CD IK Tools v1.5 For Cinema 4D 9.6+

CD IK Tools is a plugin suite of tools and expressions for character rigging and animation. It works with or without the Mocca module. The specialized expressions in CD IK Tools will allow you to easily build a stable, predictable character rig. Each expression uses the Attributes Manager interface, making manual set-ups quick and easy. All of the expressions' parameters are accessible through Xpresso and can be animated. The expressions are designed to be used on any type of object, so you are not restricted to creating a rig using only bones or joints.

The components of CD IK Tools plugin suite are:

Command Tools:	Expressions:	
CD Add Root Null	CD Limb IK	CD Foot IK
CD Add Tip Null	CD Quadleg IK	CD Mech IK
CD Add Tip Effector	CD Finger	CD Thumb
CD Add Tip Goal	CD Hand Tag	CD Rotator
CD Zero Global Rotation	CD Spinal	CD Linkage IK
CD Add Hand Tag	CD Spline IK	CD Piston IK
CD Hand Pose Copy	CD Dual Target	
CD Hand Pose Save	CD Smooth Rotation	
CD Hand Pose Load		
CD Setup Tool		
CD IK Handle Tool		

Command Tools

The command tools are designed to help make setups quick and easy.

CD Add Root Null
This command adds a Null object at the selected object's root position. The null object is added above the selected object at the same level in the hierarchy as the selected object. This command utilizes Cinema 4D's standard modifier key convention for adding objects. Holding the shift key down adds the Null object as a child of the selected object. Holding the control key down adds the object below the selected object at the same level in the hierarchy. Holding the option key down (alternate key on Windows) adds the Null as a parent of the selected object. If no modifier key is depressed this command will work with multiple selected objects to add Null objects for each selected object.

CD Add Tip Null

This command adds a Null object at the selected object's tip position. The Null object is added outside of the hierarchy at the root level in the Object Manager. This command also uses Cinema 4D's modifier key convention as described above in the CD Add Root Null description. If no modifier key is depressed this command will work with multiple selected objects to add Null objects for each selected object.

CD Add Tip Effector

This command adds a tip effector null object at the tip of the selected object. This Null object is added as a child of the selected object. Since a tip effector object is the last object in a hierarchal chain, this command does not use any modifier keys to place the object elsewhere in the hierarchy. This command will also work with multiple selections.

CD Add Tip Goal

This command adds a tip effector to the active bone along with an IK Expression (older legacy IK Expression) and a target Null object. The target Null object is inserted outside of the hierarchy at the root level in the Object Manager. The tip effector is inserted as a child of the active bone. This command is not available in R12+ versions.

CD Zero Global Rotation

This command sets the selected object's orientations to global zero. This is useful for objects, used as controllers, that are located inside or outside of the hierarchy. Holding the shift key down will reorient the selected object without changing it's child objects. This command will also work with multiple selections.

CD Add Hand Tag

This command adds a CD Hand tag to the selected object. To use the command, you select the object on which you wish to place a CD Hand tag (usually an arm controller), then shift select the CD Thumb and CD Finger tags you wish to be included in the CD Hand tag's links and click on the CD Add Hand Tag command. The command will then add a CD Hand tag to the selected object, place the selected CD Thumb and CD Finger tags in the links and set the Base Pose in the Pose tab.

CD Hand Pose Copy

This command copies the values of a CD Hand tag's sliders to another CD Hand tag's sliders. To use the command, you first select a source object which has a CD Hand tag on it, then shift select a destination object which also has a CD Hand tag on it, and click on the CD Copy Hand Pose command. The current slider values from the source object's CD Hand tag will then be copied to the destination object's CD Hand tag.
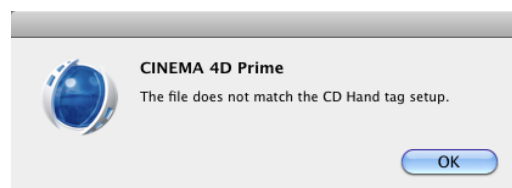
CD Hand Pose Save

This command will save all of the poses of a selected CD Hand tag or a selected object that has a CD Hand tag on it. The command will open a file selector dialog where you will choose a directory. The command will then save each pose to a separate file and name the files with the same name as the poses.

CD Hand Pose Load

This command will load a pose into a selected CD Hand tag or a CD Hand tag on a selected object. The command will open a file selector dialog where you can choose a previously saved hand pose to load. The loaded

CINEMA 4D Prime
The file does not match the CD Hand tag setup.

OK

hand pose will be added to the end of the pose list in the CD Hand tag. If the setup in the hand pose file does not match the setup of the target CD Hand tag, you will get a message dialog informing you that the setups do not match and the loading will be aborted.

CD IK Setup

This command tool is designed to automatically set up the CD IK Tools expressions for you. It uses a standard Non-Modal dialog interface which can be tabbed and docked in any of your Cinema 4D layouts. In the *Expression Type* section you choose what type of expression to set up for the selected object. The options that are available in the next section will depend on which type of expression is selected in the *Expression Type* section. The *Pole Axis* option is a pop up menu that allows you to choose on which axis the Pole Vector Object will be set. This option will be available for all of the expression types that are based on a rotation plane solver. The *Line Target* option is a popup menu that will allow you set the target of the line that is drawn from the Pole Vector object to the bone. The line can be set to target the root position of the object or the tip position of the object. This option is only available for the *CD Limb IK, CD Quadleg IK* and the *CD Rotator* expressions. The *Spinal Axis* option is only available for the *CD Spinal* tag and it determines along which axis the objects will be aligned. The *Number of Spline IK Targets* option allows you to set how many *Target Objects* you want to create to control the shape of the spline object used in the *CD Spline IK* expression. This option is only available when *Spline IK* is selected in the *Expression Type* section. The *No. Bones in Chain* option allows you to set the number of objects in the chain that will be affected by the expression. This option is only available when *Rotator, Spinal*, *Spline IK* or *Piston IK* is selected in the *Expression Type* section of the Setup dialog. The *Setup IK Chain* button will set up the expression on the selected object according to the selected options and the selected expression type.

CD IK Handle Tool

This Viewport Editor Tool is a companion tool to set up the **CD IK Handle** tag on a chain of joints or bones. To use the tool you first select the root joint of the chain in the viewport and then select the tip joint of the chain in the viewport. The tool will then setup the **CD IK Handle** tag on the root joint according to the options set in the tool's Attributes Manager dialog. The *Radius* option sets the viewport selection radius of influence. The *IK Solver* option determines the type of IK solver will be selected in the **CD IK Handle** tag. The choices are *IKRP Solver*, *IKSC Solver* and *IKHD Solver*. The *Pole Axis* option determines which pole vector direction axis will be set in the **CD IK Handle** tag. The choices are +X, +Y, -X and -Y.

Expressions

What is a Rotation Plane Solver?

The IK expressions are based on a Rotation Plane Solver which restricts the objects in a chain to a "plane of rotation" making the object chain's movement stable and predictable. Looking at Figure 2.1, you'll see that the plane of rotation is defined by three position points, which are the global positions of a Pole Vector object, IK Handle object and the chain's Root object to which the expression has been assigned. The plane is constantly redefined as the Pole Vector and IK Handle objects change position. The plane is oriented to either XZ or YZ with the plane's Z axis always pointing to the IK Handle object. The axis pointing to the Pole Vector object can be set to +X, +Y, -X or -Y. If any of the three objects are at the exact same position, then the expression will have no effect on the object chain. This is due to a safeguard built into the expression that prevents the calculation result to be zero, which would cause the object chain to collapse.
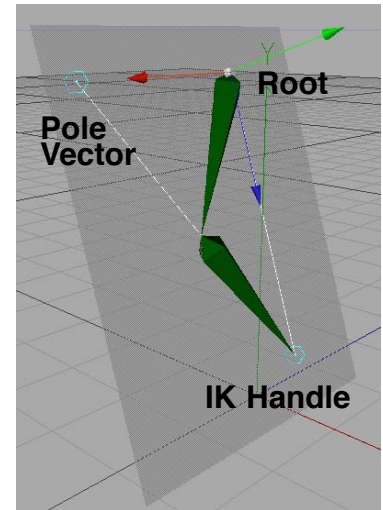
Figure 2.1

IK/FK Blending

All of the IK tags have an IK Blend slider in the Attributes Manager, which is used for IK/FK Blending. When the IK Blend slider is at 100%, then the solution is in full IK mode, and when the slider is at 0%, the solution is in full FK mode. IK/FK blending gives you smoother transitions than IK/FK switching. When the slider is set to a percentage less than 100%, there will be lines drawn in the view port to show where the bones would be located if the IK blend was in full IK mode. This gives you a guide while in FK mode, so that you can adjust the positions of the IK Handle and Pole Vector objects to the positions of the bones, and set a key for them before blending back to IK mode. An interesting thing about the IK Blend slider, is that if you set the blend to a percentage between 0% and 100%, and then animate the IK Handle and Pole Vector objects, you can get a sort of "fake" dynamic effect.
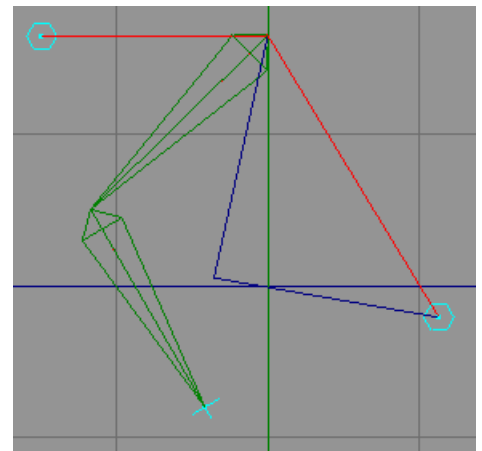
Squash & Stretch

All of the IK tags and the CD Dual Target tag have built in squash & stretch. The squash & stretch parameters are available in the Stretch tab in the tags attributes. The *Set Length* button stores the current length of the bones or joints. The length must be set before any of the other options will be

available. The *Clear Length* button clears the previously set length and disables all the other options. The *Reset Length* button resets the stored length to the current joint length. *Squash & Stretch* is a toggle switch used to turn the squash and stretch on and off. *Change Skin Volume* is an option only available when using CD Joints & Skin. This will preserve the mesh's skin volume so that the skin spreads when squashed and thins when stretched. The *Skin Volume* slider allows you to control the strength of the skin volume. The slider's min/max values are from 0% to 100%, but the number field's values can be set past 100%. The two options *Clamp Squash* and *Clamp Stretch* are used to limit the distance at which the squash and stretch will be active. The *Set* buttons allow you to set these distances according to the current position of the

IK controller objects. The *Use Curve* option enables the S&S Curve. The *Mix Curve Volume* enables the curve's shape to be blended with the curve of another IK tag which is on the same bone chain. This option is only available on the CD Spline IK, CD Spinal and CD Dual Target tags. The S&S Curve is a standard Cinema 4D curve attribute which allows you to shape the way the squash & stretch affects
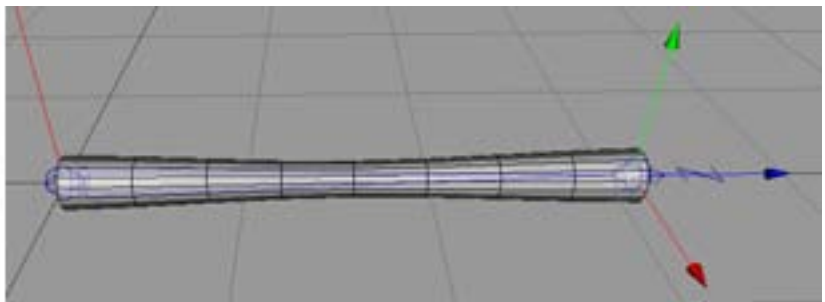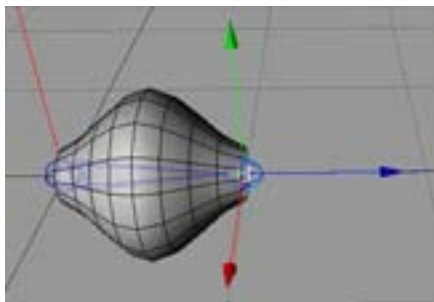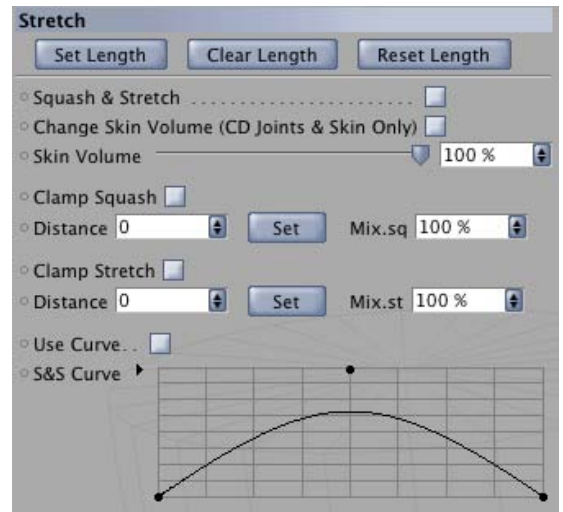

the volume of the skin. By setting the curve points so that the curve is high in the center and low on the ends you can make the volume change more in the center of the skinned mesh.

CD Limb IK Expression

This expression is a simple 2 bone expression useful for setting up a character's arms and legs. There are two object links that will be used for the RP Solver calculation. These links hold the *Pole Vector Object* and *IK Handle Object,* and they will accept any basic object.
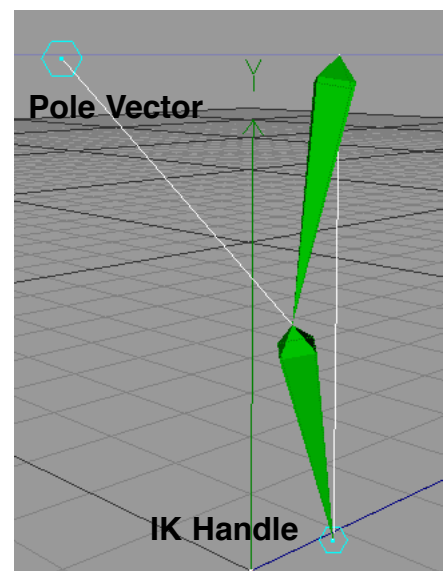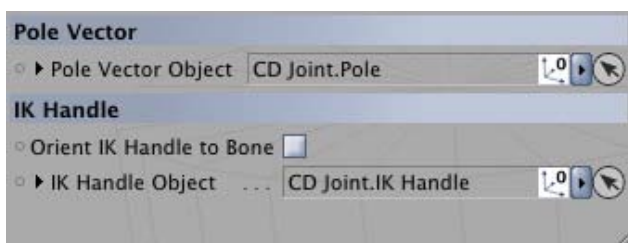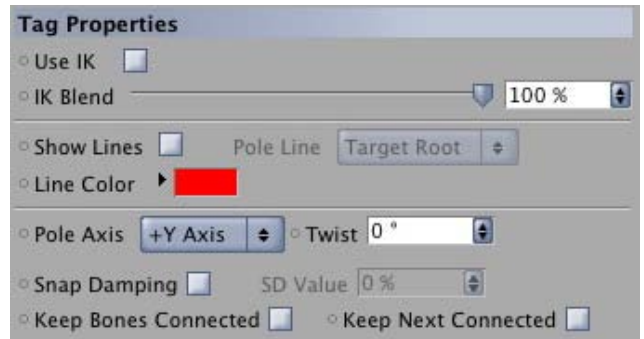

Important Note: The second bone needs a child to perform the IK calculation, so if there will be no child bone after the second

bone in the chain, then there must be a tip effector at the end of the second bone. Otherwise the expression will have no effect.

Tag Properties Tab

Use IK turns the IK calculation on and off. When IK is off, the object in the *IK Handle Object* link will be locked to the tip position of the second bone, and the object in the *Pole Vector Object* link will be locked to the first bone at its current position at the time when the *Use IK* switch is turned off. This parameter will check down the hierarchy to see if a CD Foot IK tag is also used and link both *Use IK* switches together. The *IK Blend* slider is used for IK/FK blending as described above in the *IK/FK Blending* section. This parameter will also check down the hierarchy to see if a CD Foot IK tag is also used and link both *IK Blend* sliders together. *Show Lines* will display lines between the IK Handle Object, the Bone and the Pole Vector Object, and also lines through the center of the bones. The *Pole Line* can be set to target the Root or the Tip of the Bone. *Line Color* allows you to change the color of the lines that are drawn. *Pole Axis* is a pop-up menu allowing you to choose which axis will point to the Pole Vector (+X, +Y, -X or -Y). The *Twist* attribute allows the IK to be calculated at an angle rotated around the vector between the root bone and the *IK Handle Object*. *Zero Angle Damping* is for smoothing out the "snap" into position that happens when the limb is fully extended. The amount of damping can be set from 0% to 100%. Higher values are good for arms but a value of 30% or lower should be used for legs. *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression.
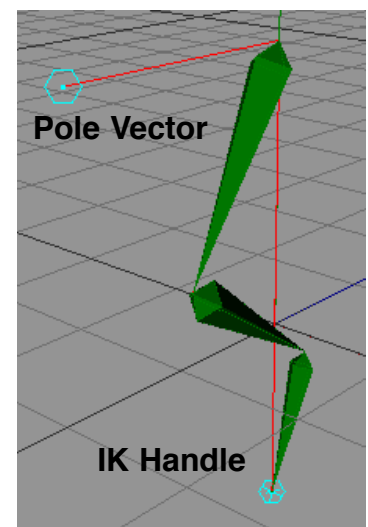
CD QuadLeg IK Expression

This expression is a 3 bone expression useful for setting up quadruped legs. There are two object links that will be used for the RP Solver calculation. These links hold the *Pole Vector Object* and *IK Handle Object* and they will accept any type of object.


Important Note: The third bone needs a child to perform the IK calculation, so if there will be no child bone after the third bone in the chain, then there must be a tip effector at the end of the third bone. Otherwise the expression will have no effect. This Tip Effector object is automatically added if needed when using the Setup Tool.
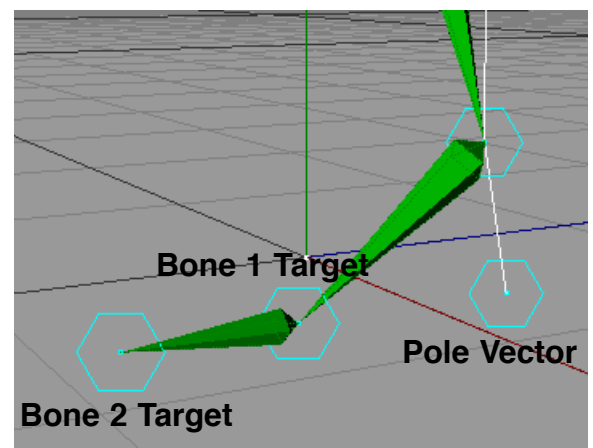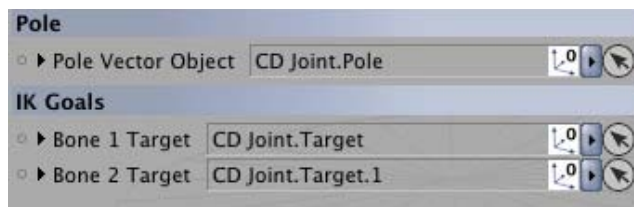
Tag Properties Tab

Use IK turns the IK calculation on and off. When IK is off, the object in the *IK Handle Object* link will be locked to the tip position of the third bone, and the object in the *Pole Vector Object* link will be locked to the first bone at its current position at the time when the *Use IK* switch is turned off. This parameter will check down the hierarchy to see if a CD Foot IK tag is also used and link both *Use IK* switches together. The *IK Blend* slider is used for IK/FK blending as described above in the *IK/FK Blending* section. This

parameter will also check down the hierarchy to see if a CD Foot IK tag is also used and link both *IK Blend* sliders together. *Show Lines* will display lines between the IK Handle Object, the Bone and the Pole Vector Object, and also lines through the center of the bones. The *Pole* line can be set to target the Root or the Tip of the Bone. *Line Color* allows you to change the color of the lines that are drawn. *Pole Axis* is a pop-up menu allowing you to choose which axis will point to the Pole Vector (+X, +Y, -X or -Y). The *Twist* attribute allows the IK to be calculated at an angle rotated around the vector between the root bone and the *IK Handle Object*. *Lower IK Angle* sets the angle limit of the IK in the third bone. There is a Minimum and Maximum angle limit that you can set for this parameter, which is between -100º and +60º. *Zero Angle Damping* is for smoothing out the "snap" into position that happens when the limb is fully extended. The amount of damping can be set from 0% to 100%. *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression.
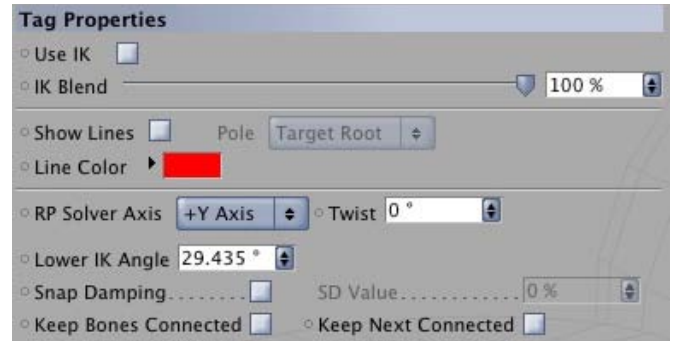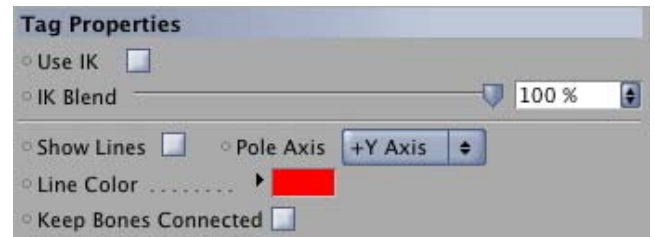

 CD Foot IK Expression

This expression is also a 2 bone expression specifically designed for a foot – toe bone set up. There are three object links in this expression. The *Pole Vector Object* link holds the Pole Vector object that is used for the rotation plane calculation. The *Bone 1 Target* link holds the Foot bone target object and the *Bone 2 Target* link holds the Toe bone target object


Tag Properties Tab

Use IK turns the IK calculation on and off. This switch is linked to the *Use IK* switch of a CD Limb IK or CD Quadleg IK tag. When IK is off, the object in the *Bone 1 Target* link will be locked to the tip position of the Foot bone while the object in the *Bone 2 Target* link will be locked to the tip position of the Toe bone. The object in the *Pole Vector Object* link will be locked to the first bone at its current position at

the time when the *Use IK* switch is turned off. *Show Lines* will display lines connecting the objects in the links to the bones, and also lines through the center of the bones. *Line Color* allows you to change the color of the lines that are drawn. *Pole Axis* is a pop-up menu allowing you to choose which axis will point to the Pole Vector (+X, +Y, -X or -Y). *Keep Bones Connected* keeps all of the bones affected by the expression connected. This switch is linked to the *Keep Next Connected* switch of a CD Limb IK or CD Quadleg IK tag.

CD Spline IK Expression

This expression aligns a bone chain to a spline object, which is useful for many things such as: a spinal rig, a tail rig, a long neck rig, etc. There are three object links that need to have an object assigned
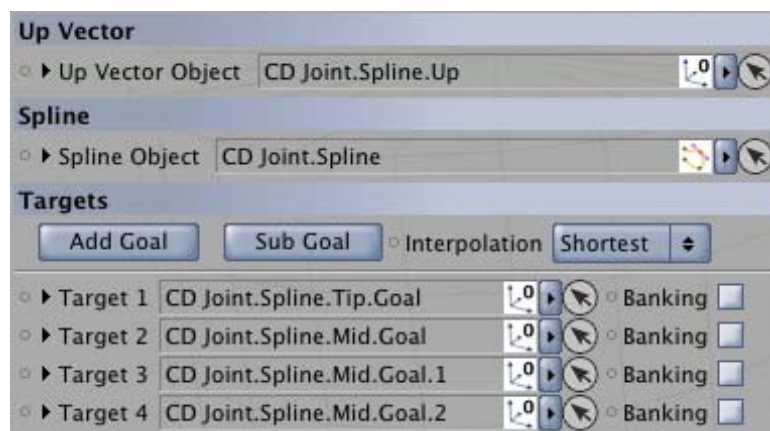
to them before the Spline IK will function. These three links are the *Up Vector Object* link, the *Spline Object* link and the *Target 1* link. The other links in the **Controllers** tab hold additional controller objects for the spline (up to 20 controllers). You can add and subtract controller links by using the *Add Goal* and *Sub Goal* buttons. The *Target* links hold the spline controller objects and will accept any
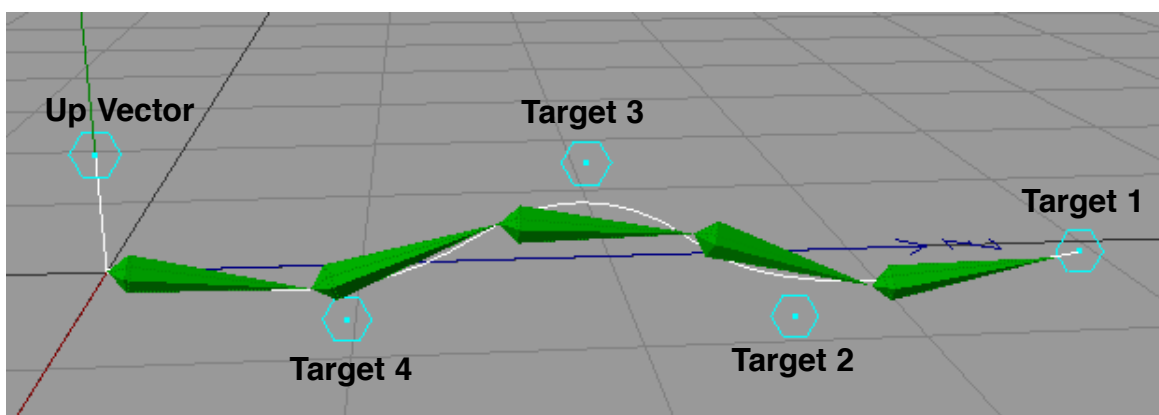
base object. The *Target 1* link will always be the tip end of the spline object. The other *Target* links are set up to be used in order from the tip to the base. Each *Target* link also has a *Banking* check

box which is used in conjunction with the Banking parameter in the **Tag properties** tab. This option allows the target objects which have their *Banking* switch enabled to control the twist of the bone chain. There are 3 types of *Interpolation* for the twist: Shortest, Average and Longest. Shortest will only interpolate between -180º and +180º. This is the most stable of the interpolations. Average will interpolate between -360º and +360º, and Longest gives you infinite twist interpolation. The *Up Vector Object* link holds the Up Vector object that is used for the rotation plane calculation. The *Spline Object* link holds the spline object used for the expression and will only accept an editable spline object. Any of the spline Types available in the spline's *Object Properties* can be used, but the *B-Spline* type seems to give the smoothest motion when animating.

Tag Properties Tab

Use IK turns the IK calculation on and off. When IK is off the bones no longer align themselves to the *Spline Object*, but the objects in the **Controllers** tab links will still control the shape of the *Spline Object,* except for the *Target 1* controller, which will be locked to the tip of the bone chain. The *IK Blend*
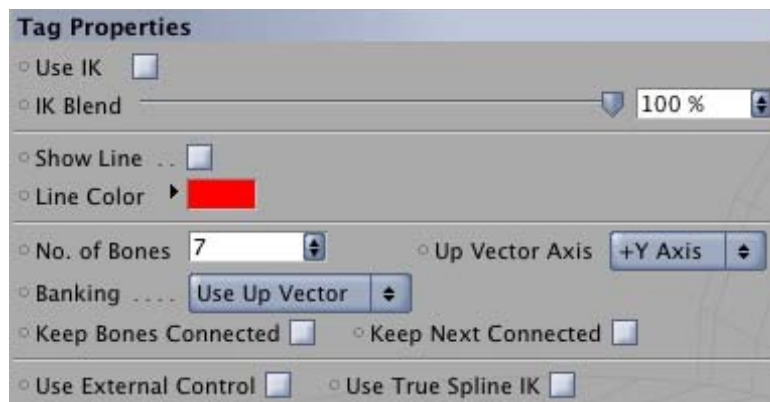

slider is used for IK/FK blending as described above in the *IK/FK Blending* section. *Show Line* will display a line from the *Up Vector Object* to the first bone, and also lines through the center of the bones. *Line Color* allows you to change the color of the lines that are drawn. *No. of Bones* sets the number of bones in the chain that will be affected by the Spline IK expression. *Up Vector Axis* is a pop-up menu allowing you to choose which axis will point to the Up Vector (+X, +Y, -X or -Y). *Banking* is a pop-up menu allowing you to set how the rest of the bones in the chain will be aligned to the first bone. The menu choices are *Use Up Vector*, *Use Rotation* and *Use Targets*. *Use Up Vector* aligns the bones to the *Up Vector Object*. *Use Rotation* transfers the first bone's Bank Rotation to the rest of the bones in the chain. *Use Targets* allows the target objects to control the banking according to which targets have their Banking switch turned on. *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression. Use External Control disables the control of the spline points by the controller objects. This allows a dynamic spline to be used for the IK. The Use True Spline IK option makes the spline IK behave like regular IK, in that when you pull on the tip controller the bone chain tries to straighten out. The objects in the rest of the Target links can still control the general shape of the spline. This is useful when you want to rig a bone chain with a spline IK but want the tip of the chain to stay fixed to the controller.
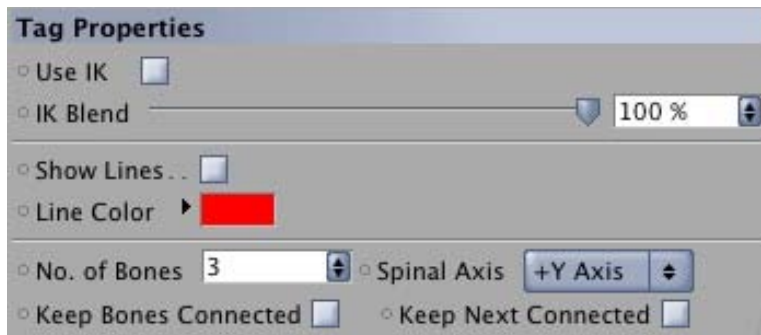
CD Spinal Expression

This expression is specifically designed for rigging a character's spine. It makes spinal rigging simple in the fact that it only needs two controllers to allow complete control over an S-shaped spine. It is designed to function very similar to the Isner Spine for XSI. In the Controllers tab there are two links for *Tip* and *Base*. These links can hold any type of object you want to use as a control object. Each controller has a *Depth* setting that will determine how much of the spinal bone chain the controllers will
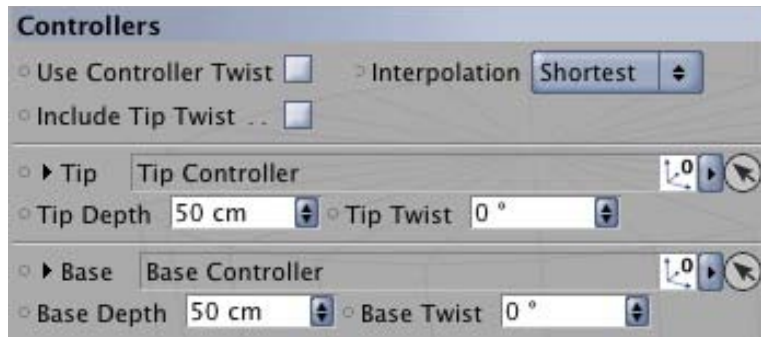
affect from the ends toward the middle. A line is drawn from the center of the control objects to give you a visual representation of the *Depth* in the editor view. Each controller also has a twist parameter that can be used together to control the twist of the entire bone chain. The Use Controller Twist allows the twist of the bone chain to be controlled by the rotation of the controller objects. When this option is enable, each controller's twist parameter is disabled. With the Include Tip Twist enabled, the twist is calculated from the tip of the last bone in the chain, otherwise the twist is calculated from the root of the last bone in the chain. There are 3 types of *Interpolation* for the twist: Shortest, Average and Longest. Shortest will only interpolate between -180° and +180°. This is the most stable of the interpolations. Average will interpolate between -360° and +360°, and Longest gives you infinite twist interpolation.

Tag Properties Tab

Use IK turns the IK calculation on and off. When IK is off, the base controller object's position is locked to the base of the bone chain and the tip controller object's position is locked to the tip of the bone chain. The two controller objects can be still rotated, though. The *IK Blend* slider is used for IK/FK blending as described above in the *IK/FK Blending* section. *Show Line* will display lines through the


center of the bones. *Line Color* allows you to change the color of the lines that are drawn. *No. of Bones* sets the number of bones in the chain that will be affected by the Spline IK expression. *Spinal Axis* is a pop-up menu allowing you to choose along which axis the bones will be aligned. *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression.

CD Finger Expression

This expression is designed to control a finger set up using sliders for *Spread, Bend* and *Curl.* The *Up Vector Object* link holds the Up Vector object that is used for the rotation plane calculation. The *Spread* slider controls the side to side motion of the finger at the first knuckle. The *Bend* slider controls the bending motion at the first knuckle. The *Curl* slider controls the bending motion of the rest
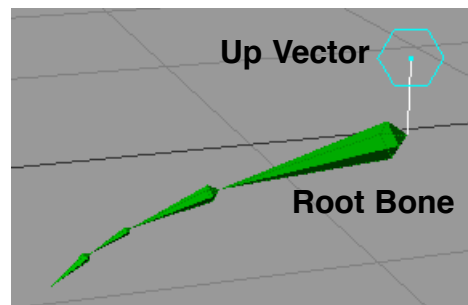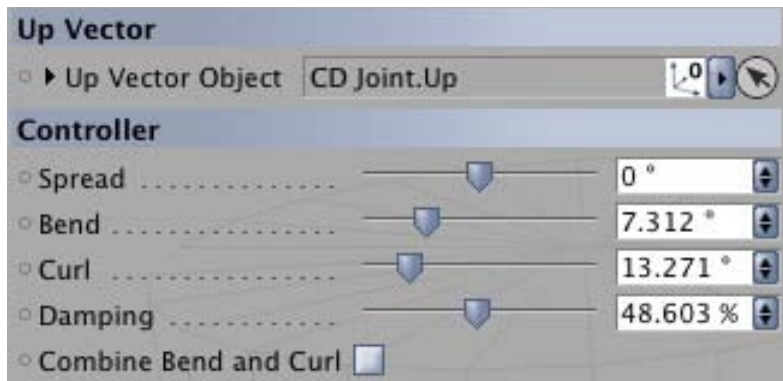
of the knuckles in the finger. The *Damping* slider controls the amount of Curl damping for the finger tip bone. Enabling the *Combine Bend and Curl* switch disables the *Curl* slider and allows the *Bend* slider to control both bend and curl.

Tag Properties Tab

Show Line will display a line from the *Up Vector Object* to the root bone, and also lines through the center of the bones. *Up Vector Axis* is a pop-up menu allowing you to choose which axis will point to the Up Vector (+X, +Y, -X or -Y). *Line Color* allows you to change the color of the lines that are drawn. *Left Hand* designates whether the finger is on the left or right hand. With this enabled the finger is determined to be a left hand finger and when it is disabled it is determined to be a right hand finger. When the finger is in left hand mode, the Spread slider works in the opposite direction. This is useful for posing the left finger to match the pose of the corresponding right finger because the left finger sliders will now have the same values as the right finger for the same pose. *Keep Bones Connected* keeps all of the bones affected by the expression connected. With the *Include Tip Curl* parameter enabled, all bones after the last bone in the finger, as shown in the example image above, will be included in the *Curl* slider's control. This allows you to have control over the fingers of creature characters that have more bones in their fingers than a normal human hand.
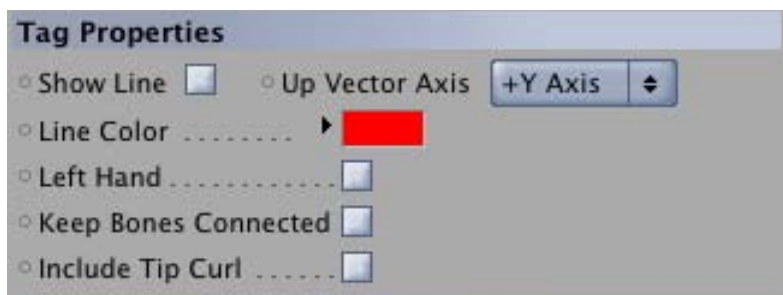
Range Tab

In the **Range** tab you can set the minimum and maximum range of the *Spread*, *Bend* and *Curl* sliders, so you can customize the slider ranges for different characters.

![CD Thumb Expression icon] **CD Thumb Expression**

This expression is designed to control a thumb set-up and works similar to the CD Finger expression but with added sliders for *Grip* and *Twist*. The set-up of the bones is a bit different here. There must be a *Root Bone*, preferably a Null bone, at the base of the thumb bone chain. The next bone in the chain will be controlled by the *Grip, Twist* and *Spread* sliders. These three sliders are essentially controlling
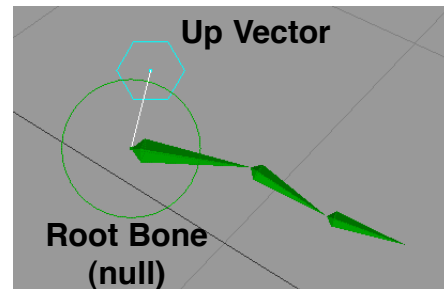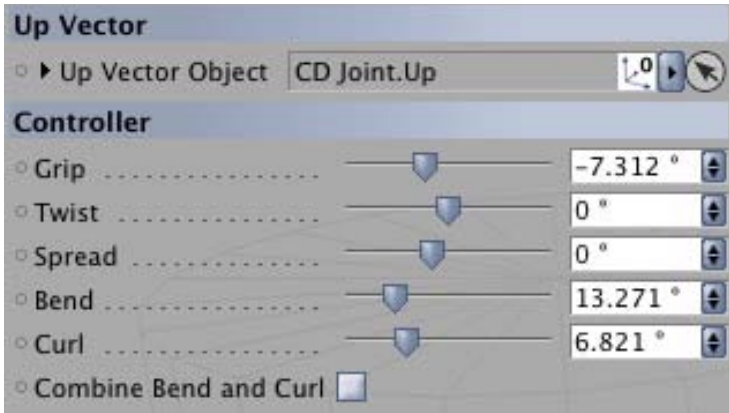
the rotation around the three axes of the bone. The *Bend* slider controls the bending motion at the first knuckle. The *Curl* slider controls the bending motion at the second knuckle (the tip of the thumb). Enabling the *Combine Bend and Curl* switch disables the *Curl* slider and allows the *Bend* slider to control both bend and curl. The *Up Vector Object* link holds the Up Vector object that is used for the rotation plane calculation.

Tag Properties Tab

Show Line will display a line from the *Up Vector Object* to the *Root Bone Object*, and also lines through the center of the bones. *Up Vector Axis* is a pop-up menu allowing you to choose which axis will point to the Up Vector (+X, +Y, -X or -Y). *Line Color* allows you to change the color of the lines that are drawn. *Left Hand* designates
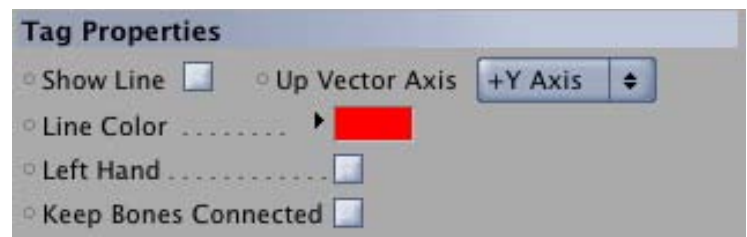
whether the thumb is on the left or right hand. With this enabled the thumb is determined to be a left hand thumb and when it is disabled it is determined to be a right hand thumb. When the thumb is in left hand mode, the Twist and Spread sliders work in the opposite direction. This is useful for posing the left thumb to match the pose of the corresponding right thumb because the left thumb sliders will now have the same values as the right thumb for the same pose. *Keep Bones Connected* keeps all of the bones affected by the expression connected.

Range Tab

In the **Range** tab you can set the minimum and maximum range of the *Grip*, *Twist*, *Spread*, *Bend* and *Curl* sliders, so you can customize the slider ranges for different characters.
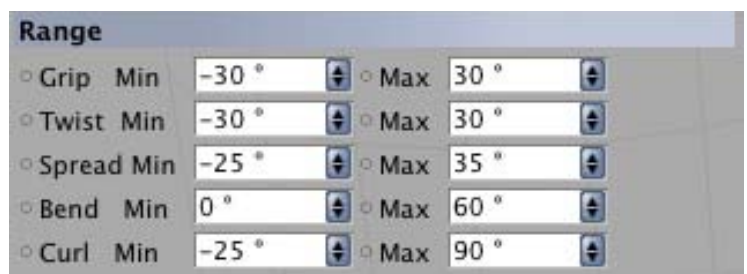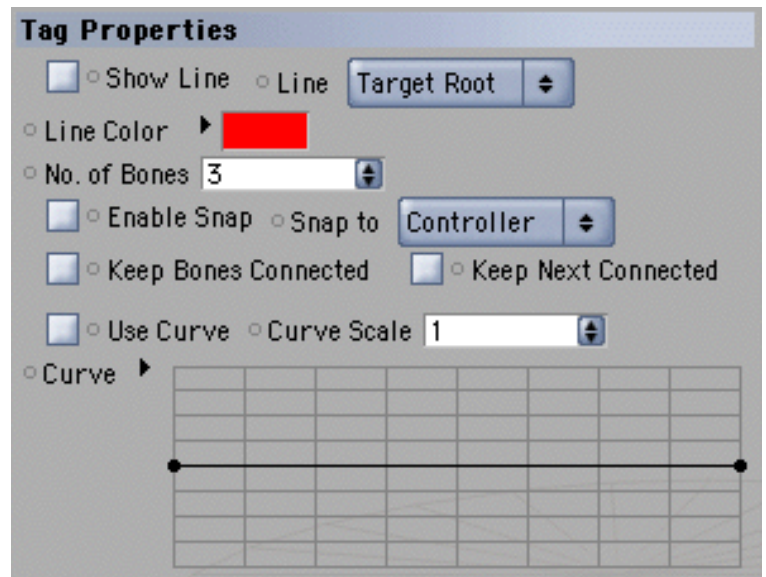
![CD Rotator Expression icon] **CD Rotator Expression**

This expression is designed to control the hierarchical rotation of a bone chain using another object as the controller. The *Control Object* link holds the object that will control the bone chain's rotation
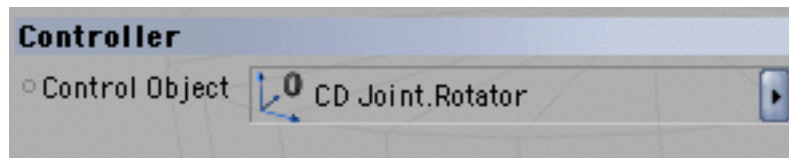
Tag Properties Tab

Show Line will display a line from the *Control Object* to the first bone. *Line* is a pop-up menu allowing you to set the line to target the root or the tip of the bone. *Line Color* allows you change the color of the lines that are drawn. *No. of Bones* sets the number of bones in the chain that will be affected by the expression. *Enable Snap* allows you to lock the controller object and the bone object to the same position. When this is enabled, the *Snap to* pop-up menu becomes available which allows you to choose whether to snap the controller to the bone or to snap the bone to the controller. *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression. *Use Curve* enables the curve parameter to control the amount of rotation that is transferred down the bone chain. *Curve Scale* scales the Y value of the curve points.

Hierarchical Rotation using CD Rotator Expression

It is important to understand how hierarchical rotation works with the CD Rotator expression. The *Control Object* controls the **global** rotation of only the first bone in the chain (the one to which the expression is assigned). In Figure 8.1, you can see that the first bone in the chain has the same orientation as the *Control Object*.
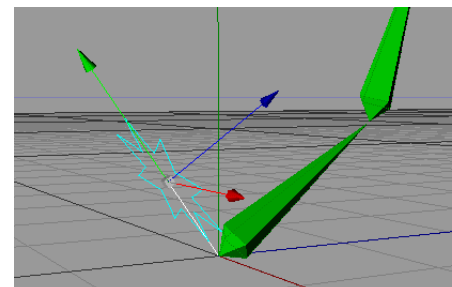

Figure 8.1

This first bone then passes its **local** rotation on to the next bone. If the first bone has no parent, then its **global** rotation *is* its **local** rotation. If the first bone has a parent, then its **local** rotation is relative to its parent's rotation. For example: if you rotate the *Control Object's* pitch 90° so that its Z axis is pointing straight up, the first bone's **global** rotation will be 90° pitch. If the first bone has no parent, then it's **local** rotation is also 90° pitch and that will be passed on to the next bone. If the first bone has a parent
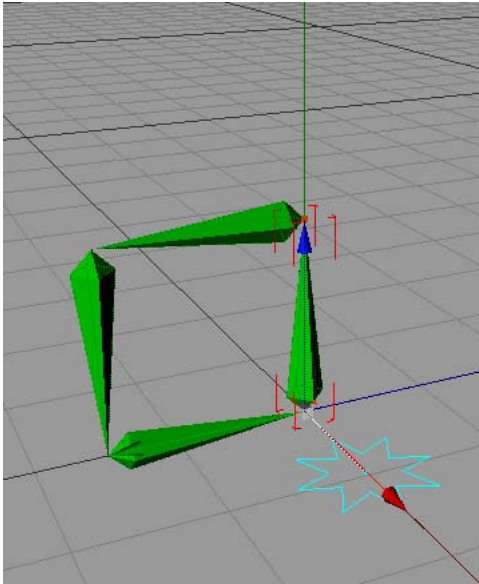
90° pitch without a parent bone.
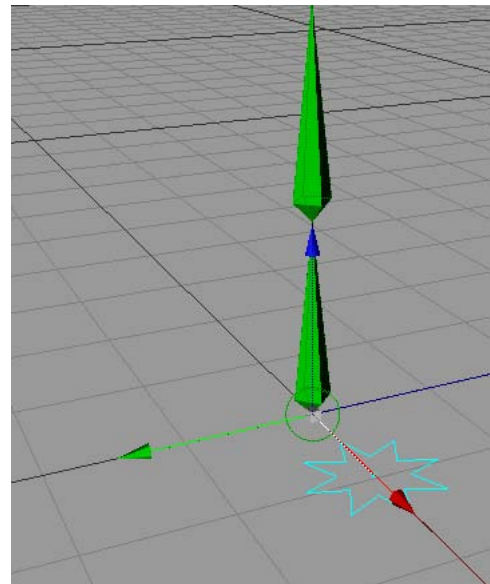
90° pitch with a parent bone also set to 90° pitch

and the parent's **global** rotation is also 90° pitch, then the first bone's **local** rotation is 0° pitch and that will be passed on to the next bone. With this in mind, it is always a good idea that the first bone in a hierarchal rotation set-up has a parent when using the CD Rotator expression.

CD Dual Target Expression

This expression is a very simple targeting expression with a *Target* object link and an *Up Vector* object link. The expression will function if either or both links hold an object. The Z axis of the object that this expression


affects will point its Z axis to the object assigned to the *Target* link. By leaving the *Target* link empty, the expression essentially becomes an *Up Vector* expression. By leaving the Up Vector link empty, the expression will assume a World Up Vector direction unless the Up Vector Axis is set to Off.
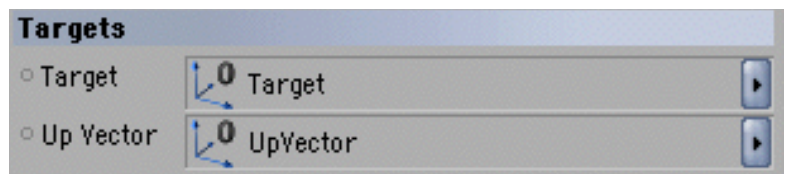
Tag Properties
Show Lines will display lines between the Target, the Bone and the Up Vector. The axis pointing to the *Up Vector* object can be set to either Off, +X, +Y, -X or -Y by using the *Up Vector Axis* pop-up menu. *Line Color* allows you change the color of the lines that

are drawn. The Strength slider can be set between 0% and 100%. This parameter can be used to blend between the object's current orientation and the targeting orientation.
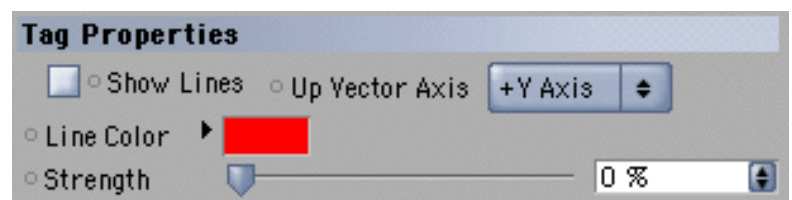
CD Hand Tag

The CD Hand tag is designed to work with the CD Finger and CD Thumb expressions to combine all of these two expressions relating to the individual hand into one convenient interface.

Tag Properties

This is where you create the links for the CD Finger and CD Thumb expressions of the hand. To add and subtract links, use the *Add Finger* and *Sub Finger* buttons. These links will only recognize CD Finger or CD Thumb expressions and they will also distinguish between the two. The names of the links will assume the names of the expression tags dropped into them. You can change the name of any expression tag by renaming it in the Basic tab of the tag's Attributes Manager.
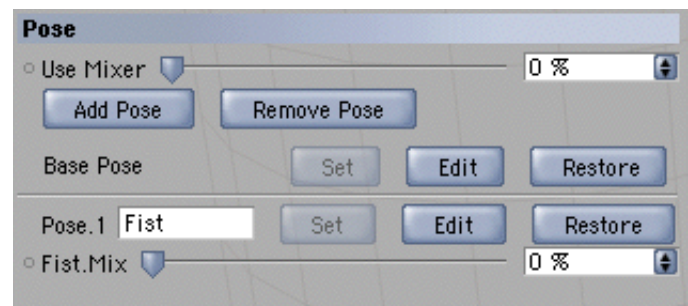
Controllers

This tab will hold the sliders to control the individual expressions. The controllers are created automatically when you drop an expression into one of the links created in the **Tag Properties** tab. Each set of sliders is created according to the type of expression to which it is related and placed in a foldable subgroup. These subgroups also assume the names of the expressions to which they are linked. The *Left Hand* switch controls the *Left Hand* switches of the linked *CD Thumb* and *CD Finger* tags.
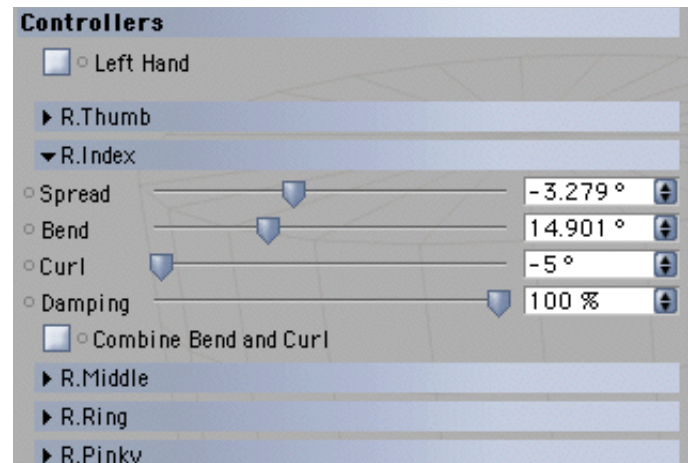
Pose

In this tab you can save and mix poses, which are sets of slider values for all of the expressions associated with the CD Hand tag. *Use Mixer* is the main pose blend slider which blends between stored poses and the current slider values in the **Controllers** tab. *Add Pose* will add new poses to the bottom of the pose list. *Remove Pose* will remove poses from the pose list starting from the bottom of the list. The *Base Pose* is a permanent pose which can not be removed and is considered the basic rest state or "bind pose" of the hand. Each pose has 3 buttons: *Set*, *Edit* and *Restore*. The *Set* button stores the current slider values into the pose. The *Edit* button restores the saved slider values and "unsets" the pose so that you can edit the pose and then "reset" the edited pose with the *Set* button. The *Restore* button simply restores the saved slider values. Each additional pose has a name field so you can name the pose and also has a *Mix* slider so you can blend between poses. The *Mix* slider will assume the name of the pose.
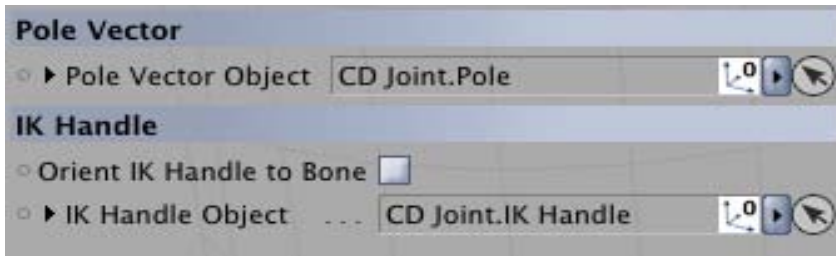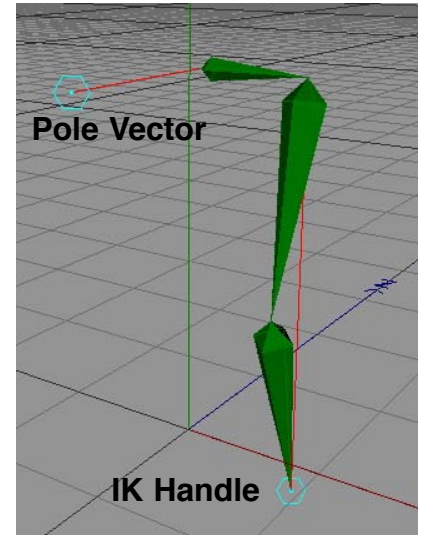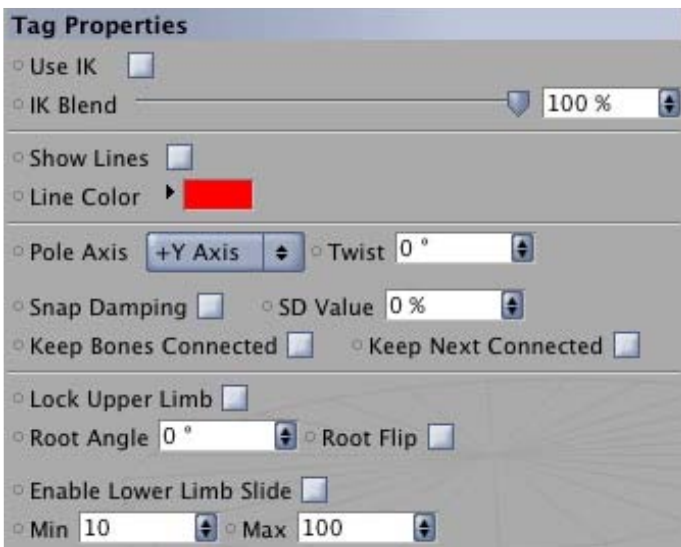
CD Mech IK Expression

This expression is a 3 bone expression useful for setting up a mechanical arms and legs. There are two object links that will be used for the RP Solver calculation. These links hold the *Pole Vector Object* and *IK Handle Object,* and they will accept any basic object.

Pole Vector

IK Handle

Important Note: The third bone needs a child to perform the IK calculation, so if there will be no child bone after the third bone in the chain, then there must be a tip effector at the end of the third bone. Otherwise the expression will have no effect.

Tag Properties Tab

Use IK turns the IK calculation on and off. When IK is off, the object in the *IK Handle Object* link will be locked to the tip position of the third bone, and the object in the *Pole Vector Object* link will be locked to the first bone at its current position at the time when the *Use IK* switch is turned off. This parameter will check down the hierarchy to see if a CD Foot IK tag is also used and link both *Use IK* switches together. The *IK Blend* slider is used for IK/FK blending as described above in the *IK/FK Blending* section. This parameter will also check down the hierarchy to see if a CD Foot IK tag is also used and link both *IK Blend* sliders together. *Show Lines* will display lines between the IK Handle Object, the Bone and the Pole Vector Object, and also lines through the center of the bones. *Line Color* allows you to change the color of the lines that are drawn. *Pole Axis* is a pop-up menu allowing you to choose which axis will point to the Pole Vector (+X, +Y, -X or -Y). The *Twist* attribute allows the IK to be calculated at an angle rotated around the vector between the second bone and the *IK Handle Object*. *Snap Damping* is for smoothing out the "snap" into position that happens when the limb is fully extended. The amount of damping can be set from 0% to 100%. Higher values are good for arms but a value of 30% or lower should be used for
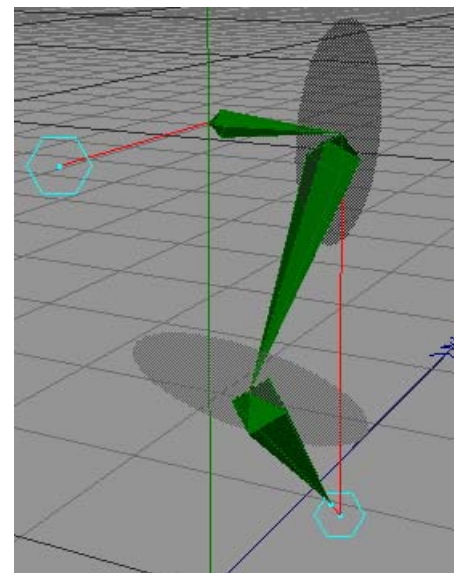
Figure 2.2

legs. *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression. *Lock Upper Limb* will lock the second and third bones to a rotation plane that is perpendicular to the parent of each bone (see figure 2.2). *Root Angle* sets the angle of the root bone in relation to the *IK Handle Object* direction. At 0º the root bone is perpendicular to the *IK Handle Object* direction. *Root Flip* reverses the perpendicular direction of the root bone so that it can be used for setting up the other side of the character. Both the *Root Angle* and *Root Flip* parameters are only available when the *Lock Upper Limb* parameter is disabled. The *Enable Lower Limb Slide* parameter allows the tip effector of the chain to slide up and down along the third bone's Z axis, while the *Min* and *Max* parameters set the clamping limits of the tip effector's sliding. These parameters are only available when the *Lock Upper Limb* parameter is enabled.

![icon] CD Smooth Rotation

This expression tag is designed to smooth out the interpolation between animation keys of an object's HPB tracks to eliminate the wobble caused by gimbal lock problems.

Tag Properties
The *Use Smooth Rotation* parameter can be used to turn the tag's smoothing function on and off.

![icon] CD IK Handle

This expression tag is a multi-joint IK solver initially designed to be compatible with importing IK constraints through the CD FBX Import/Export plugin. It supports the features, supported by the FBX SDK, that other 3D applications would support for importing and exporting IK constraints.

Tag Properties

Use IK turns the IK calculation on and off. The *IK Blend* slider is used for IK/FK blending as described above in the *IK/FK Blending* section. *Show Lines* will display lines between the *IK Handle Object*, the root bone and the *Pole Vector Object*, and also lines through the center of the bones. The *Pole* line can be set to target the Root or the tip of the first Bone. *Line Color* allows you to change the color of the lines that are drawn. *IK Solver* is a pop-up menu allowing you to choose the type of IK solver. The choices are *IKRP Solver* (rota-

tion plane), *IKSC Solver* (single chain) and *IKHD Solver* (history dependent). The *Unlock Root* option will enable the root bone to be free floating. *Pole Axis* is a pop-up menu allowing you to choose which
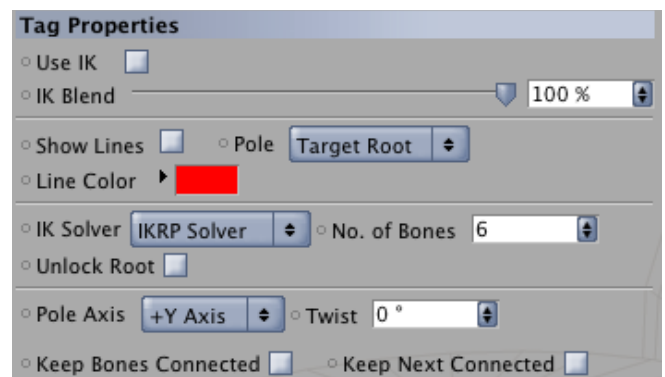
axis will point to the *Pole Vector* (+X, +Y, -X or -Y). The *Twist* attribute allows the IK to be calculated at an angle rotated around the vector between the root bone and the *IK Handle Object*. *Keep Bones Connected* keeps all of the bones affected by the expression con-nected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression. *Pole Vector Object* allows you to assign an object to control the pole vector direction of the *IKRP Solver*. *Pole Vector* allows you to set an arbitrary vector to determine the pole vector direction. This parameter is inaffective when an object is in the *Pole Vector Object* link. *IK Handle Object* is the IK solver's target object which serves as the handle.
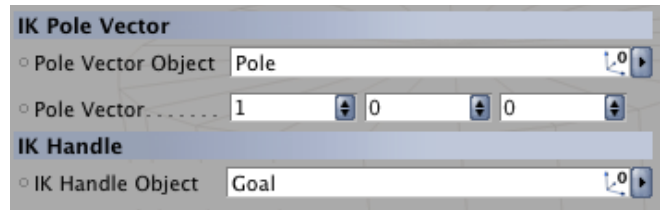
CD Linkage IK

This expression tag is designed for rigging mechanical linkages that convert linear motion into circular motion, for example as would be needed for a crank shaft and connecting rod in a steam engine or gasoline engine. **NOTE:** The expression works in the opposite way that a real engine would work. In other words where a real engine would convert linear motion to circular motion by the piston pushing the connecting rod to turn the wheel or crank shaft, the CD Linkage IK tag converts circular motion into linear motion by allowing the rotation of the wheel or crank shaft to pull the connecting rod and piston.

Tag Properties

Show Lines will display lines between the *Goal Object*, the root bone and the *Pole Object*, and also lines through the center of the bones. *Line Color* allows you to change the color of the lines that are drawn. *Pole Axis* is a pop-up menu allowing you to choose which axis will point to the *Pole Vector* (+X, +Y, -X or -Y). *Keep Bones Connected* keeps all of the bones affected by the expression connected, while *Keep Next Connected* keeps the next bone down connected to the last bone affected by the expression. *Pole Object* is a link that holds an object to control the pole vector. The pole vector determines which axis the root joint will rotate around. *Goal Object* is the target object which determines the direction of the converted linear motion.
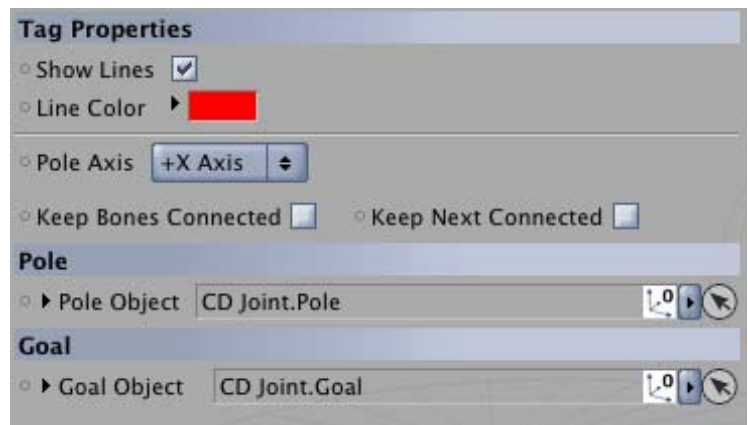
CD Piston IK

This expression tag is a multi-joint prismatic IK solver specifically designed for rigging telescoping hydrolic pistons. The tip joint will be locked to the IK Handle object while all of the joints between the root joint and the tip joint will adjust their position according to a percentage mix of the total distance between the root and tip.

Tag Properties

Show Lines will display lines between the *IK Handle Object*, the root bone and the *Pole Vector Object*, and also lines through the center of the bones. *Line Color* allows you to change the color of the lines that are drawn. *Pole Axis* is a pop-up menu allowing you to choose which axis will point to the *Pole Vector* (+X, +Y, -X or -Y). *Position mix* will dynamically create *Mix* sliders for all of the joints in between the root joint and the tip joint. The *Mix* sliders allow you to set the positions of the in between joints as a percentage of the total distance between the root joint and the tip joint. *Pole Vector Object* is a link that holds the pole vector object. *IK Handle Object* is a link that holds the IK handle object.

C.O.F.F.E.E. Functions and Symbols

These functions and symbols provide C.O.F.F.E.E. with access to layer properties in R10 and up, and provide the CallButton() function for pre R11 versions.

Symbols for layer parameters:
```
LAYERDATA_SOLO;
LAYERDATA_VIEW;
LAYERDATA_RENDER;
LAYERDATA_MANAGER;
LAYERDATA_LOCKED;
LAYERDATA_GENERATORS;
LAYERDATA_DEFORMERS;
LAYERDATA_EXPRESSIONS;
LAYERDATA_ANIMATION;
```

[bool] LayerOn([BaseList2D] bl, [int] id);
Enables an object's layer property.

Returns TRUE if successful

Parameters

    BaseList2D bl   The object which will have its layer property enabled.

    int id   The ID of the layer property to enable. *See symbols above*.

[bool] LayerOff([BaseList2D] bl, [int] id);
Disables an object's layer property.

Returns TRUE if successful

Parameters

    BaseList2D bl   The object which will have its layer property disabled.

    int id   The ID of the layer property to disable. *See symbols above*.

[bool] CallButton([BaseList2D] bl, [int] id);
Button call, the same as clicking a button in the user interface.

Returns TRUE if successful

Parameters

    BaseList2D bl   The object to which the button belongs.

    int id   The ID of the button.