so on). At this point, you can go back and paint in the weights to fix any problems you see.

As a general workflow process, painting weights can seem somewhat repetitive, tedious, and often frustrating. It can feel like as soon as you change one joint's weights to look good in one pose, the other pose no longer works. It is important to note that sometimes it is simply a process of finding an acceptable state in between. Usually, though, if you follow the workflow outlined in the steps ahead, the painting of your character's weights should end up being a very smooth process (no pun intended!).

Exercise 17.13 Common Workflow for Effectively Painting Smooth Skin Weights

1. Select the smooth-bound polygon mesh and begin to paint weights using the Artisan options found under the Skin, Edit Smooth Skin, Paint Skin Weights Tool options box (see Figure 17.68).
2. Select the bound character. Under Skin, Edit Smooth Skin, Prune Small Weights (with a setting of about .4), get rid of all traces of pointlessly weighted vertices before you begin your weight painting. This enables you to see exactly which joints are the major influences deforming the geometry of your character. You will have a better idea of which joints you need to paint weights for the most (see Figure 17.69).

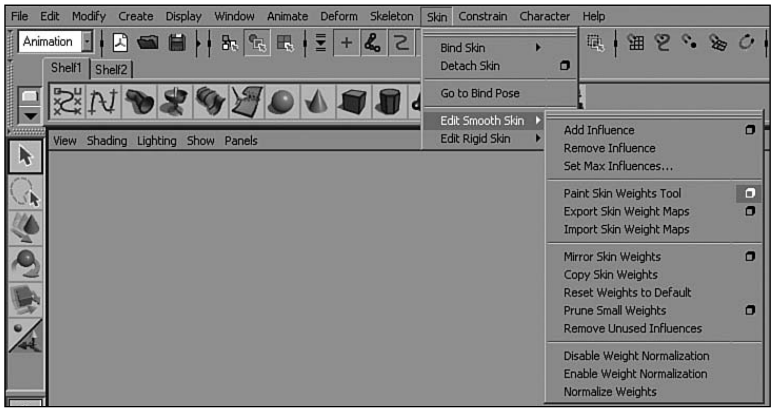


Figure 17.68 The Paint Skin Weights menu.

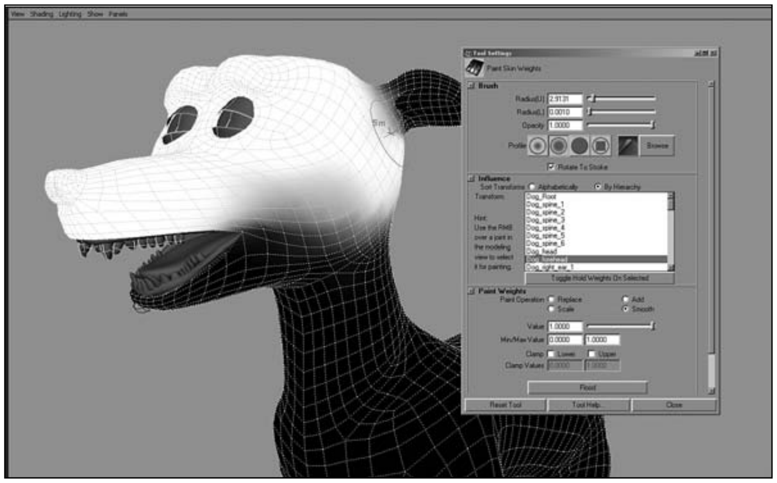
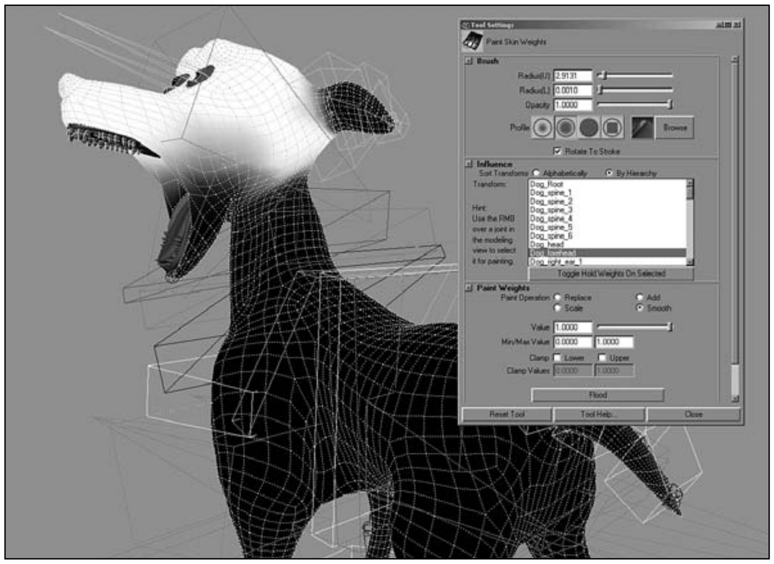

Tool Settings
Paint Skin Weights
Brush
Radius(U) 2.9131
Radius(L) 0.0010
Opacity 1.0000
Profile
Browse
[✓] Rotate To Stroke
Influence
Sort Transforms ○ Alphabetically [✓ ● By Hierarchy]
Transform: Dog_Root, Dog_spine_1, Dog_spine_2, Dog_spine_3, Dog_spine_4, Dog_spine_5, Dog_spine_6, Dog_head, [illegible], Dog_right_ear_1
Hint: Use the RMB over a joint in the modeling view to select it for painting.
Toggle Hold Weights On Selected
Paint Weights
Paint Operation ○ Replace ○ Add ○ Scale [✓ ● Smooth]
Value 1.0000
Min/Max Value 0.0000 1.0000
Clamp ☐ Lower ☐ Upper
Clamp Values 0.0000 1.0000
Flood
Reset Tool
Tool Help...
Close

Figure 17.69 Painting weights with Artisan.

3. Deform the character by placing it into several extreme poses and setting keys across the timeline.

   A common sequence of poses during this phase would be a "jumping-jack" sequence, with the character's legs and arms reaching their full upward and downward extensions. This is known as range-of-motion testing. You want to paint the weights for your character so that they look decent even at the most extreme poses. This way, you will be sure that they will look good when the animators pose the character in a more normal, expected pose (see Figure 17.70).



Radius(U) 2.9131
Radius(L) 0.0010
Opacity 1.0000
[✓] Rotate To Stroke
Sort Transforms: Alphabetically [✓ By Hierarchy]
Transform: Dog_Root, Dog_spine_1, Dog_spine_2, Dog_spine_3, Dog_spine_4, Dog_spine_5, Dog_spine_6, Dog_head, [✓ Dog_forehead], Dog_right_ear_1
Paint Operation: Replace, Scale, Add, [✓ Smooth]
Value 1.0000
Min/Max Value 0.0000 1.0000
Clamp: Lower, Upper
Clamp Values 0.0000 1.0000

Figure 17.70 Testing deformations while painting weights.

4. Paint the weights for only half of the mesh, until deformations are acceptable on that half. I almost exclusively use Replace mode and Smooth mode in Artisan to paint skin weights. These modes are set in the Paint Weights section of the Paint Skin Weights tool options.

5. When you have the weights painted for half of the character, select the skin and use the Mirror Weights feature under the Skin, Edit Smooth Skin, Mirror Skin Weights options box (see Figure 17.71). Be sure to use the correct axis settings that you want to mirror across.

6. Now you can clean up your mirrored weights (they never come out perfect) by checking all the deformations and going through the same steps that you did previously to make sure all your weights are perfect on both sides. Painting precise and sparing brush strokes with the Smooth mode of the Paint Weights tool only where it's needed is crucial at this stage for really well-painted smooth skin weight deformations.

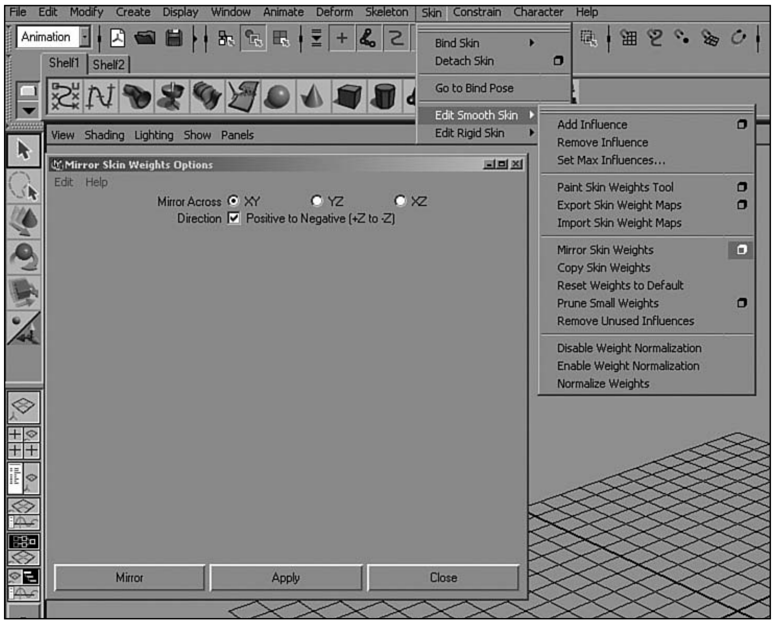
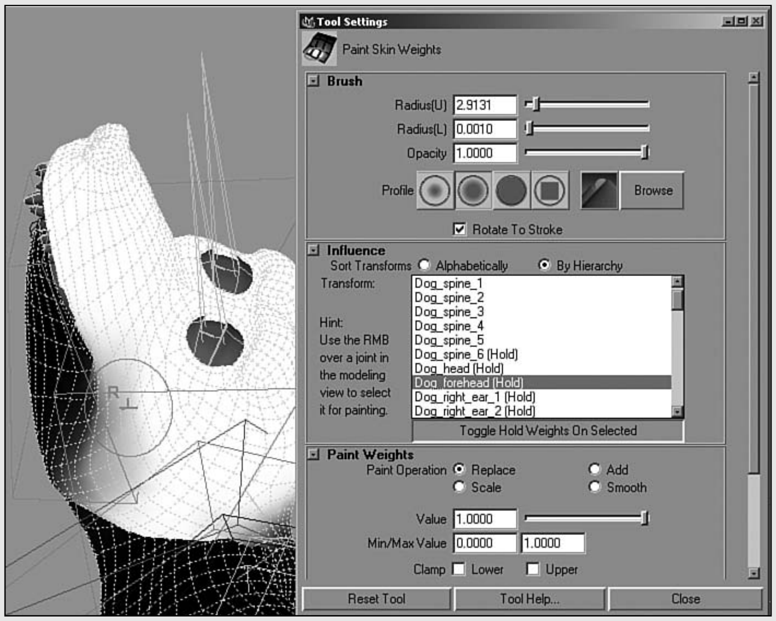


Figure 17.71 Use the Mirror Weights feature to create your mirrored weights.

Tip

Use the Toggle Hold Weights on Selected button in the Paint Weights window to keep a joint's weights from changing after you have painted them (see Figure 17.72).



Radius(U) 2.9131
Radius(L) 0.0010
Opacity 1.0000
☑ Rotate To Stroke

Sort Transforms ○ Alphabetically ● By Hierarchy

Transform:
Dog_spine_1
Dog_spine_2
Dog_spine_3
Dog_spine_4
Dog_spine_5
Dog_spine_6 (Hold)
Dog_head (Hold)
Dog_forehead (Hold)
Dog_right_ear_1 (Hold)
Dog_right_ear_2 (Hold)

Hint: Use the RMB over a joint in the modeling view to select it for painting.

Paint Operation ● Replace ○ Add ○ Scale ○ Smooth

Value 1.0000
Min/Max Value 0.0000 1.0000
Clamp ☐ Lower ☐ Upper

Figure 17.72 Using Toggle Hold Weights.

Paint Weights Using per-Vertex Selections

You can use the Skin, Edit Smooth Skin, Paint Skin Weights tool on a per-vertex level as well as an entire object level. Many people are not aware that you actually can use the Paint Weights tool on a per-vertex level by selecting the vertices and loading the paint weights tool. This is extremely useful when you first start painting the weights on your character and you are trying to lay out your initial weights, or when you are trying to "point-tweak" certain vertices and leave others alone. Select the vertices whose weights you want to change, and use the Flood button to flood those vertices in Replace mode with a value of 1; this is a great first step at very quickly roughing in your character's weights. You can then go in and use low opacity in Replace mode with a value of 1, as well as Smooth mode with flooding, to really disperse the gradual fall-offs of your joints' weighting.

Sometimes it is difficult to paint or select the correct vertices on a character that you are trying to change the weights on because those areas are in little crevices, such as under the armpits, in folds of skin, between the legs, or between crevices in fingers. These most difficult areas to paint the weights on also end up becoming the most crucial areas for making the best-looking deformations on your character. So, having a quick and easy way of selecting and editing these areas ends up being crucial as well. A great tip for selecting these difficult vertices of your polygon character is to use the UV Texture Editor, but still select it using Vertex Component Selection mode. The geometry is literally unwrapped in UV space. If your modeling and texturing departments have done a good job laying out your UVs, the process of selecting vertices using this unwrapped representation of your character becomes an extremely quick and easy trick to use.

Figure 17.73 shows difficult vertices to select in 3D space and the exact same vertices selected in UV space. This is an example of how much easier and quicker it can be if you have the right UV layout at hand.

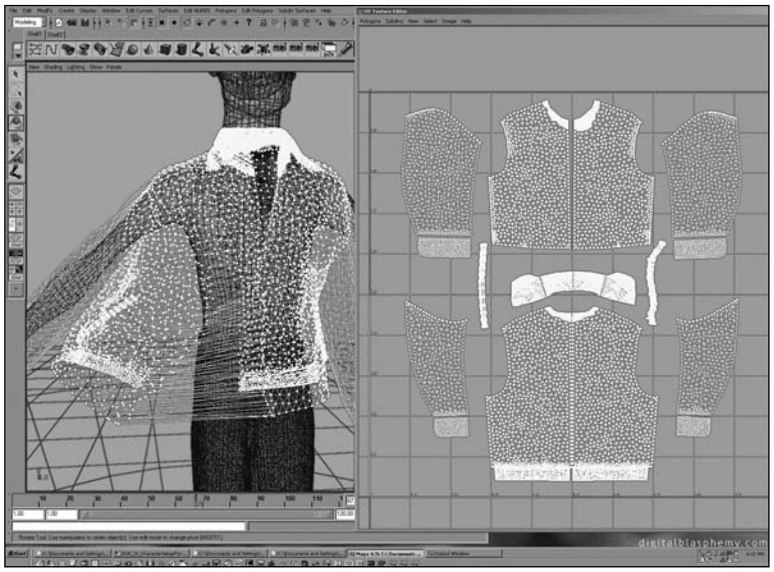
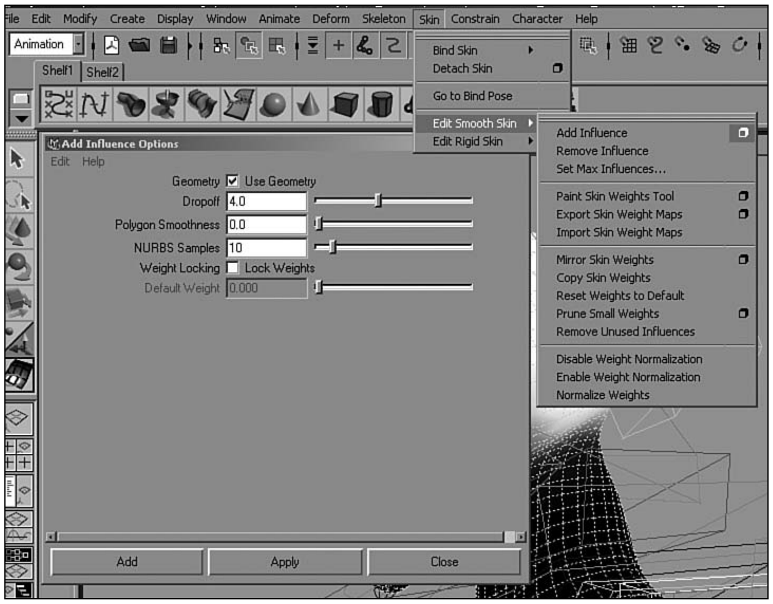


Figure 17.73 Using the UV layout to quickly select vertices.

Using Additional Influence Objects

The smooth binding in Maya works quite nicely because it enables you to use multiple influence objects. It even allows geometry to become an influence object that you can paint weights for.

Although it wasn't necessary to use influence objects for our character rig, I highly recommend using them to achieve complex deformations. Check them out in the Maya documentation. You create an influence object from any transform node in Maya by selecting the smooth bound mesh and then the object that you want to become an influence. Then you choose Skin, Edit Smooth Skin, Add Influence (see Figure 17.74).



Geometry ☑ Use Geometry
Dropoff 4.0
Polygon Smoothness 0.0
NURBS Samples 10
Weight Locking ☐ Lock Weights
Default Weight 0.000

Figure 17.74 The Add Influence menu command.

When you have finished painting weights and you have done all the other steps necessary to finish setting up your character, such as parenting low-res geometry and creating control boxes (as explained in earlier sections of this chapter), you are ready to hand off your file to the animator.

Summary

Character rigging can be a very fun and interesting process. The one thing to remember about this entire process, though, is that it will always be a collaboration between you and other teams. The way that the file is set up, as well as the controls there, will ultimately be used by the animator; thus, they need to be easily understood and controllable. The deformations of the character will ultimately change the shape and nature of the character's model and must therefore stay true to the design and style in which the character was originally modeled. The character that you set up must eventually be textured, lit, and rendered, so it absolutely must not have geometric problems such as bad normals or bad UVs when you bind it to the skeleton. The difficult part in setting up a character is being able to systematically take all of this into consideration, with the final goal being a stable character whose transformation space has been manipulated to offer full control to the animator.

Character animation is a long and difficult process, and the capability to have the character react in a desirable and predictable way is the most valuable thing that can be achieved. To make the character's controls and deformations predictable, and to give the character the capability to be textured, lit, and rendered are all vital in their own ways. The process of character animation will continue to become more simplified—and, therefore, capable of more sophistication—as time goes by. The same can be said of the techniques to rig a good character that is capable of achieving more types of motion. Always remember that, much like a puppet, there is a human behind the controls of your character breathing the appeal of artificial life into its computer-generated soul.