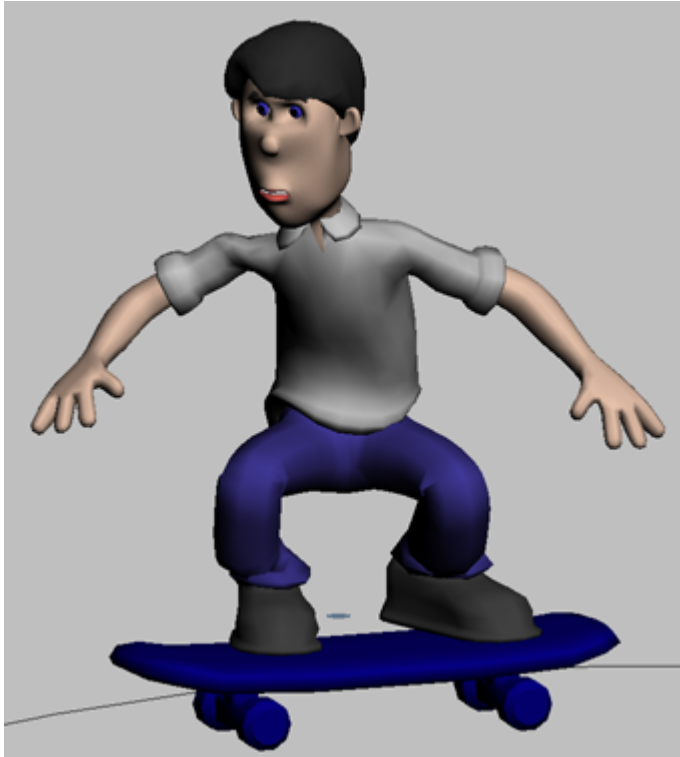


Interacting with Objects

This tutorial shows you how to animate a biped interacting with other objects.

The movement of the biped's hands can control the movement of the second object, or the biped's hands can be constrained to or animated by that other object. There are also lessons on creating the illusion of weight, and using In Place mode.



In this tutorial, you will learn how to:

- Make hands and feet follow objects.
- Simulate lifting and pushing heavy objects.
- Work with props.
- Look at an animated object.

Skill level: Intermediate

Time to complete: 2.5 hours

Making a Hand Follow an Object

In this lesson, you'll make a biped's hand follow an animated object.




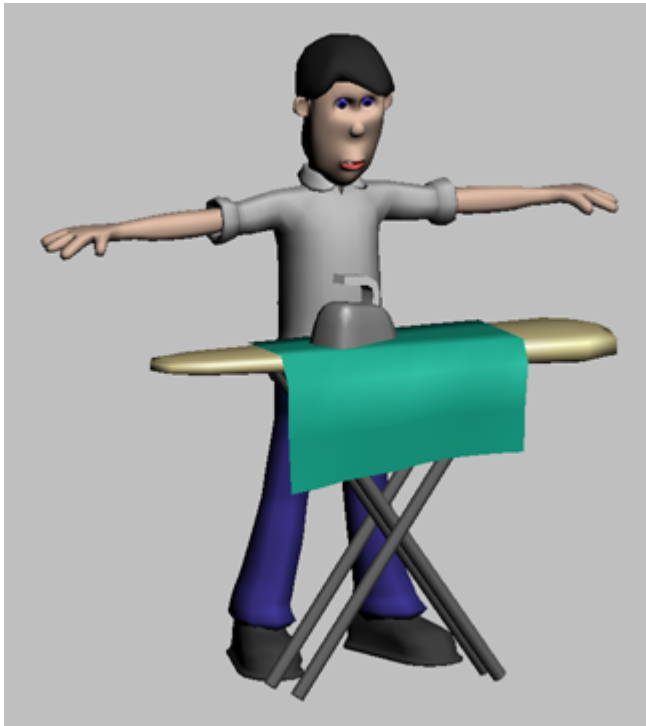
When a biped's hand must interact with an object, there are two methods you can use to create the animation:

- Animate the hand, then link the object to the hand with Select And Link, or
- Animate the object, and use IK settings to make the hand follow the object.

The second method has some practical advantages, which are illustrated in this lesson.

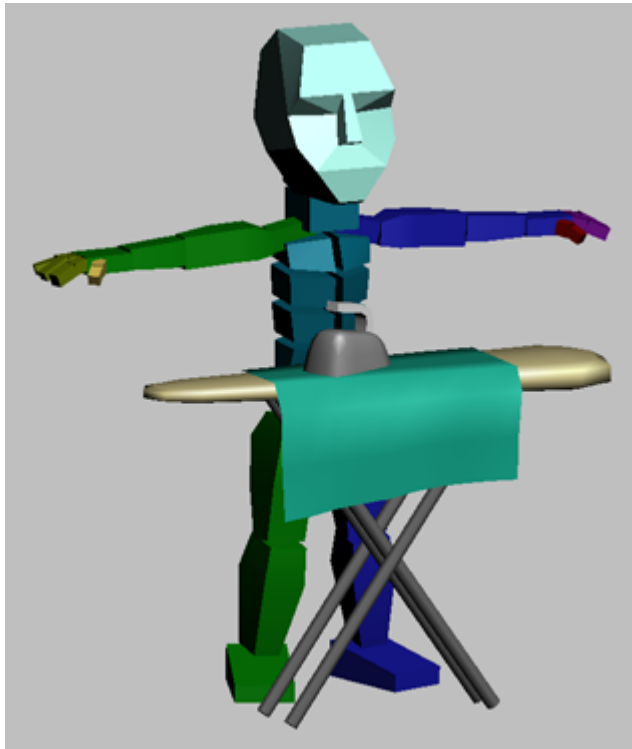
Set up for this lesson:

- 1  On the Quick Access toolbar, click the Open File button, navigate to the `\animation\character_animation\interacting_with_objects` folder, and open `ironing_start.max`.






This file features a character named Wilson standing in front of an ironing board.

- 2 Play the animation. The iron is animated to move over the cloth on the ironing board.
This character already has a biped with Physique applied to it. To work with the character, you'll hide the mesh and unhide the biped.
- 3 Choose the named selection set *Wilson Biped*. When the warning dialog appears, click Yes.
The biped appears in the scene.
- 4 Choose the named selection set *Wilson Mesh*.
- 5 On the Display panel, click Hide Selected.
This leaves the biped in the scene without the character mesh.



Pose the hands:

- 1  Go to the Motion panel.
- 2 Go to frame 0.
- 3 Turn on Auto Key.

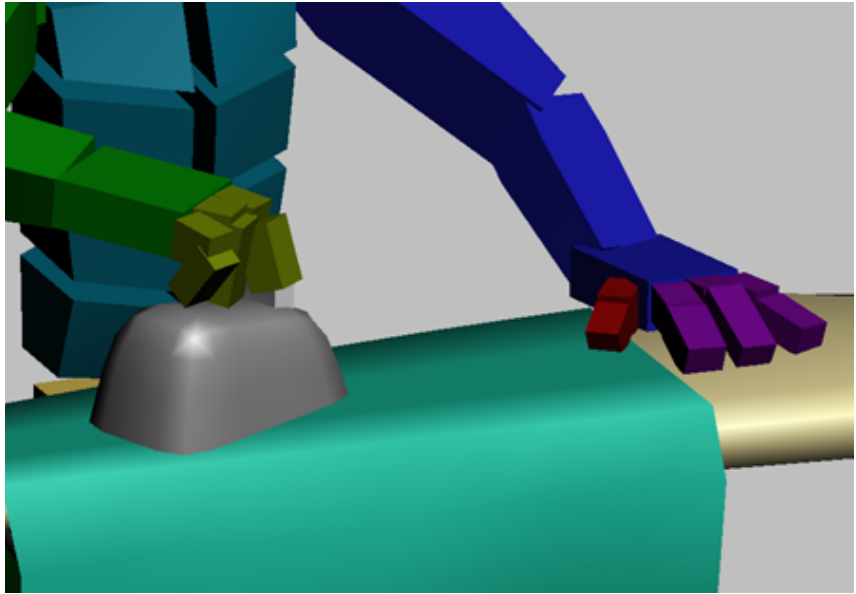
- 4   Using Select And Move and Select And Rotate, pose the right hand to hold the iron handle. Look at the hand from different angles to ensure it is gripping the handle. Don't be concerned if the fingers pass through the handle slightly.

TIP You can also right-click in a viewport and choose Move or Rotate from the quad menu.




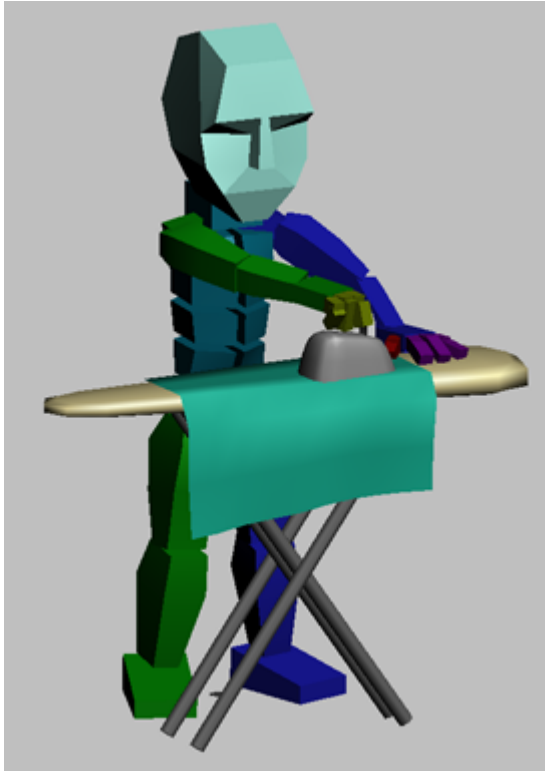
If you have difficulty with this step, open the file *ironing_handpose.max*. This file contains the biped already posed with its right hand on the iron.

- 5 With Auto Key turned on, position the left hand to hold down the fabric.



Link the right hand to the iron:

- 1 Select the right hand.
- 2 On the Motion panel > Key Info rollout, expand the IK bar.
- 3  Click Select IK Object, and click the iron.
The object name *Steam Iron* appears to the left of the Select IK Object button.
- 4 Choose the Object option just above the Select IK Object button.
- 5 Change IK Blend to **1.0**.
- 6 Play the animation. The hand follows the iron.




You could have created a similar animation by linking the iron to the hand with Select And Link, then animating the hand. However, this type of animation is limited. For example, if you later bend the biped's spine so he could get a closer look at his ironing, the hand would move with the spine and sink into the ironing board. With IK linking, the hands will stay put when you rotate the spine.

Right now, if you bend the spine, the right hand would stay on the iron but the left hand would move. You can keep the left hand from moving by anchoring it to the ironing board.

Link the left hand to the ironing board:


- 1 Select the left hand.

- 2  Click Select IK Object, and click the ironing board.

The object name *Ironing Board* appears to the left of the Select IK Object button.

- 3 Choose the Object option just above the Select IK Object button.
- 4 Change IK Blend to **1.0**.

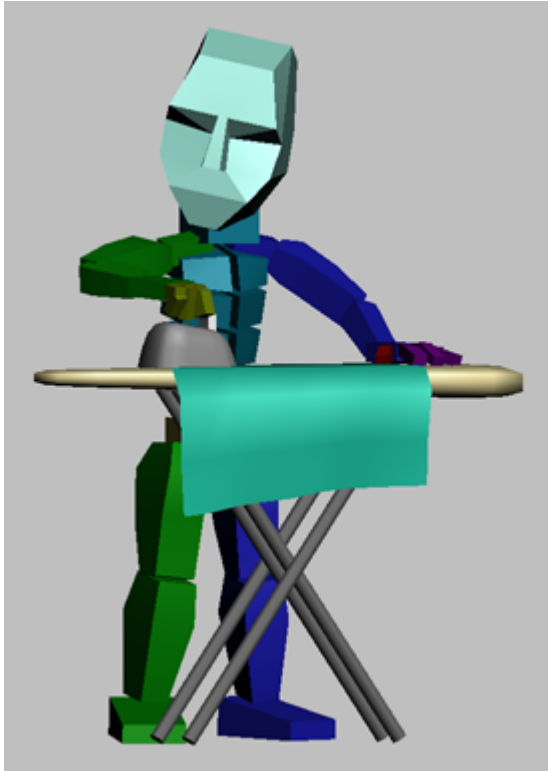
Bend the biped over:

- 1 Select all the biped's spine links.
- 2 Make sure you're at frame 0.
- 3  In the Key Info rollout, click Set Key.
- 4 Go to frame 40.
- 5 Make sure that Auto Key is turned on.
- 6 Rotate the biped's spine links so the biped bends slightly forward.



The biped's hands stay in place when the biped bends forward.

- 7 Go to frame 80, and rotate the spine links to make the biped stand up straight again.
- 8 Animate the biped's head every 30-40 frames to make him look at the iron as he works.

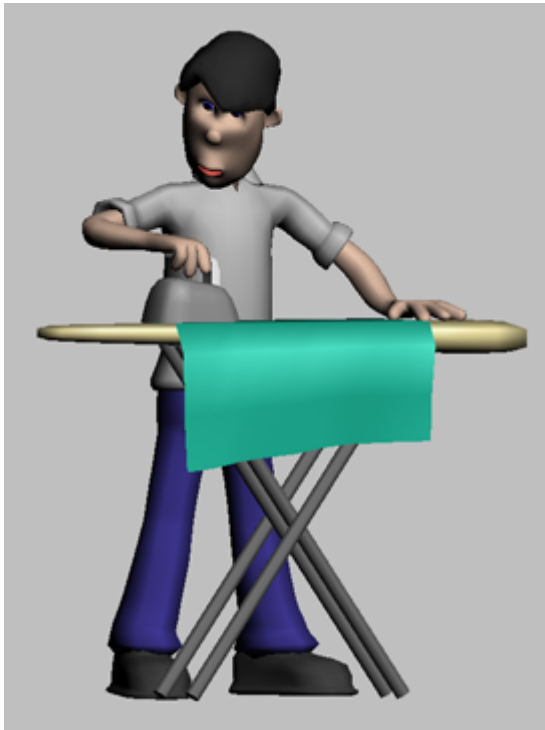


Unhide the character:

- 1 From the Named Selection Sets list, choose *Wilson Mesh*. When the warning dialog appears, click Yes. The character mesh appears in the scene.



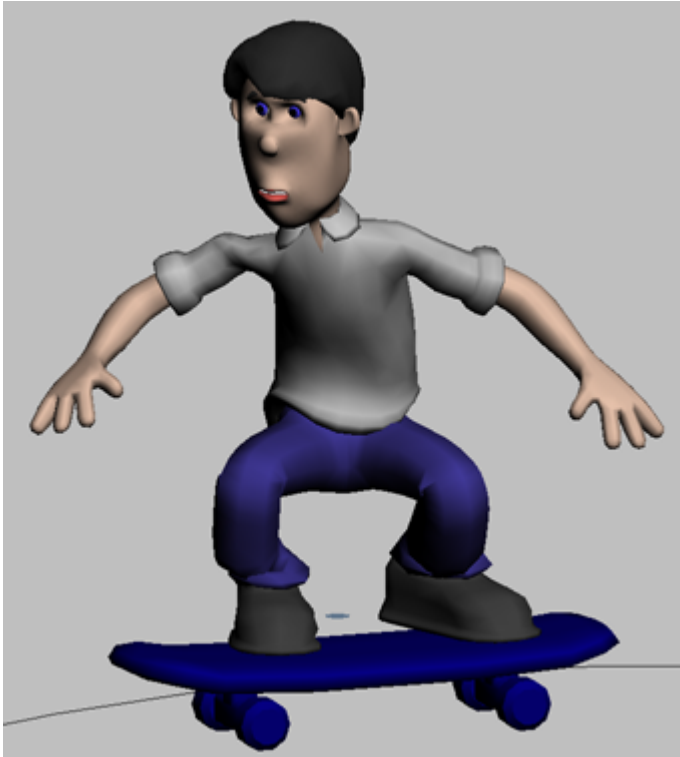
- 2 From the Named Selection Sets list, choose *Wilson Biped*.
- 3 Go to the Display panel and click Hide Selected.
The biped is hidden, leaving only the character mesh.



- 4 Play the animation. Wilson irons the cloth and bends over to take a closer look.
- 5 Save your work in the file **my_wilson_ironing.max**.
You can find a completed version of this animation in the file *ironing_complete.max*.

Making Feet Follow Objects

In this lesson, you'll make a character ride a skateboard.



In practice, you could accomplish this animation by linking the skateboard to one of the biped's feet and animating the entire biped. However, this would make it extremely difficult to animate the biped's upper body leaning and dipping as he rides the skateboard. If you did so, every time you moved the biped's foot or leg, the skateboard would skitter and slide unnaturally.

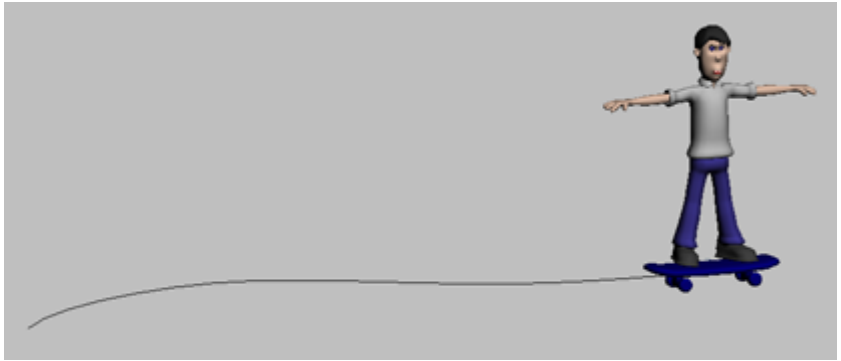


You can't link the biped's feet directly to the skateboard with Select and Link. These body parts are already linked to the legs, and linking them to another object would cause them to become disengaged from the legs and the rest of the body.

Instead, you'll use IK linking to make the biped feet and body follow an animated skateboard. With this method, you can animate the upper body leaning and turning without interfering with the motion of the skateboard. This feature makes it easy to animate a character doing any motion where the feet must remain stuck to the apparatus while the body moves freely, such as pedaling a bicycle or skiing down a slope.

Set up for this lesson:

- 1 Open the file *skating_start.max*.



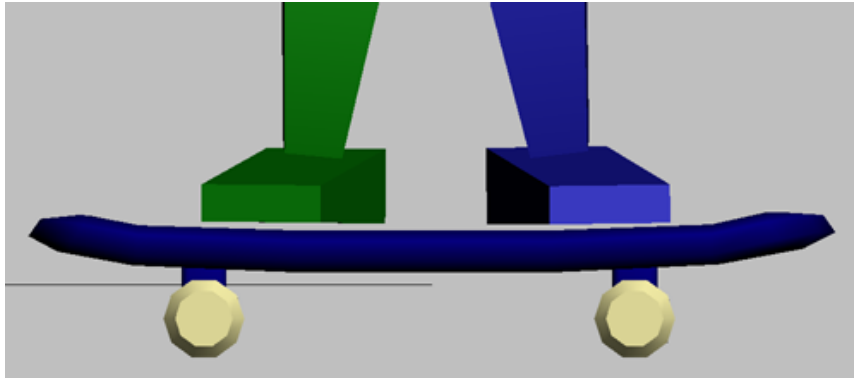
This scene features Wilson on a skateboard.

- 2 Play the animation.
The skateboard follows a path, but Wilson doesn't go with it. You'll work with Wilson's biped to make him ride the skateboard.
- 3 Choose the named selection set *Wilson Mesh*, and hide the selected objects.
- 4 Choose the named selection set *Wilson Biped*, and click Yes on the warning dialog to unhide the biped.

Position the feet:




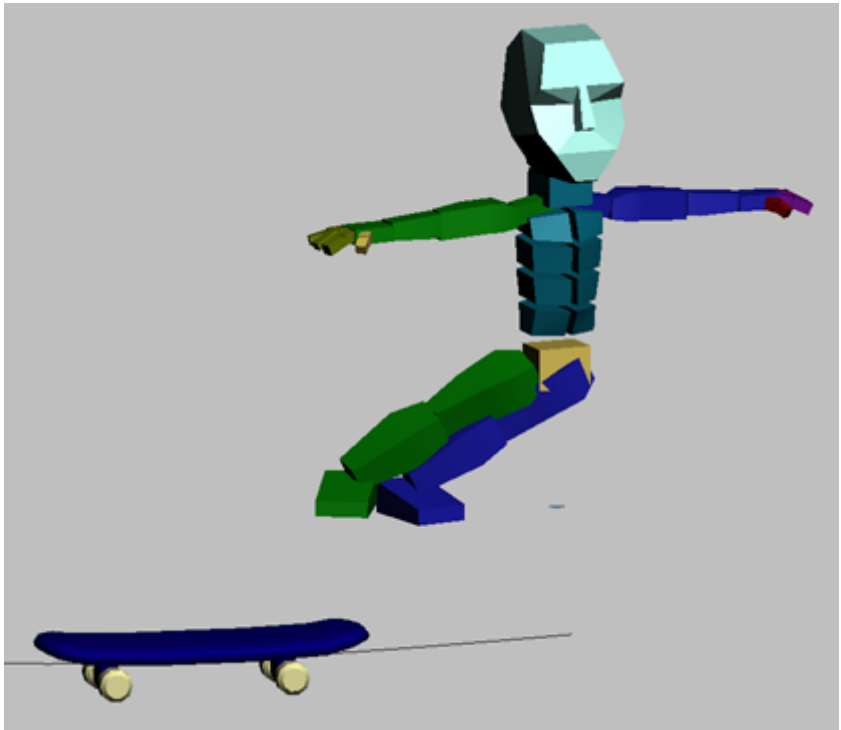
- 1 Go to the Motion panel.
- 2 Go to frame 0.
- 3 In the Front viewport, zoom in on the feet.
- 4 Turn on Auto Key.
- 5 Rotate each foot so it sits parallel to the top of the skateboard.



Link the feet to the skateboard:

In order to link the feet to the skateboard, each needs a key set at frame 0. You have already created keys for the feet by posing them on frame 0. If you hadn't, you could use the Set Key button on the Key Info rollout to set keys for each foot/leg.

- 1 Select a foot or leg.
You can select any part of the leg or foot to link it to the skateboard.
- 2 On the Motion panel > Key Info rollout, expand the IK bar.
- 3  Click Select IK Object, and click the top portion of the skateboard. The object name *Skateboard Top* appears to the left of the Select IK Object button.
- 4 Choose the Object option just above the Select IK Object button.
- 5 Change IK Blend to **1.0**.
- 6 Select any part of the other foot or leg, and repeat these steps to link it to the skateboard.
- 7 Play the animation.



The biped tries to follow the skateboard, but he's not very successful. The legs extend as much as they can, but the skateboard moves away and the biped's center of mass stays in the same place.

To make the entire body go along with the skateboard, you'll link the center of mass to it.

Link the COM to the skateboard:

The center of mass object (COM) is the only object in the biped that isn't linked to other objects in the biped. It can be linked to any object with Select And Link to make the entire body follow along with the object.

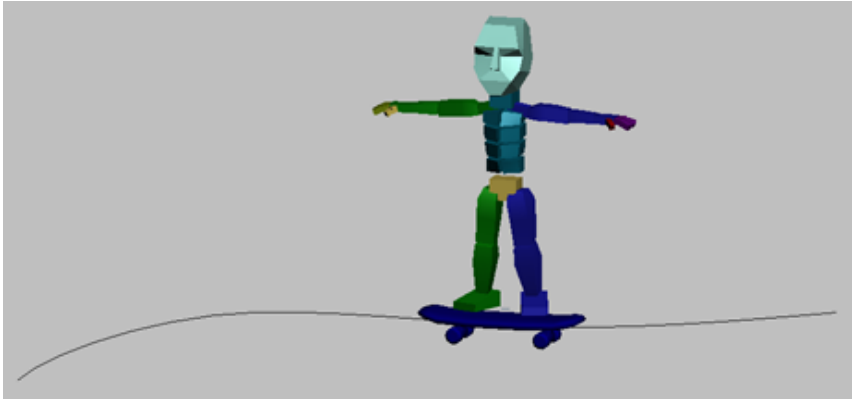
- 1 Select the center of mass object, named *Wilson Biped*.



- 2 On the main toolbar, click Select And Link.
- 3 Link the center of mass to the skateboard.

4 Play the animation.

The entire biped moves with the skateboard.



Animate the upper body:

The linking method you've used allows you to animate the upper body freely without interfering with the skateboard motion.

- 1** Go to frame 0.
- 2** Make sure that Auto Key is turned on.
- 3** Pose the biped in a crouch, as if ready to turn a corner on the skateboard. Move the center of mass downward to bend the biped's knees, and move it horizontally to shift the biped's weight. Rotate the spine to make the biped lean forward, and pose the head and arms.



TIP To rotate the legs outward, rotate the calf and not the thigh. This will rotate the legs while keeping the feet in place.

- 4 Go to frame 60 and change the pose slightly. You can move the center of mass to shift the biped's weight, turn his head, or move his arms to different positions.
- 5 On frame 120, change the pose again.
- 6 Play the animation.
The biped rides the skateboard, leaning and dipping to keep his balance.

See the animation on the character mesh:

- 1 Select the named selection set *Wilson Mesh*, and click Yes to unhide the mesh.
- 2 Select the named selection set *Wilson Biped*, and hide the selection.

3 Play the animation. Cowabunga!



You can see a finished version of this animation in the file *skating_complete.max*.

Creating the Illusion of Weight

There are two techniques for giving the illusion of weight to a biped object in an animation. Both affect the biped center of mass.

The first technique uses Balance Factor, which moves the center of mass. Balance Factor is available on the Body Horizontal track. This technique creates the illusion of lifting a heavy object. It lets you keyframe the center of mass moving in and out of the body.

The second technique uses Figure mode to turn on Rubber Band; you then move the center of mass in front of or behind the body. This technique creates

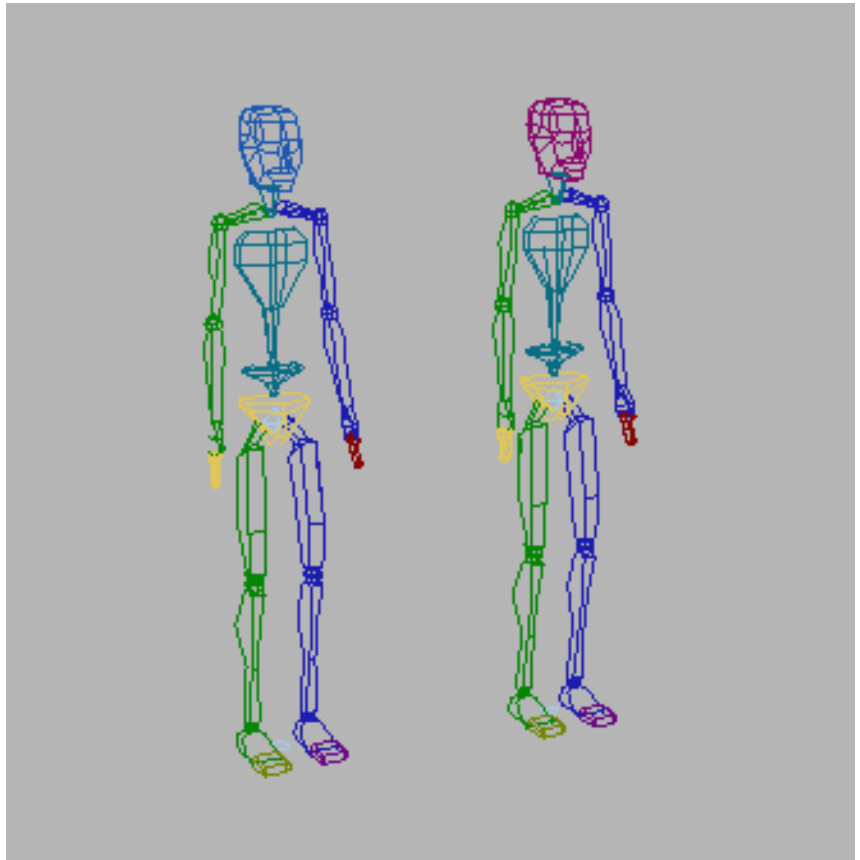
the illusion of the biped pushing or dragging a heavy object. You can't keyframe the center of mass with this technique; instead, you set it for the entire animation.

Lifting Heavy Objects

Set up for this part of the lesson:

- 1 Open *balancefactor_start.max*.

Two bipeds have planted keys set on their feet, with the pivot points set at their toes.



- 2 Select any part of the biped on the left, and then open the Motion panel.


Use Balance Factor:

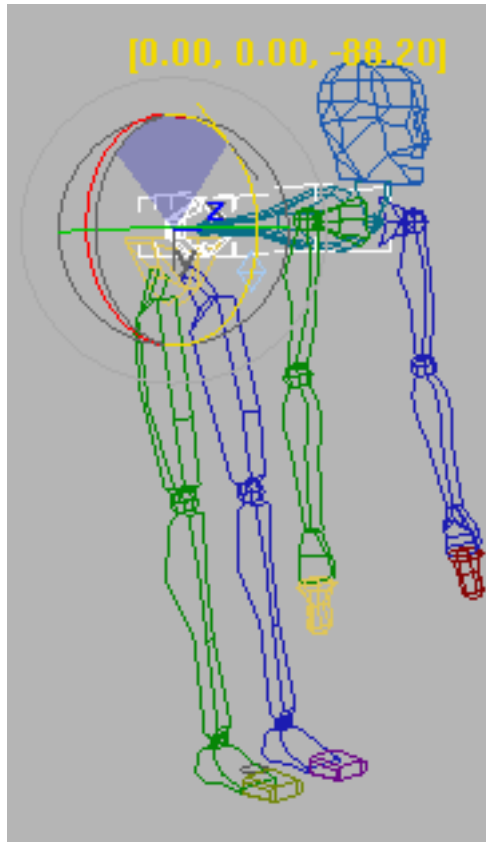


- 1 On the Track Selection rollout, click the Body Horizontal button.
- 2 In the Key Info rollout, expand the Body expansion bar so you can see the Body parameters. Then set Balance Factor to **0**.

The Balance Factor is available because this file contains a keyframe on the Body Horizontal track at frame 0.

TIP Many parameter settings will not be available unless you have a key set on a particular track. If a parameter is unavailable, click Set Key in Key Info rollout and see if it becomes available.

- 3  Move to frame 15, then turn on Auto Key mode.
- 4 Select *Bip01 Spine* object (the first, or lowest, spine object).
- 5 Use Orbit to see the biped from the side.
- 6 Rotate the spine about the Z-axis.
Notice that the upper body rotates, while the legs stay firmly planted.



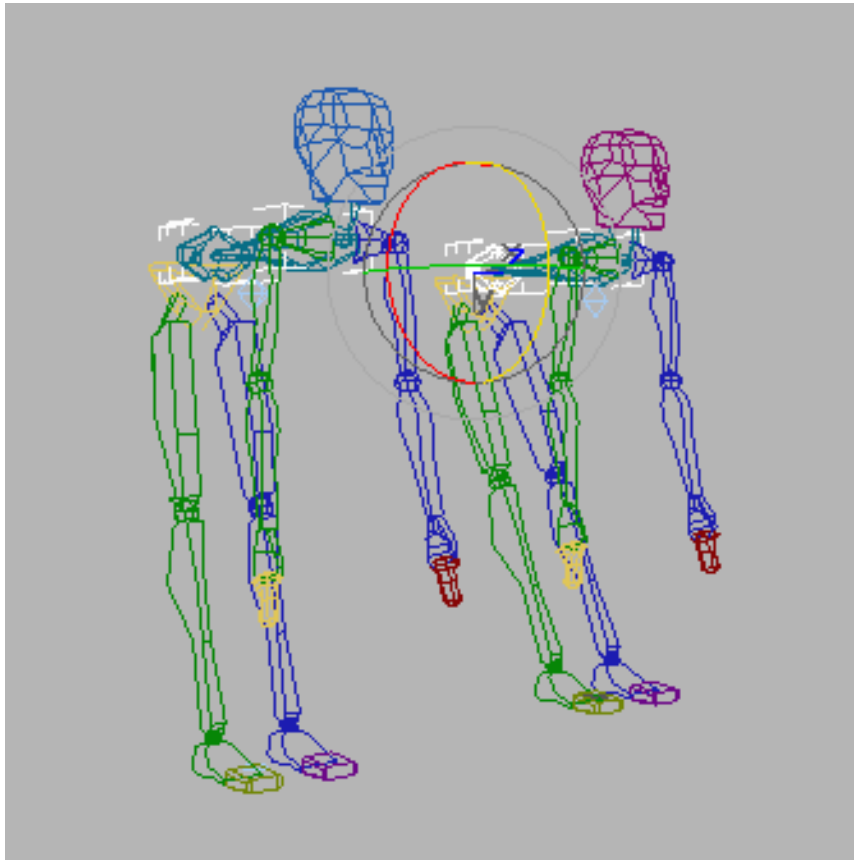
Only the upper body rotates.

Animate the Balance Factor:

- 1 Select any part of the other biped.
- 2 In the Track Selection rollout, select Body Horizontal.
- 3 In Key Info rollout, click Set Key.
Now Balance Factor is available.
- 4 Change Balance Factor to 2.
- 5 Select *Bip02 Spine*. Rotate this spine.

This time the hips move back as the torso rotates forward. If you rotate the torso enough, the feet move off the floor.

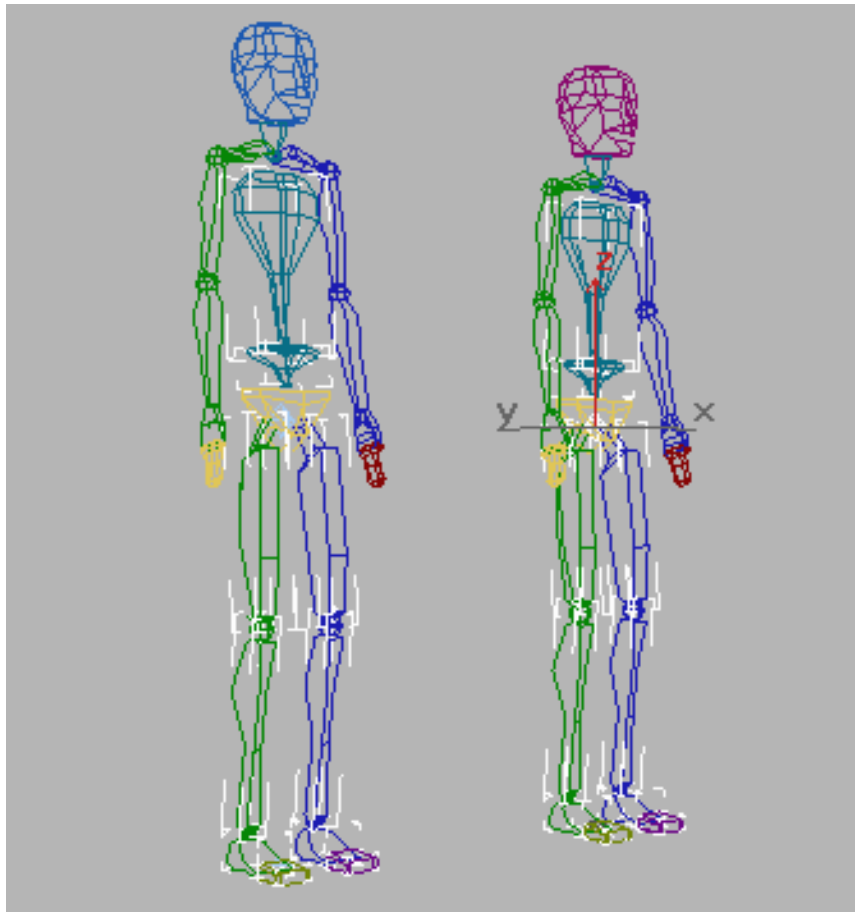
Notice also that the center of mass is now in front of the body.



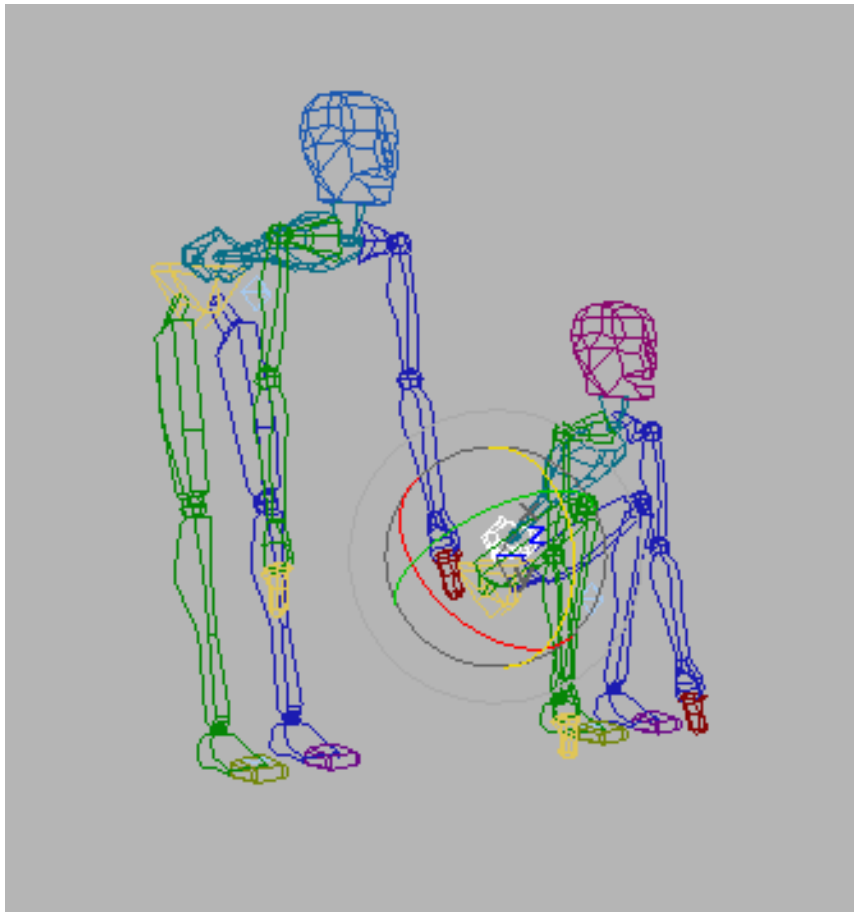
Hips move back, torso rotates forward.

- 6 Move to frame 0, and select Body Vertical in the Track Selection rollout. In the viewport, use the Transform gizmo to move the center of mass down, so the knees are bent.
- 7 At frame 15, also move the center of mass down so that the knees stay bent.
- 8 Use the time slider to view the motion. Notice that you no longer have the original standing poses at frame 0.

- 9 Go to frame 0. Rotate *Bip02 Spine* so the standing pose is re-established. Adjust the COM so the knees are not bent.

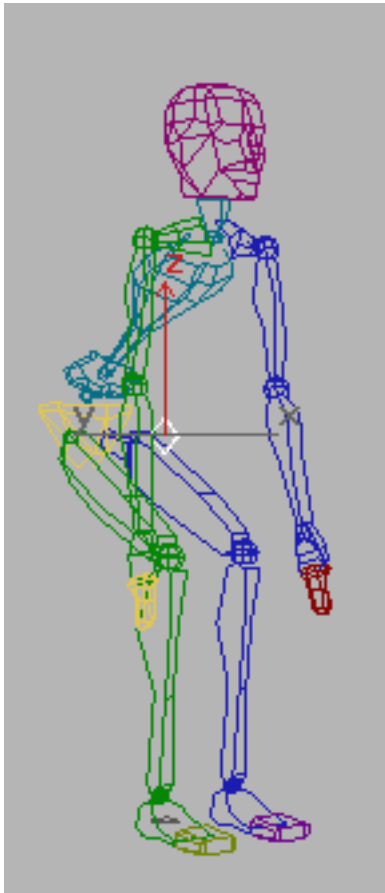


- 10 At frame 23, move the COM way down so the chest goes right through the leg (this will look wrong, but don't worry). Then rotate the *Bip02 Spine* so the knees almost touch the chest.

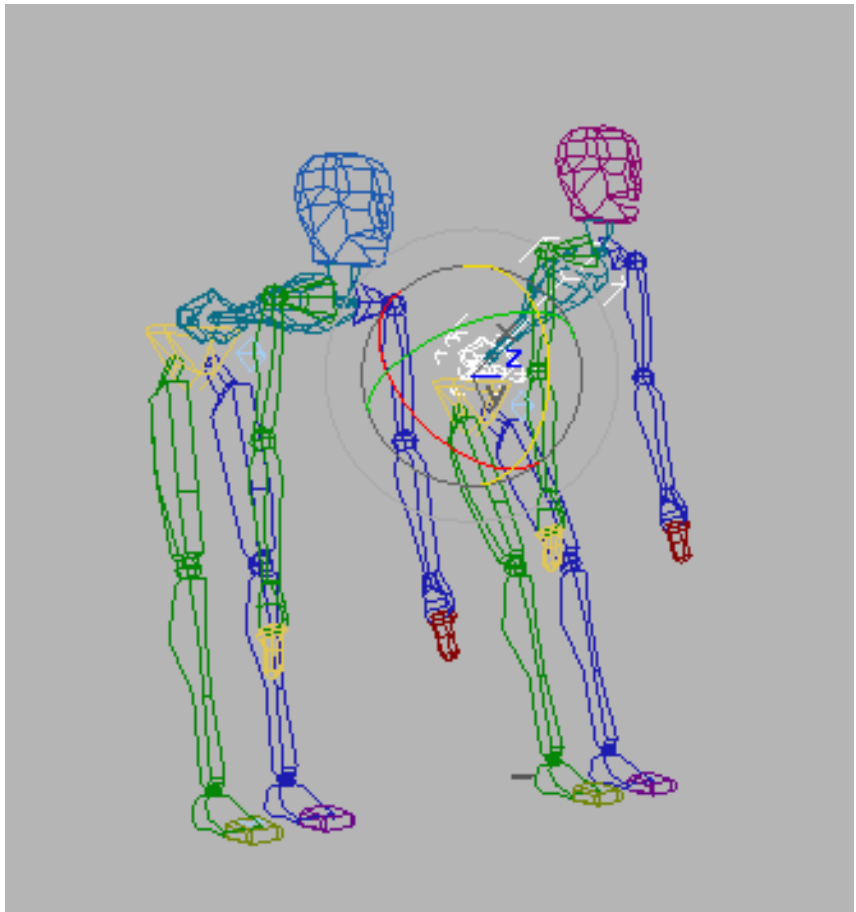


TIP There's nothing that prevents biped body parts from intersecting. Check your animation for these intersections visually and correct by adjusting keyframes.

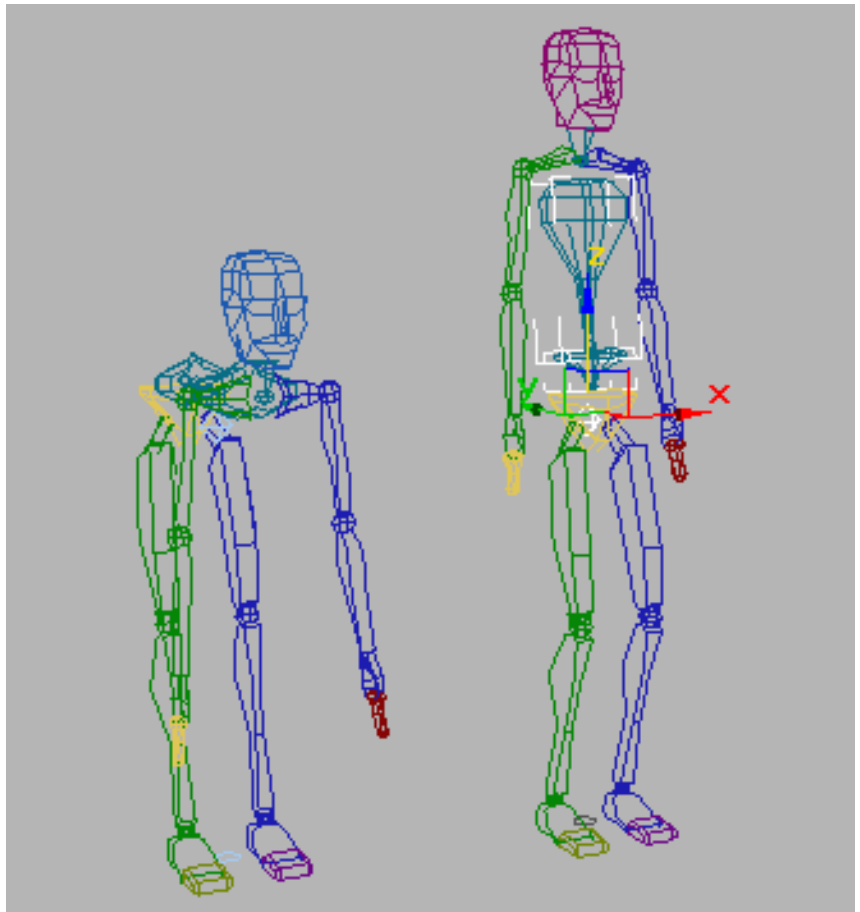
- 11 At frame 30, move the center of mass so the biped starts to lift the imaginary object using its legs, rather than its back.



- 12 At frame 38, in the Track Selection rollout, click the Body Horizontal button.
- 13 On the Key Info rollout, click Set Key.
- 14 Change the Balance Factor to **1**.
The center of mass moves back closer to the biped.
- 15 Select and rotate the spine.



- 16 At frame 45, rotate the spine more.
- 17 Move the center of mass so the biped stands up straight. Now the center of mass is back inside the body.



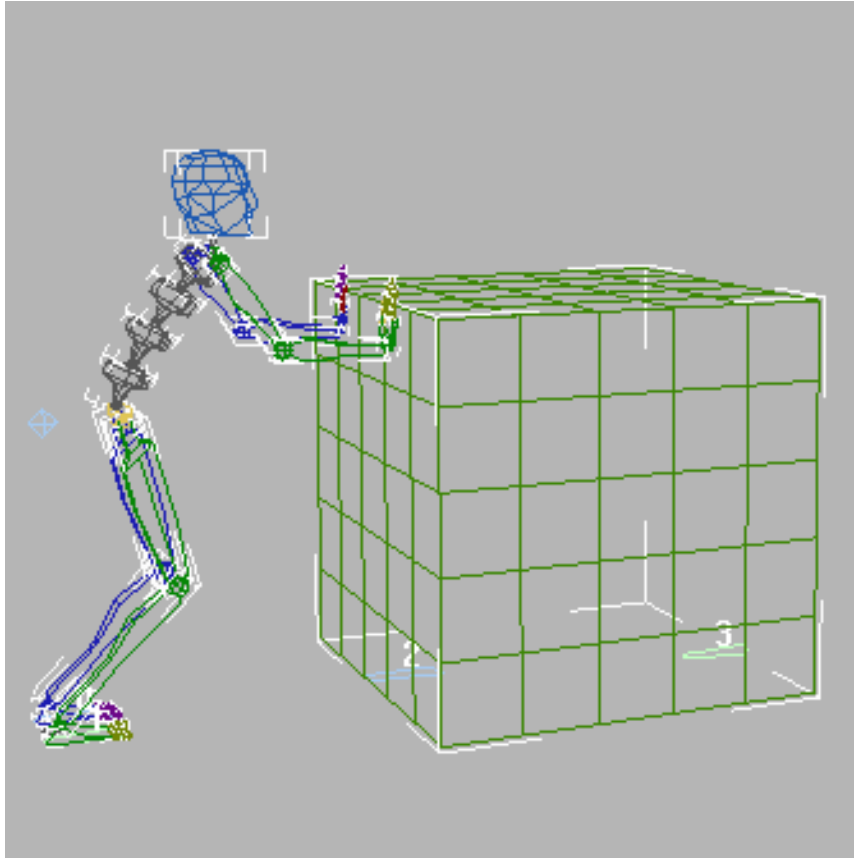
- 18** Move the time slider back and forth to view the animation.
Watch how the center of mass moves outside the biped, then back again.
The biped appears to be lifting something heavy because of the positioning of the knees and spine.
- 19** For extra credit, finish the animation of the other biped. Save your work as **my_balancefactor_final.max**, or open *balancefactor_final.max* for comparison.

Pushing Heavy Objects

Set up for this part of the lesson:

- 1 Open *pushbox_start.max*.
- 2 Play the animation.

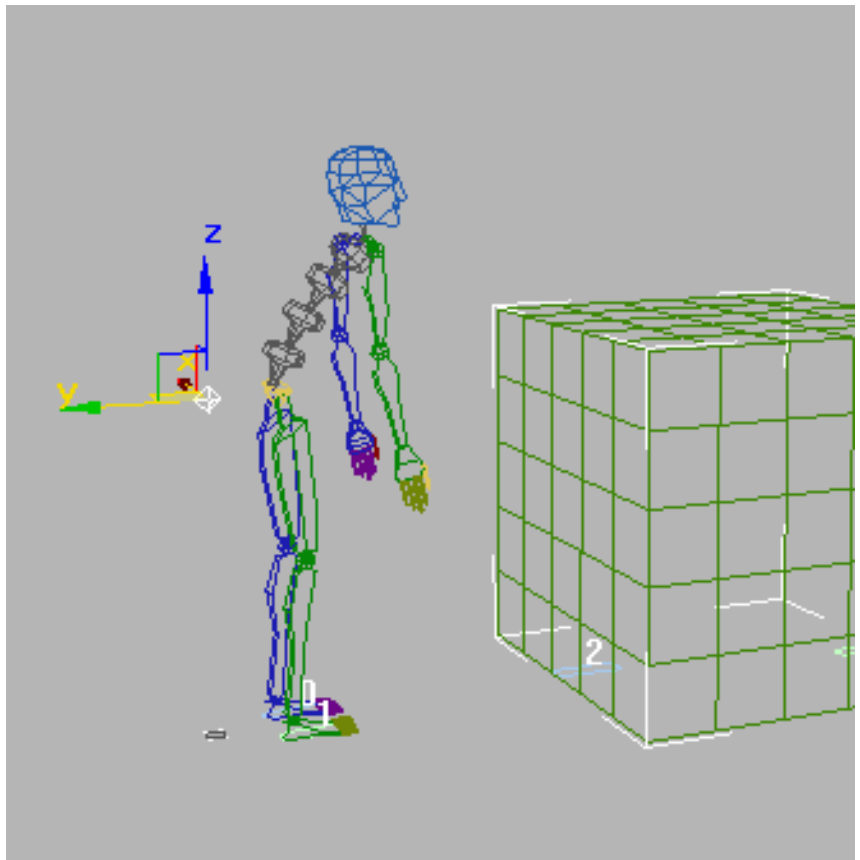
The biped is pushing a box along the floor. Notice that the center of mass is behind the biped.





Adjust the center of mass with Rubber Band:

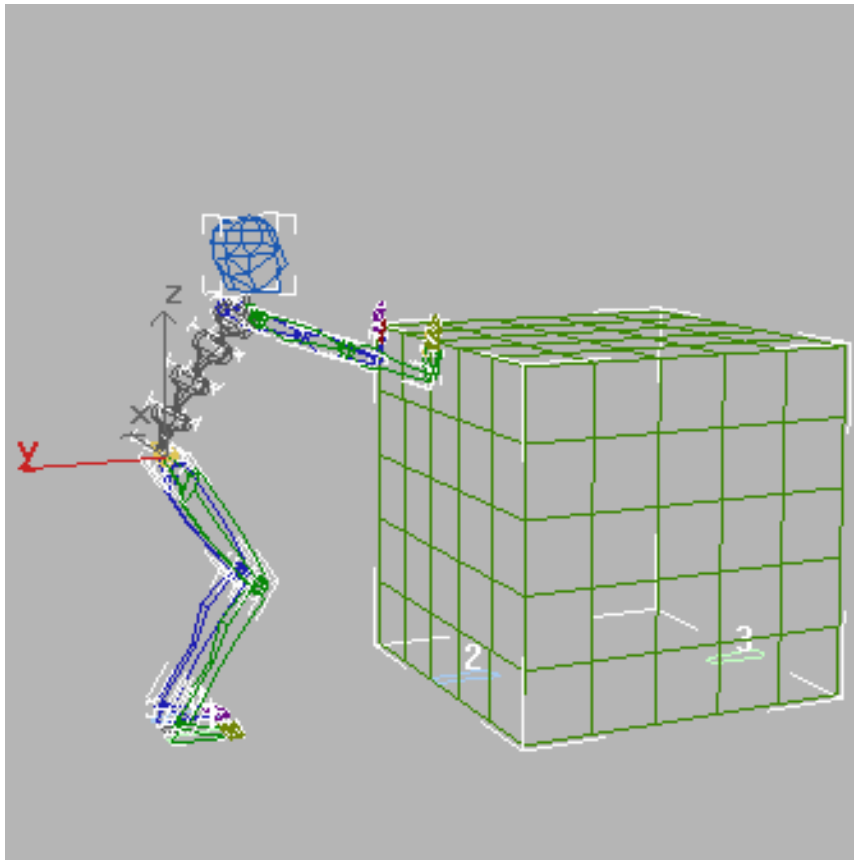
- 1 Select any part of the biped.
- 2 In the Motion panel, in the Biped rollout, turn on Figure mode.

The biped moves so his hands are no longer touching the box. Notice that, for this figure, the spine objects are rotated so the biped has a rounded back.



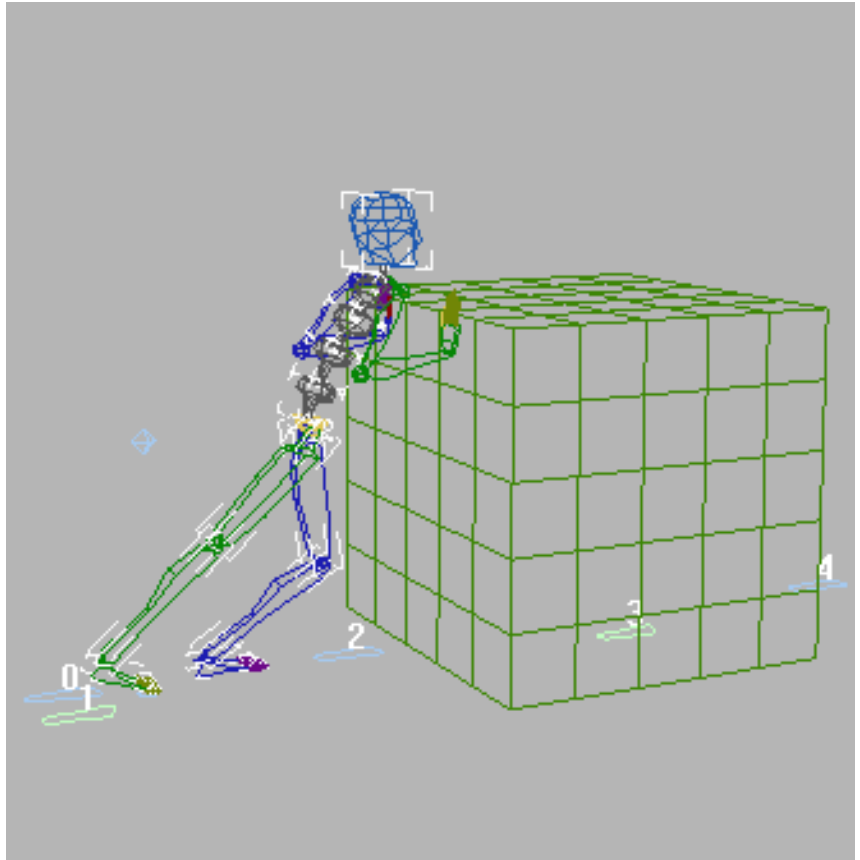
- 3  In Track Selection rollout, click Body Horizontal.
- 4  Expand the expansion bar in the Biped Rollout. In the Modes group, turn on Rubber Band Mode. Then move the biped's center of mass so it's back inside the body.
- 5 Turn off Figure mode and play the animation.

The upper torso moves back over the feet. The illusion of weight is diminished.



- 6 Turn on Figure mode. Move the center of mass far behind the body, and then turn off Figure mode.

The biped leans into the box, as though the box were heavy.



7 Play the animation.

Using Props

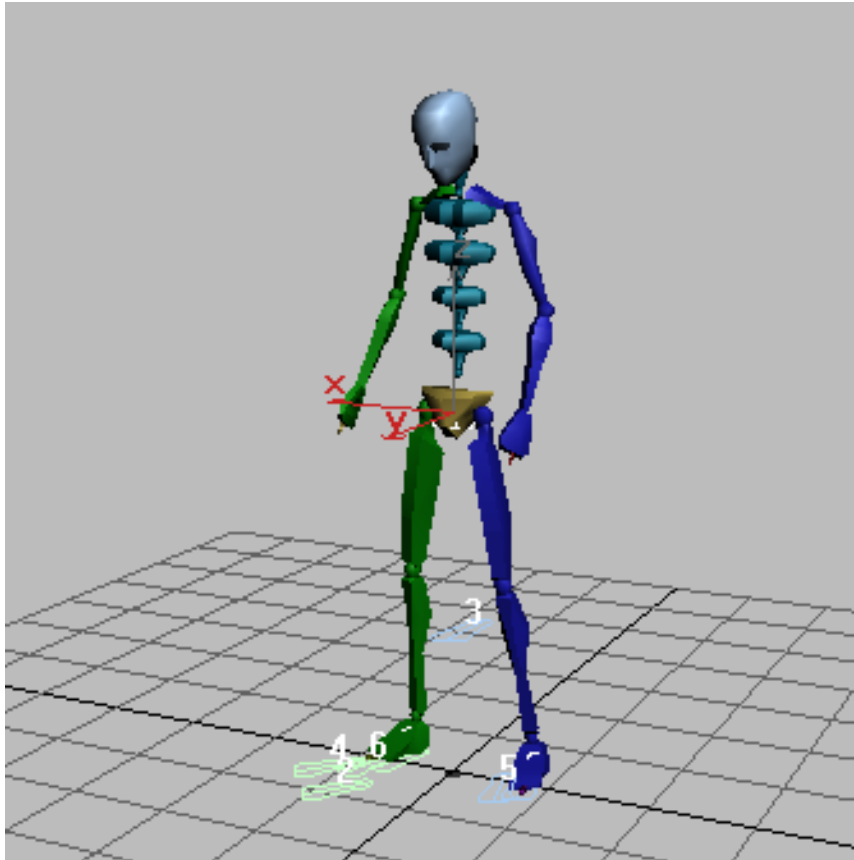
Props are objects that a biped might be carrying or swinging, such as a sword, spear, or “lightsaber”. They are parametric objects that are included as part of the biped skeleton, so that if you have motion capture data with prop information, there is a place for that information to reside. You can have up to three props saved with the biped.

Props have two parameters for Position Space and Rotation Space that can be keyframed. This makes it easy to have the prop follow the biped's hand, or to switch the prop from one hand to another.

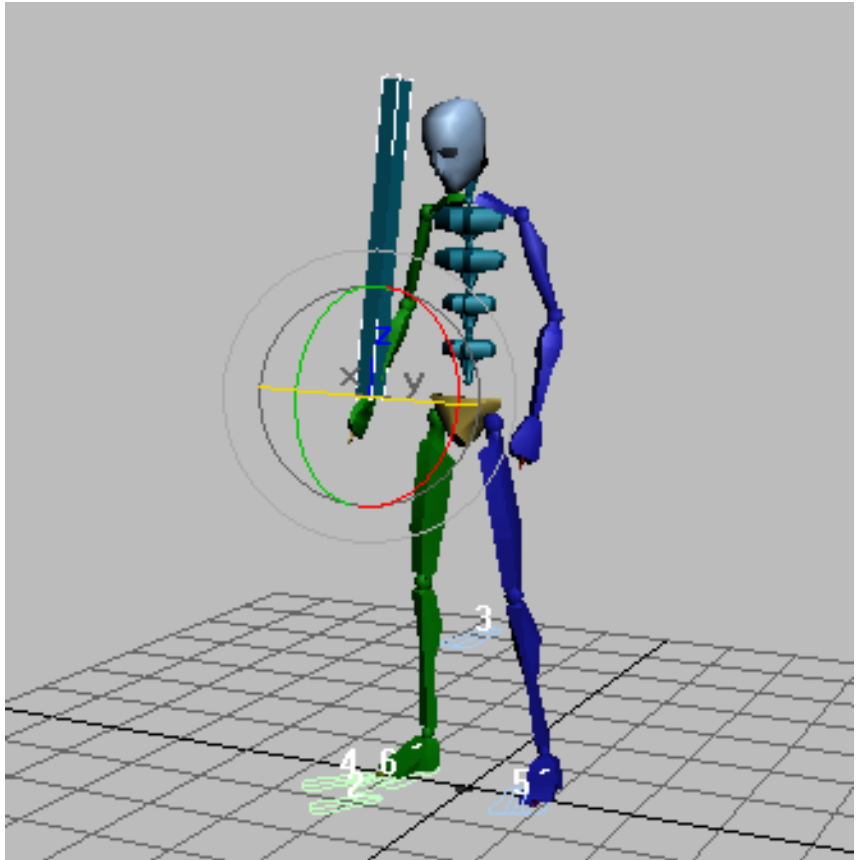
Add a prop to an animated biped:

This procedure starts with a biped sawing a board. You'll create a prop to take the place of the saw.

- 1 Open *saw_wood_start.max*.

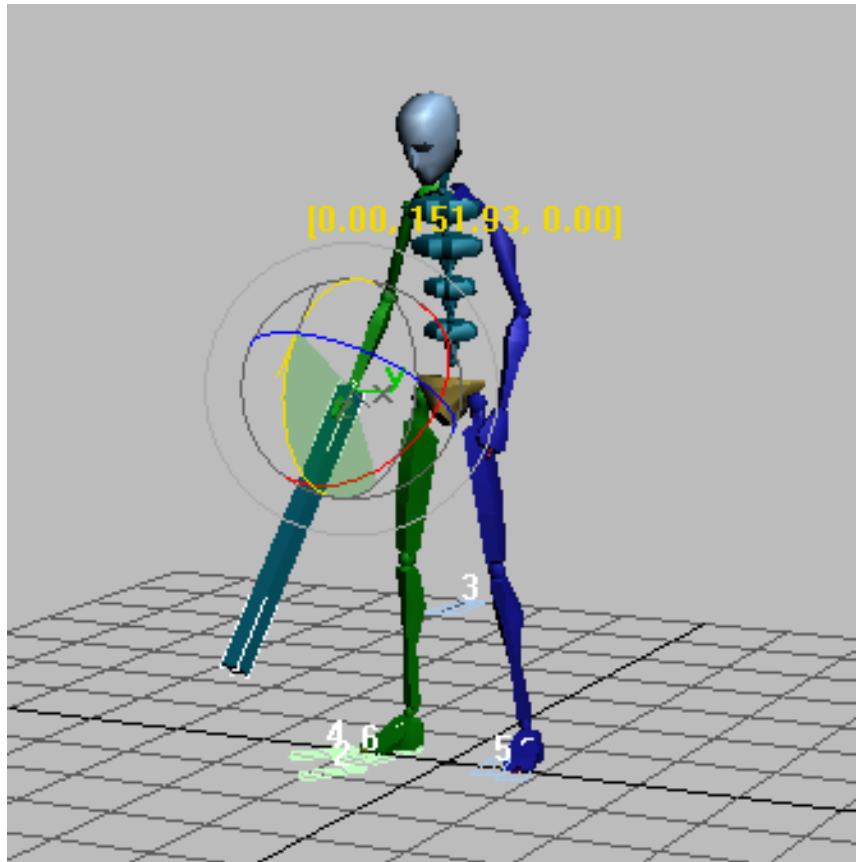



- 2 Play the animation. The biped rests one knee on the invisible board, and saws it with an invisible saw.

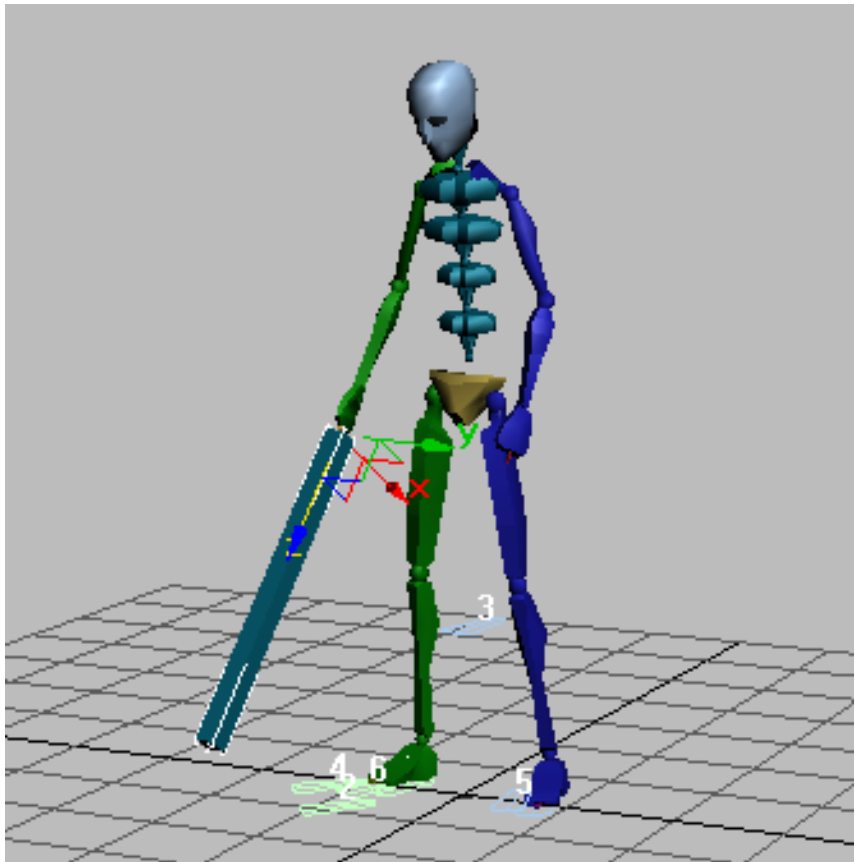


To align and position the prop to the hand, you'll leave Figure mode and set a key for the prop.

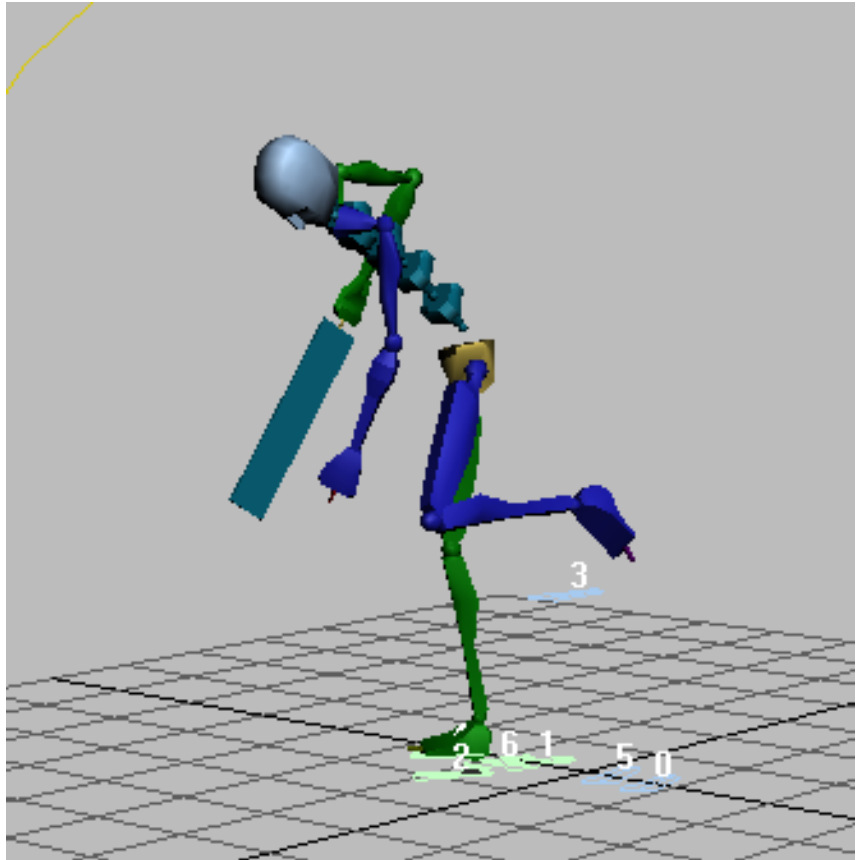
- 6 Turn off Figure Mode, and then select the prop in the viewport.
- 7 Move the time slider to frame 0.
- 8 In the Perspective viewport, rotate the prop approximately **152** degrees around the Y-axis.
The rotation is displayed in yellow in the viewport, and in the Coordinate Display below the viewport.



- 9  On the Key Info rollout, click Set Key.
- 10 Expand the Prop divider bar. In the Rotation Space drop-down list, choose Right Hand.
This puts the prop in right-hand rotation space. As the right hand rotates, the prop will follow. Notice that you can't make changes here unless you have set a key.
- 11 On the main toolbar, click Select And Move, and then change the Reference Coordinate system to Local.
- 12 In the Perspective viewport, move the prop along the Z-axis so it is slightly in front of the hand, then click Set Key again to keyframe the position of the prop.



- 13 Play the animation. The prop follows the movement of the hand nicely.
- 14 To make the prop more closely resemble a saw, turn on Figure mode and scale the prop so its proportions match those of a hand saw. Then turn off Figure mode and play the animation.




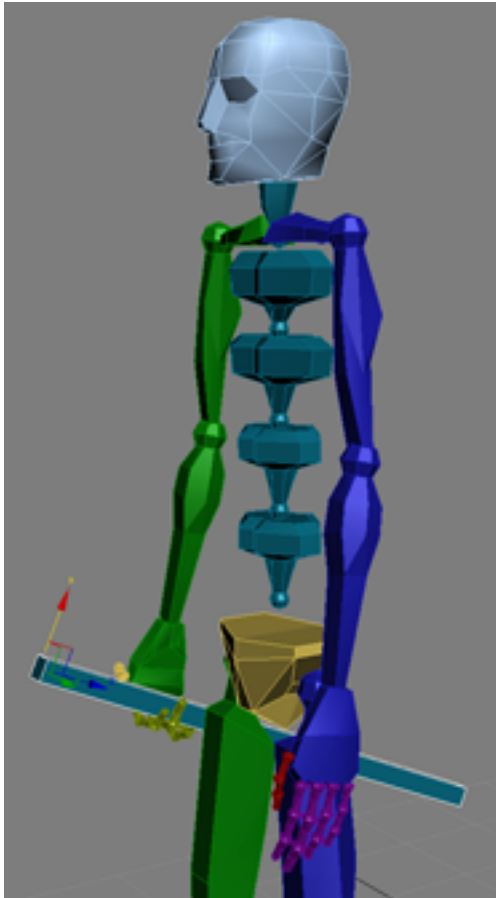
If you like it, save your work to **mysawingwood.max**.

Animate props switching hands:

This procedure starts with a file of an animated biped. You'll add a prop, and then keyframe it to switch hands to follow the motion.

- 1 Open *samurai_start.max*.
- 2 Play the animation.
The biped first holds his weapon in one hand and then swings it with the other.
To create a prop you will go into Figure mode.
- 3 In the viewport, select any part of the biped.

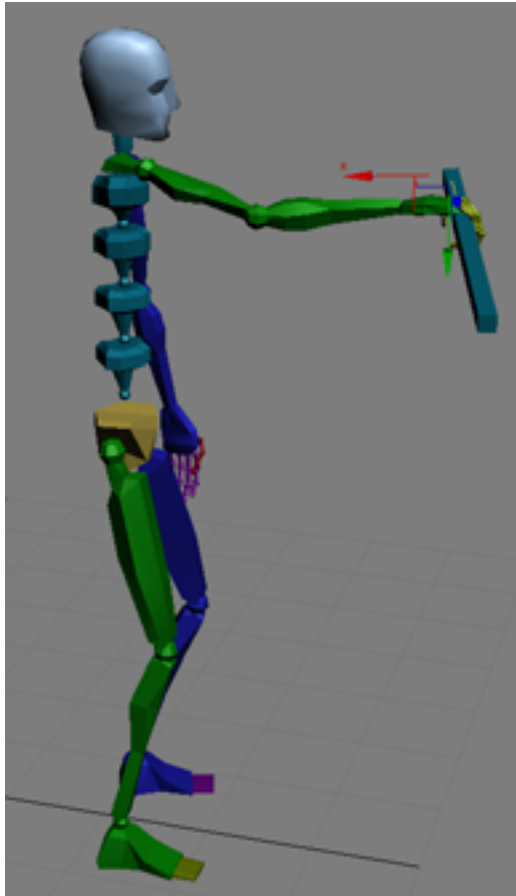
- 4  Open the Motion panel, and on the Biped rollout, turn on Figure Mode.
- 5 Open the Structure rollout and turn on Props 1.
The prop appears in the viewport beside the biped's right hand.
- 6 Turn off Figure mode and play the animation.
The prop follows the movement of the pivot point of the right-hand wrist. To adjust the size of the prop, you can use the Scale transform.
- 7 Turn on Figure mode and select the prop.
- 8 On the main toolbar, choose either Scale or Non-Uniform scale to change the size and proportions of the prop. Turn off Figure mode when you are through.
- 9 Turn on Auto Key mode. Rotate the prop so it's perpendicular to the hand.



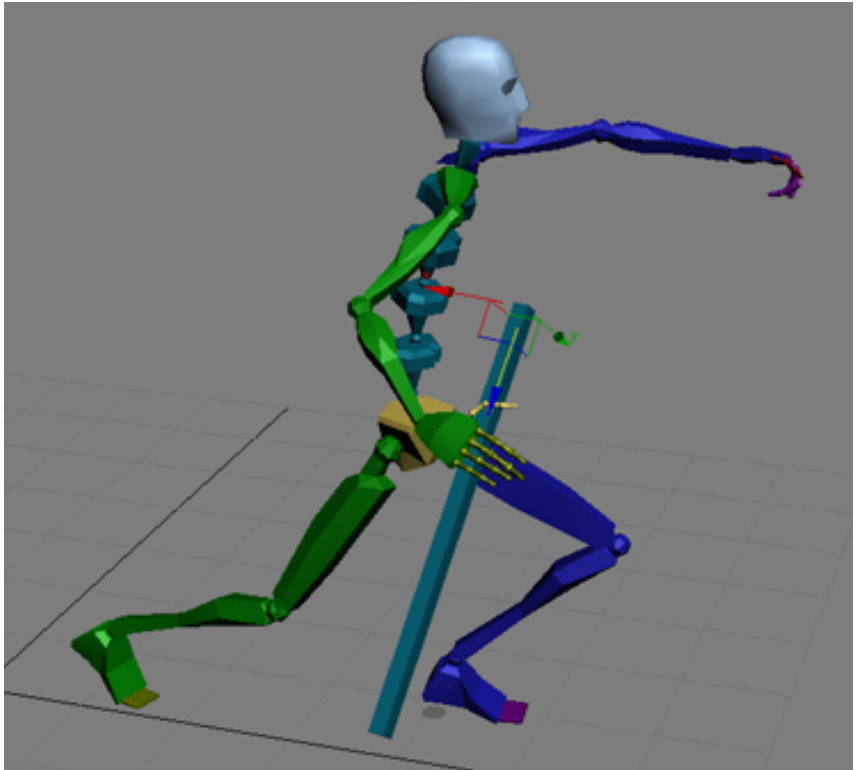
Rotate and move the prop near the palm of the hand.

- 10** On the main toolbar, click Select And Move. Then in the Reference Coordinate drop-down list, choose Local. Move the prop on its local X and Y-axes so the prop is in contact with the palm of the hand. Make sure to leave enough room between the prop and the right thumb so the left hand can grab it as well.
- 11** Make sure that the prop is still selected, and then open the Key Info rollout.
- 12** Expand the Props bar, and click Set Key so the Position Space and Rotation Space fields are accessible in the Props group.

- 13 Using the drop-down list, change both Position Space and Rotation Space to Right Hand.
- 14 Play the animation.
The prop follows the movement of the right hand throughout the whole animation.



Prop follows the right hand.



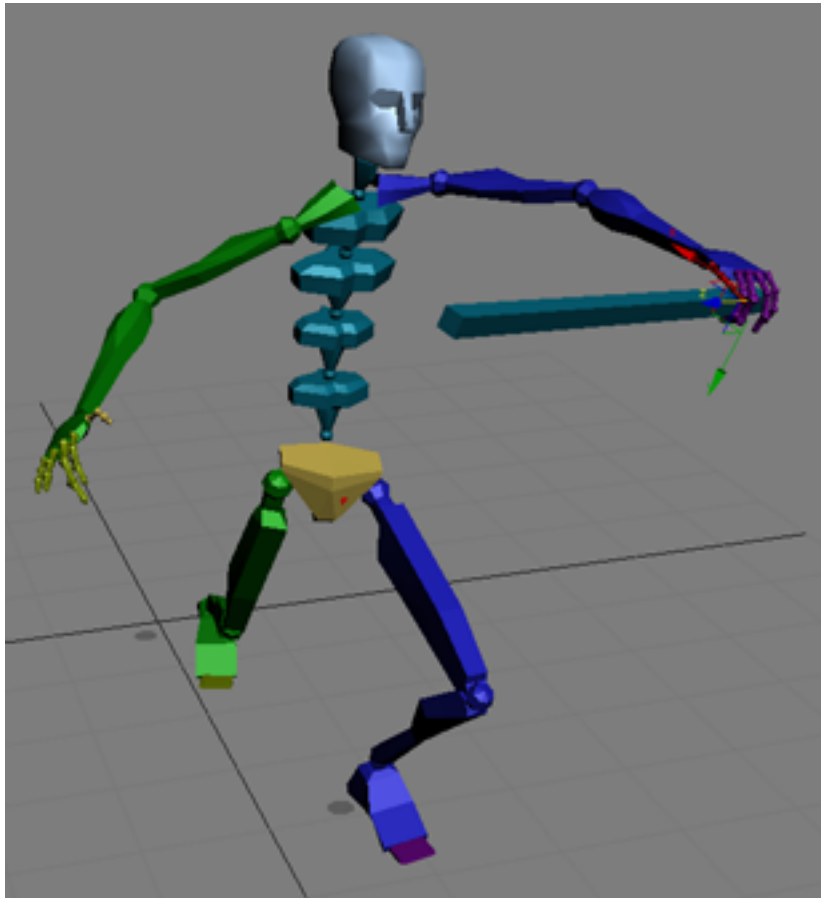
Prop follows right hand for the entire animation.

To make the biped switch hands, you can keyframe the Position and Rotation Space.

- 15** Move to frame 74. The prop should still be selected. In the Key Info rollout, click Set Key.
This sets a key
- 16** Move to frame 75, and click Set Key.
This activates the Position and Rotation Space fields.
- 17** Change Position Space and Rotation Space to Left Hand. Now play the animation.
The prop follows the movement of the right hand until frame 75. It follows the movement of the left hand from 75 to the end of the animation.

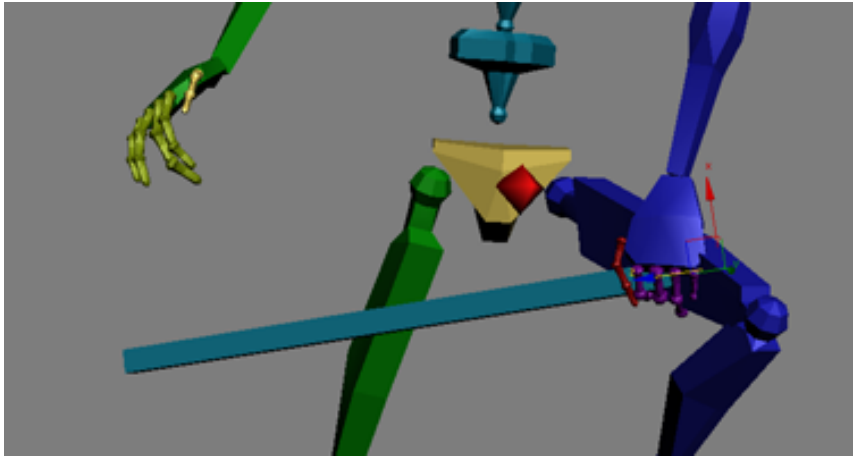
18 Play the animation.

The prop follows the movement of the hands correctly. The prop follows the right hand until frame 75, then switches and follows the left hand until the end of the animation.

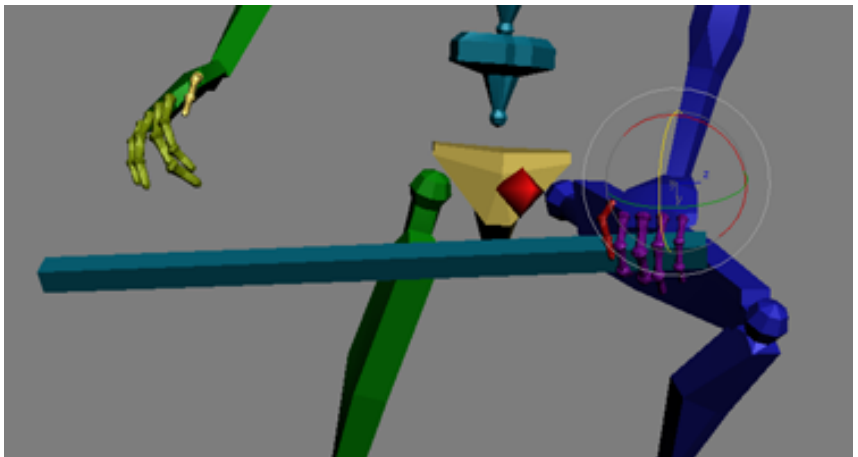


Prop follows the other hand.

19 Depending on the length of the prop, you may find that it passes through the head or other body part. If this happens, you can keyframe the rotation of the hand so the prop avoids this intersection. You can also keyframe the prop independently of the hand, if needed.



The prop may intersect the leg.



Rotate the hand or the prop to correct.

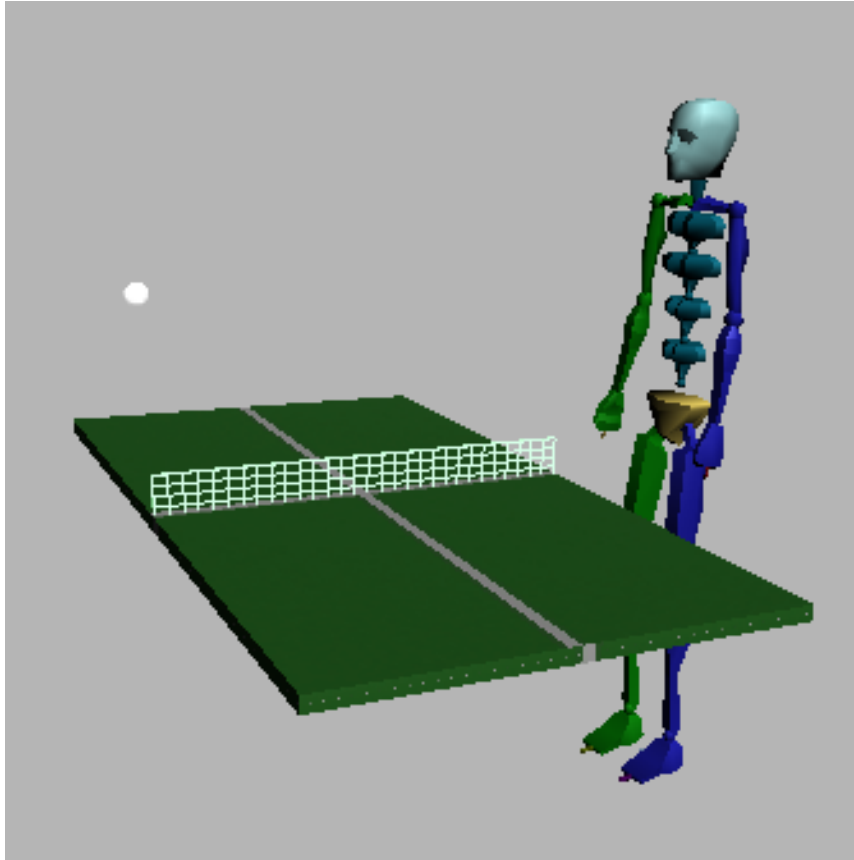
20 Save your work as **mysamurai.max**.

Making the Biped Look at Objects

You can easily have a biped's head look at another object in the scene. In this lesson, you'll animate a biped watching a table tennis match.

Set up this lesson:

- 1 Open *lookat_tabletennis_start.max*.
- 2 Play the animation in the Perspective viewport.
The ball bounces back and forth over the net four times, then the ball bounces up and done in place four times.

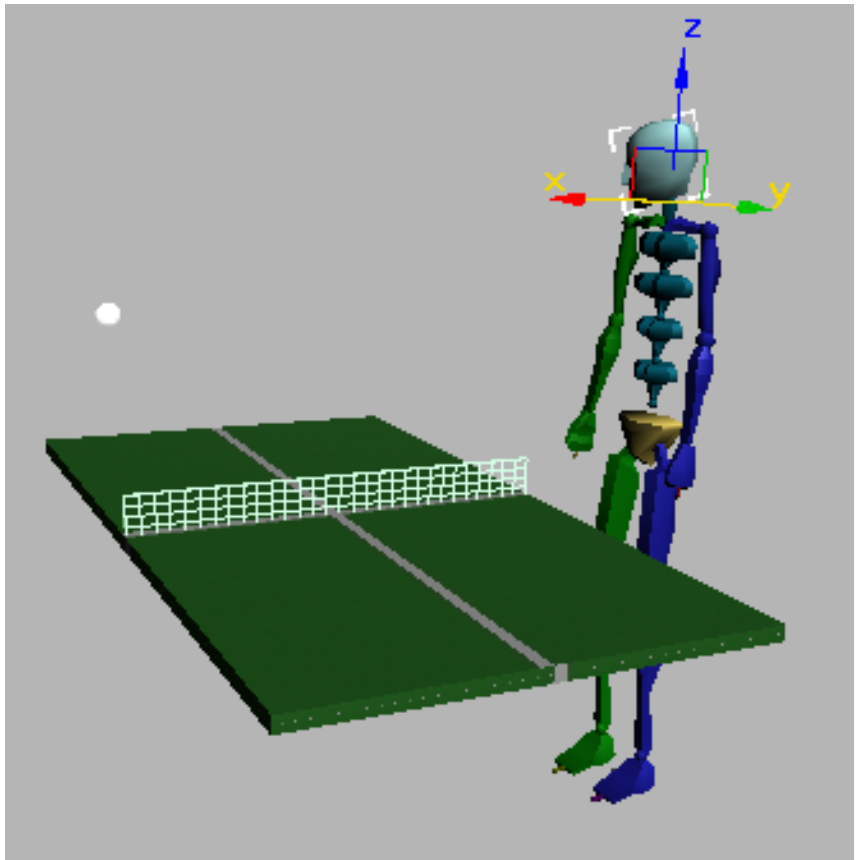


Ball bounces, but biped isn't watching.

Make the biped look at a target:

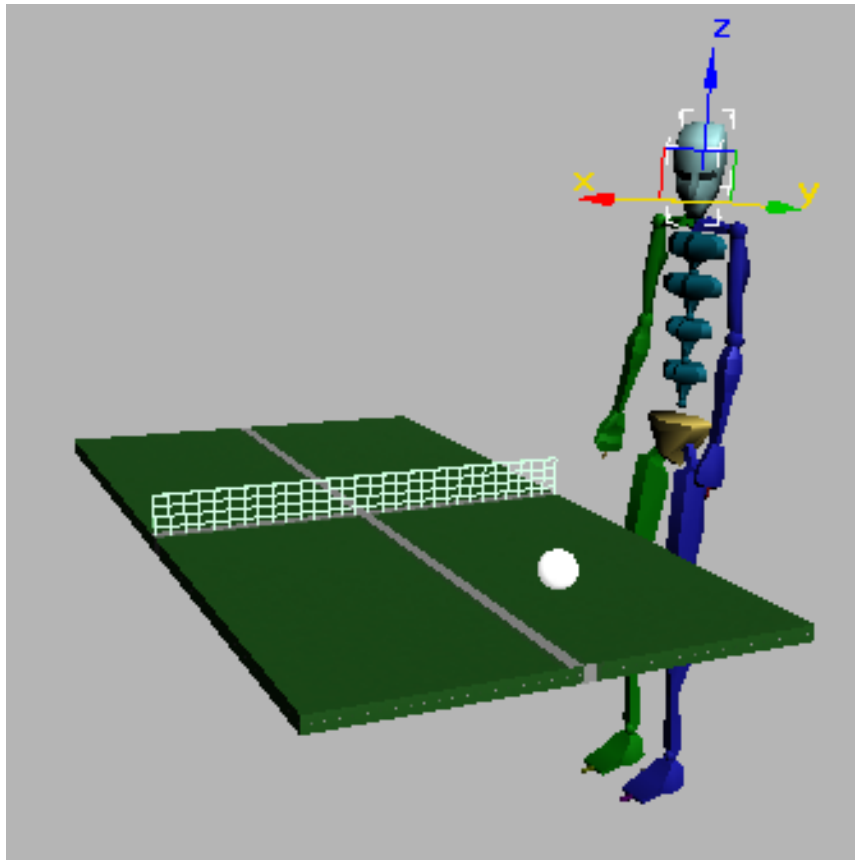
Suppose you want to animate the biped watching the ball going over the net, but not follow the bounce in place. By animating Target Blend, you can create this effect.

- 1** In the Perspective viewport, select the head of the biped. Open the Motion panel.
- 2** Open the Key Info rollout and expand the Head bar. On the Key Info rollout, click Set Key.
The Target Blend field becomes available.
- 3** Click the Select Look At Target arrow, below the Target Blend spinner, then click the table tennis ball in the viewport.
The name *pingpongball* appears in the field.
- 4** Change Target Blend to **1**.
The biped is now looking at the ball.



The biped looks at the ball automatically.

- 5 Play the animation.
The biped watches the bouncing ball intently.



The biped's head follows the movement of the ball.

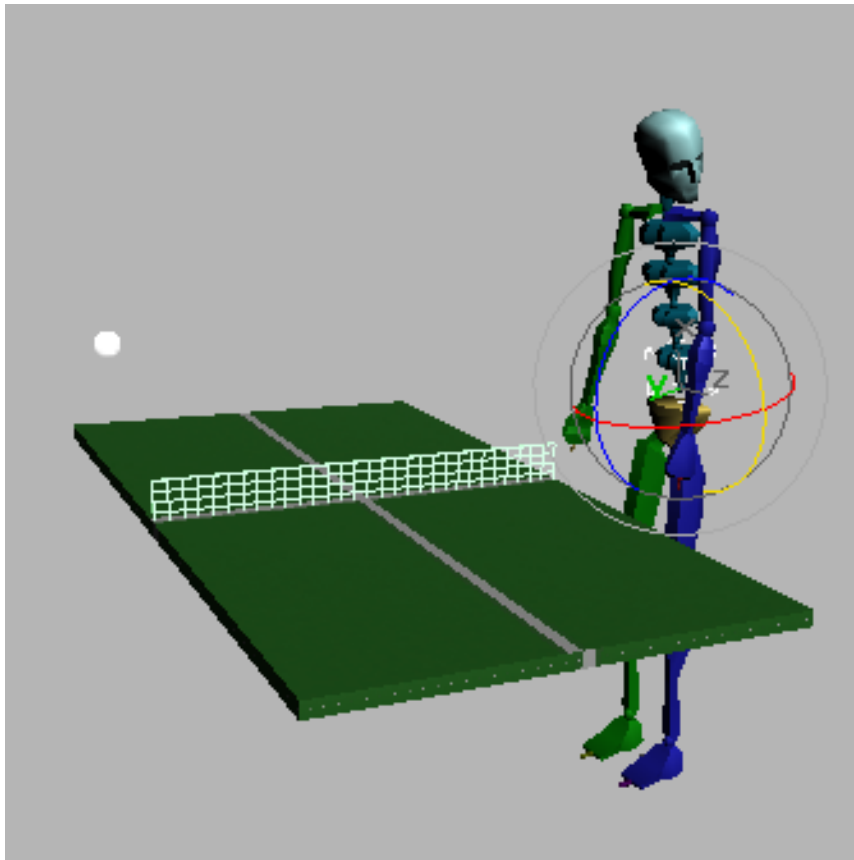
Make the biped look around:

In this procedure, you make the biped look around as the ball bounces in place.

- 1 Move the time slider to frame 200.
At frame 200, the period begins where the ball bounces in place.
- 2 On the Key Info rollout, click Set Key and set the Target Blend to **0**.
- 3 Move to frame 199. On the Key Info rollout, click Set Key and set the Target Blend to **1**.

Between frames 0 and 199, the Target Blend parameter is set to 1; at frame 200, it changes to 0. Setting these keys this way is a way to control interpolation. You could also change the interpolation for the key at frame 200 to a step value coming in, and then not bother setting the other key.

- 4 Move the time slider to frame 210. Rotate the head so it's looking away from the bouncing ball.
- 5 Add more rotation keys to the biped's head until frame 300.



Rotate the biped head freely when Target Blend is zero.

- 6 Play the animation.

The biped looks at the ball bouncing over the net, but then switches focus to something else.

NOTE You can't select multiple objects within a single animation. If you need to do that, try using a List Controller with several LookAt constraints, then animate the weights of the list items.

- 7 Save your work as **mylookat_tabletennis.max**, or open *lookat_tabletennis_final.max* for comparison.

Using In Place Mode

When you're animating a character that's moving through space, it's hard to evaluate the motion when the character moves out of your view. You can use In Place mode to keep the viewport centered on the moving character.


Use In Place mode:

- 1 Open *Inplace_start.max*.
- 2 Play the animation.

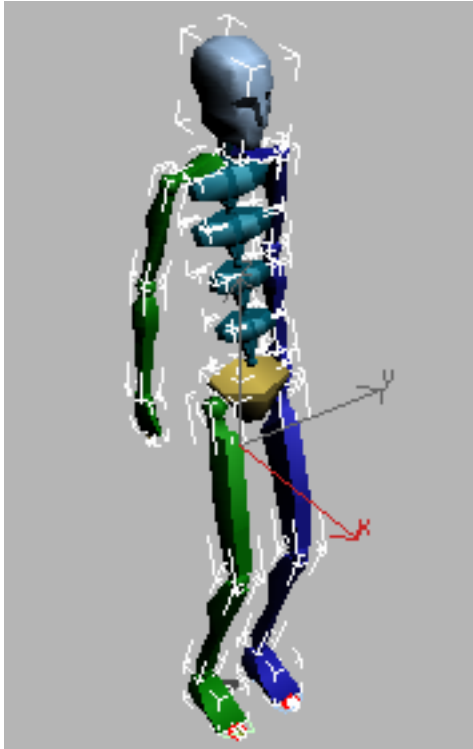
This is an animation of a biped running. You can see the entire animation, but you're too far away to see what's really going on.



3 At frame 0, select the entire biped with a selection rectangle.

4  Choose Zoom Extents Selected from the flyout.

The viewport zooms to frame the biped, and you can see the pose clearly.



5 Open the Motion panel.



6 On the Biped rollout, click the plus to expand the expansion bar. In the Modes group, turn on In Place mode.

7 Play the animation in the Perspective viewport.

8 While the animation is playing, click Orbit in the viewport navigation controls.

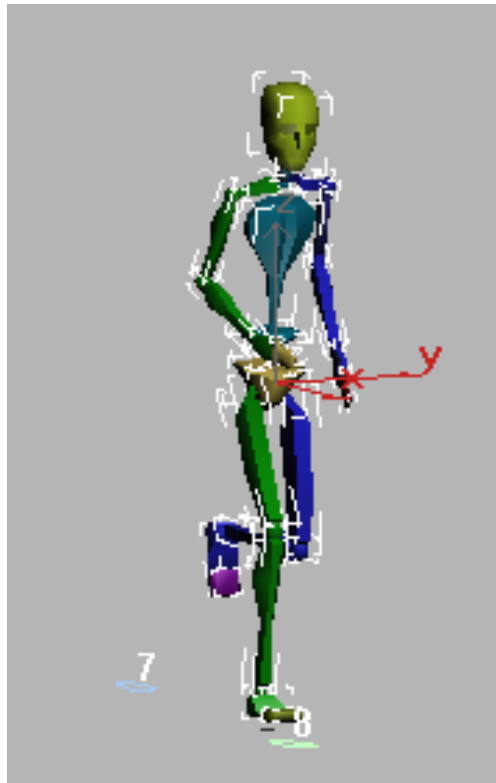
Orbit lets you rotate the viewport while the animation plays.

9 Rotate the viewport around while the biped is running, so you can see the animation from all sides.

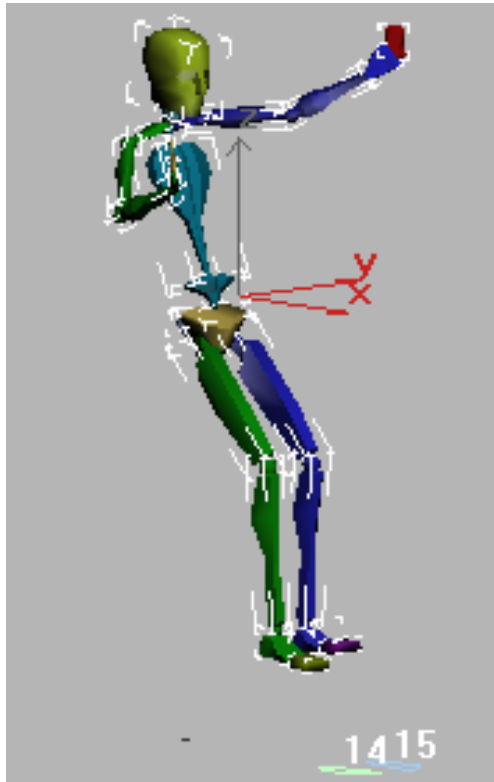
Since you are using In Place mode, the biped remains in view and never leaves the frame.

TIP If you click In Place mode and the biped disappears, navigate the viewport to the center of the home grid. In Place mode plays the biped animation at this location.









You can use In Place mode when you need to view and adjust the animation of a biped that moves beyond the confines of the viewport. In Place mode is just a viewing mechanism: it doesn't actually create an in-place animation. To change the animation so the biped stays in the same space, create a dummy object and link the COM to the dummy. Then keyframe the dummy so that the biped stays in the same place as the animation progresses.

Summary

This tutorial showed you a biped can interact with objects in its environment, including linking hands so they hold objects, or feet so they stand on other objects. It also showed how to create the illusion of weight by adjusting the biped's Center Of Mass. It showed using a Look At target so the biped appears to watch a moving object. Finally, it showed how In Place mode to preview the motion of a biped that moves out of a viewport's field of view.