



Pittsburg State University

Kansas Technology Center

1701 S. Broadway • Pittsburg, KS • 66762

620-231-7000 • www.pittstate.edu

Autodesk 3D Studio

General Information

Unit #	3D Graphics – Autodesk 3D Studio (GIT334)
LAP #	LAP-26
Prerequisite	LAP-25

Objective

Upon completion of this LAP, you will be able to create and create and modify Character Animation Toolkit (CAT) rigs and animate them. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment with an 85% or higher accuracy.

Specific Objectives

1. Create and modify Character Animation Toolkit (CAT) rigs.
2. Modify CAT bones to match character meshes.
3. Use skin modifier to attach mesh objects to CAT rigs.
4. Modify bone control over skin vertexes/weights.
5. Animate a generic walk cycle.
6. Track a character to a path

NOTE: Screen shots of the software and the appearance of the software on your computer will vary. Different settings on different computers can lead to alternative highlights and button settings appearance in 3DS MAX.

LEARNING STEPS

Directions: Check each step as completed.

This LAP should take approximately 1 hours to complete.

- 1. READ** LAP and Specific Objectives on the LAP cover sheet
- 2. WATCH** All Videos / Lectures / PowerPoints for LAP
- 3. READ** All Helpful Handouts for LAP
- 4. READ** Assignment # 26
- 5. COPMLETE** Assignment # 26
- 6. CREATE** Create a folder named ***YourLastName_3DSMAX_26*** on your flash drive to store all your files for this LAP.
- 7. COMPLETE** Complete the 3DS MAX scenes using the instructions in this LAP.
- 8. SAVE**
Save the scene file as ***YourLastName_26.max***.
Save the rendered animation as ***YourLastName_26.avi***.
Save ***ALL*** of your map files.
Place the above files in a zipped folder named ***YourLastName_26.zip***
- 9. SUBMIT** Submit the ***YourLastName_26.zip*** file to the instructor using the online course site
- 10. ASK** Instructor to answer any questions you may have regarding this LAP
- 11. OBTAIN** LAP 27 from the online course site

Note!

This LAP may require you to do some reading outside of class time.

LAP 26 Assignment # 26

Setup:

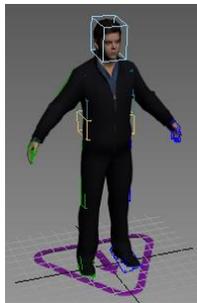
Character animation in 3DS Max has gone through several revolutions since it first began. It started with only Hierarchy Links, then Inverse Kinematics (IK), Bi-Ped, which was then turned into a plugin program called Character Studio, which then inspired another plugin program call Character Animation Toolkit (CAT) which has now been incorporated directly into the base Max program.

For this LAP we will create a CAT rig and make some character animation.

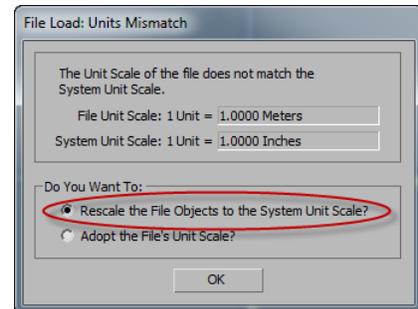
1. Download the **LAP-26-Files.Zip** file and unzip the contents into your **YourLastName_3DSMAX_26** folder.



VERY IMPORTANT! Before you open the file, read step 3.



2. Open the **CMan0002-M3-Cat.Max** file.
3. As the file loads you will get a dialogue box that asks you to rescale the object. Make sure you use **Rescale the File Objects to the System Unit Scale**. If you do not choose this option Max will not ask the question again when reloading the file and it will cause problems later on.

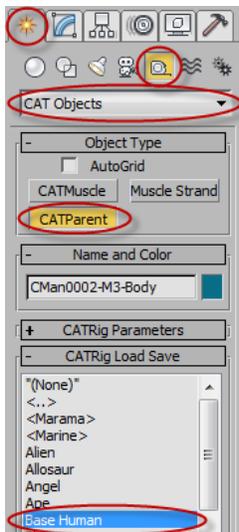


(Note: If you miss step three, to recover from the problem you will have to close the file but not Max. Go to the Customize pull down menu and choose Units Setup. Change the units to US Standard. Open any other file with different units and then reopen CMan, it should prompt you again. If not, you may even have to close and reload 3DS Max)

This is a pre rigged man that comes with 3DS Max as a sample from Autodesk. While we could work with this rig as-is for the default walk cycle, the existing CAT rig is incompatible with the MoCap data that we want to use. Thus we will remove the existing rig and learn to make our own.



Notice the large triangle at the feet of the character. This is the CAT parent object and controller for the rig. All the bones for the character are a part of, and linked to, this parent controller object.



4. Click on the CAT rig parent and delete it. Notice all the extra square boxes (the bones) also disappear.
5. Select the character's Body mesh and Hair objects and press ALT-X on the keyboard to turn on X-ray mode. Then Right click on the screen and choose Freeze Selection from the quad menu. This prevents the mesh from accidentally being selected.

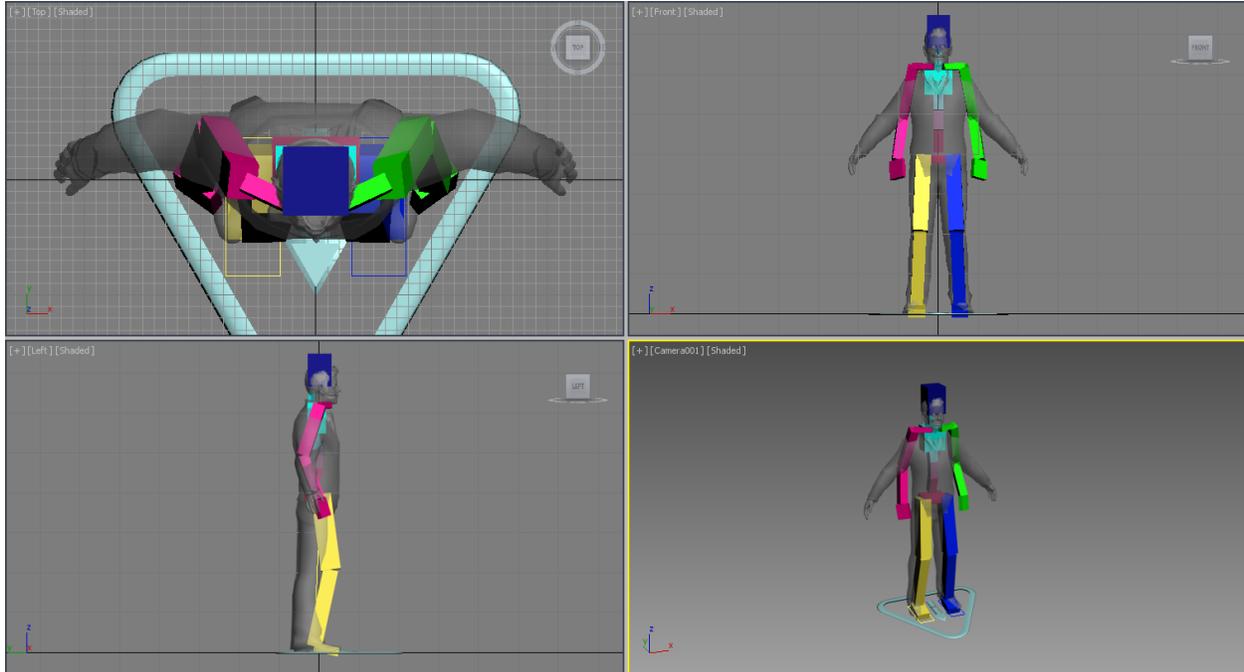


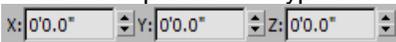
Now let's create our own CAT rig that will be compatible with the MoCap data.

6. Go to the Create Tab, Helpers, and in the drop down box choose CAT Objects.
7. In CAT Object Types, click the CAT Parent button.
8. Then from the CAT Rig Load Save list, choose Base Human.

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- Next click and drag a point from the character's feet to create a generic human rig set. Scale the rig so that the height of the pelvis (hip bone) matches to the character. The rest of the bones can be scaled easily but the pelvis is at the top of the hierarchy and controls everything else. Thus it's hardest to move once set.



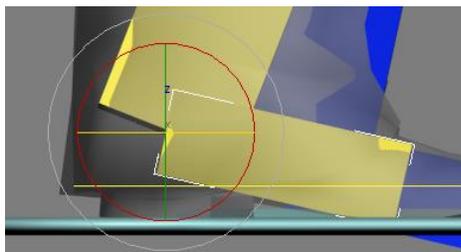
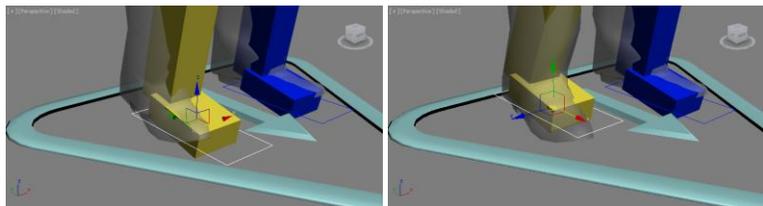
- Center the CAT rig by selecting the Move tool , then pick the CAT parent and type in 0 for X,Y, and Z on the coordinates at the bottom of the screen. 

CAT RIG SETUP:

- With the CAT controller still selected, Move it forward slightly to center the pelvis in the character. The other bones can and will stick out for now.

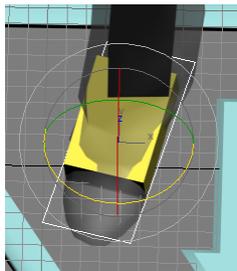
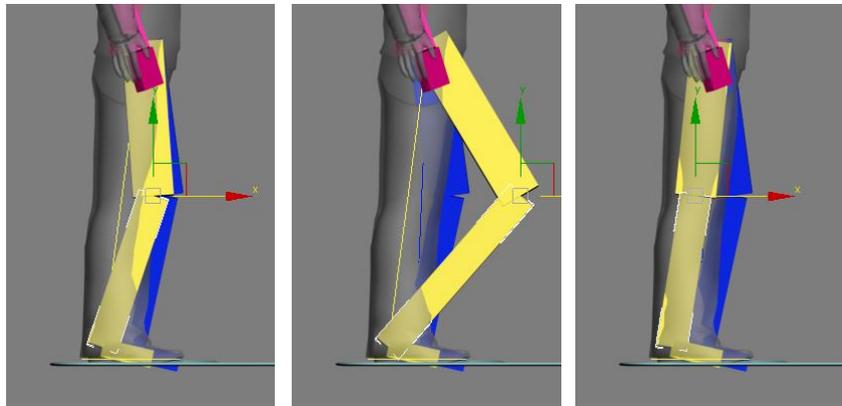
CAT bones can be easily duplicated so to match our character we only need to fix one side. You can pick either side. For the LAP we'll work off the Right side of the object.

- Start by zooming up on the character's right foot. Notice that the foot also has a rectangle called Platform. This is a tracking object that the foot will always point towards.
- Move the rectangle Base HumanRPlatform back and up to match the foot up with the character. Ideally you're trying to match up the ankle on the character to the rotational pivot point of foot bone.



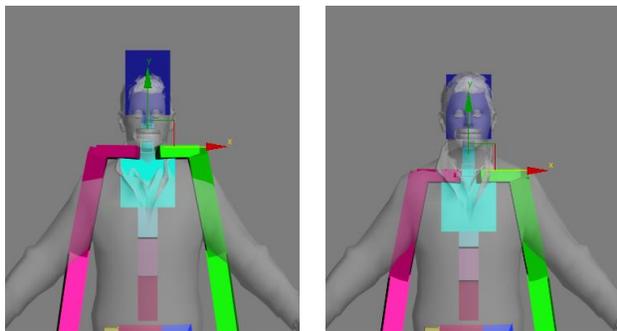
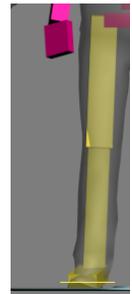
(Note: You can get a good visual representation of where a bone's pivot point is by selecting Rotate and then the bone.)

- In the Left view, select the Calf bone (shin). Use the Move tool to pull it out to the front. Notice the bones will stretch to accommodate the position change. Move the point back to match the character.
- Move the Thigh (NOT the pelvis) back slightly to center it.

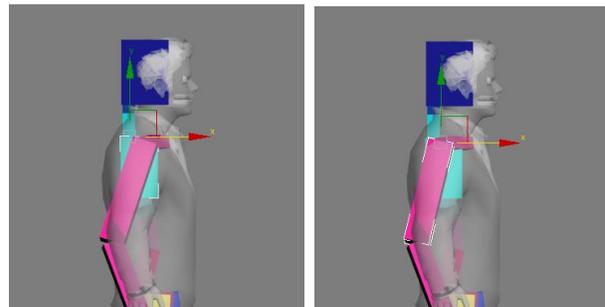


- Use the Rotate tool to align the foot Platform (NOT the foot) with the character's foot.
- In the Front view make any additional adjustments to the leg as needed.

Remember we only have to adjust one leg. The other will be copied. Next we'll adjust the arms and head.



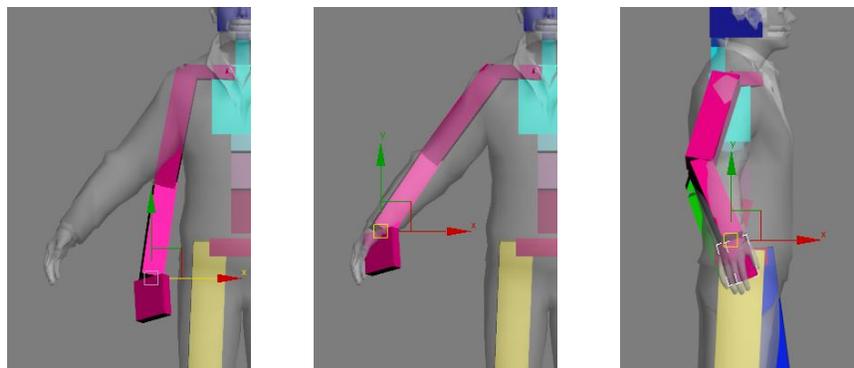
- In the Front view zoom up on the chest and select the Ribcage bone. Move it down to align the shoulders up with the character.
- Adjust the Ribcage in the Left view by moving it back a little. Notice as you move all the spine bones and linked bones automatically adjust and scale.

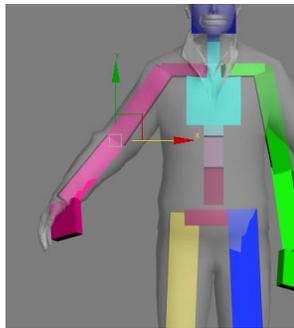
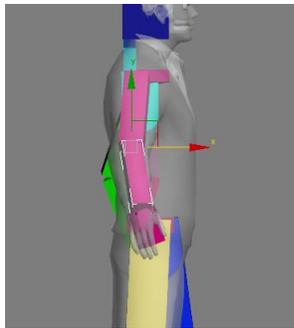


- Select the Right Upper Arm bone in the Left view and Move it back to center up the shoulder.

We'll focus on the character's right arm now. Like the leg we'll only adjust one and copy the other.

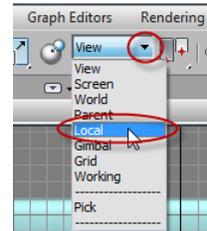
- In the Front and Left view, select the Palm bone (hand) and place its pivot point at the characters wrist. Don't worry about the hand's rotation just yet.



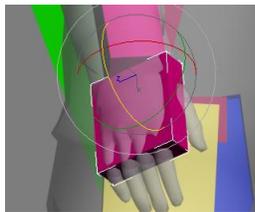


12. Center the elbow by manipulating the Forearm bone. Adjust the Ribcage and Upper Arm bones as needed to center everything up.

13. Select the Rotate tool.  Then on the tool bar change the Reference Coordinate System to Local. This will align the Move, Rotate, and Scale tools with the current angle



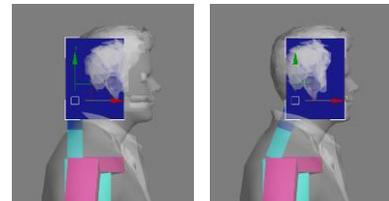
of objects.



(Note: Each tool that you use has its own settings for the Reference Coordinate System. Each one has to be set independently.)

14. Select the Palm (hand) bone and rotate it to match the characters hand.

15. Change the Reference Coordinate System back to View when you're done.



16. Select the Head (skull) bone and move it forward into place.

Mirroring Limbs:

1. Select the Right Upper Arm and go to the Modify Tab.

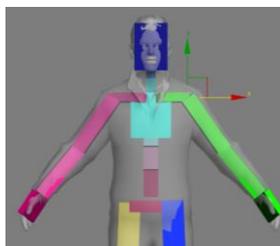
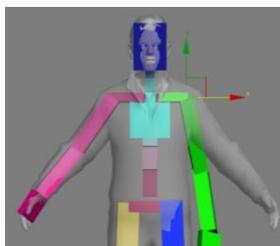


2. Under Limb Setup choose the first icon which is for Copy Limb Setting. Notice that the other two icons remain greyed out.



3. Select the Left Upper Arm. Notice the other two limb setup icons are now available.

4. Pick the third icon Paste/Mirror Limb Settings

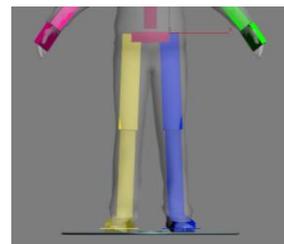
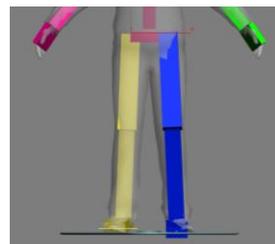


This should mirror the bones perfectly, size, length, position, and rotation. It doesn't get much easier than this.

Next let's fix the legs.

5. Select the Right Thigh and pick the Copy Limb Setting icon.

6. Select the Left Thigh and pick Paste/Mirror Limb icon.



Done. When did you save last?

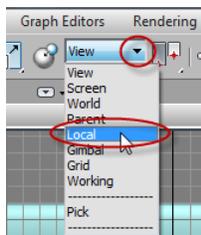
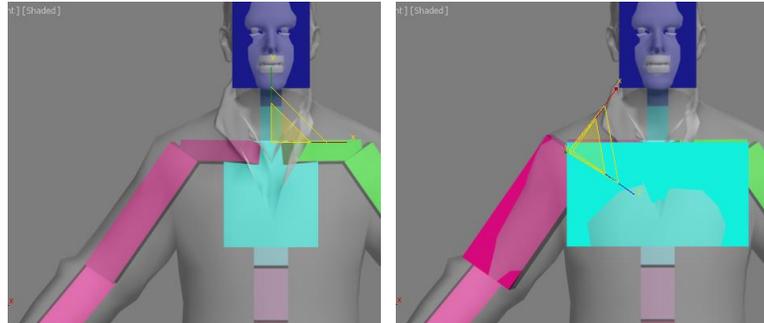
The next thing we will work on is customizing and adding additional bones to the character's CAT rig. **This is not part of your required LAP assignment. Do not complete pages 7 or 8 for the assignment.** This is however something you need to know and may be needed for your Final Animation Project.

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Customizing Rig Bones:

For our character the default bones are a fairly good match. However you may need to adjust these bones on some occasions. For a custom character you would want to make the CAT rig bones about the same size and diameter as the character's mesh. This allows for better mesh control. For example we could make our characters Arm, Ribcage, and Spine Bones larger.

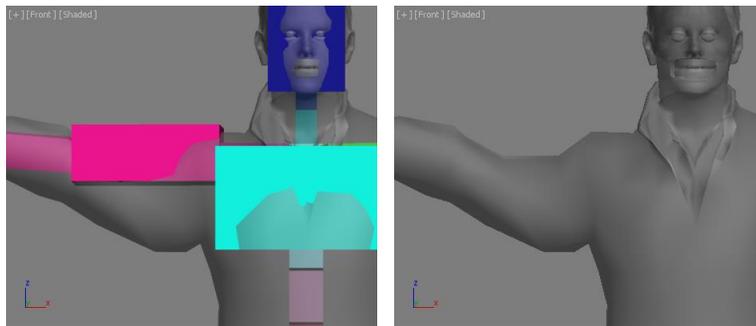
1. Click on the Ribcage bone, and select the Scale tool. 
2. Scale the Ribcage to fill the chest cavity of the character. (Each of the Spines could be expanded out to cover the rest of the body.)



3. Select the Upper Arm, then on the tool bar change the Reference Coordinate System to Local.
4. Scale the Upper Arm in the Y and Z directions to fill the mesh.

5. Change the Reference Coordinate System back to View when you're done.

The larger the bone the more control of the mesh. This can make the mesh more rigid and less stretchy during movements. This also requires more work on your part to setup the Skin modifier so that the bones only control the correct parts of the mesh.



Here you can see that due to its proximity (how close it is) the Ribcage has too much influence on the arm mesh and prevents it from moving when the arm is raised. Ouch... Looks painful. This mesh just has the default skin settings and could be adjusted to correct the problem.

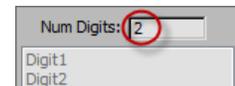
For this LAP assignment we'll leave the bones sizes alone.



Adding Fingers:

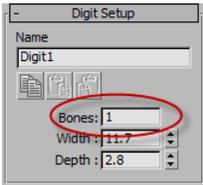
In some cases you may want your character to have a fully articulated (complete jointed movement) hand. So let's add some fingers.

1. Select the Right Palm bone. On the Modify tab notice that there is a box for Digits (fingers).



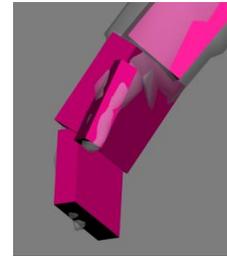
(Note: You'll find it easier to manipulate the individual bones if you set the Reference Coordinate System to Local. Make sure to set it back to view when you're finished)

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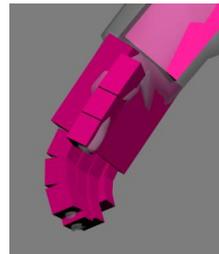


2. Change the Number of Digits to 1. This will give you three bones for a group of fingers. Scale the bones or set their length to about 3 on the Modify tab. Rotate the bones into place and you can see that you can get quite a bit of control from one digit.

3. Select the Palm. Reset the Number of Digits to 0 to clear the settings. Now set the number to 2. This gives you a set of bones for the fingers and the thumb. Select the first digit bone connected to the palm for the thumb. On the Modify tab, under Digit Setup, change the number of bones to 1. Do this for the fingers too. Move, Rotate, and Scale the bones into position. This would be ideal for a basic set up. Only two bones to worry about animating.



4. Select the Palm. Reset the number to 0 to clear the settings. Now set the number to 5. Move, Rotate, and Scale the bones into position. This would be the most complex setup and the most articulate at 16 bones for the entire hand. Once set it can be easily copied to the other hand (see steps 1-4 page 6).

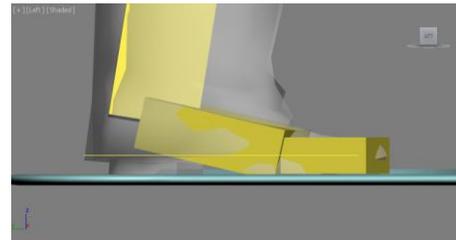


For this LAP assignment we'll leave the hand alone.

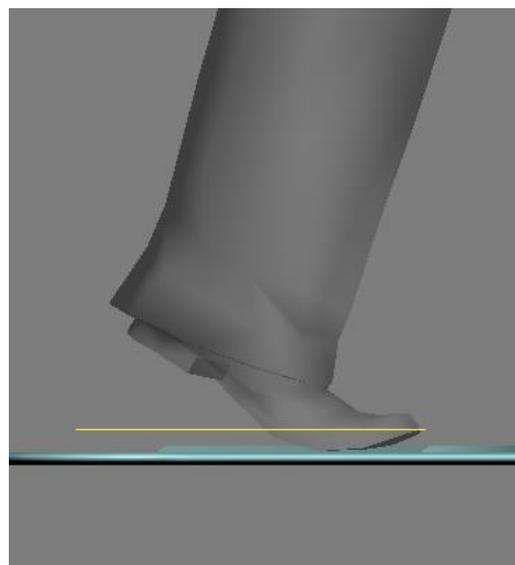
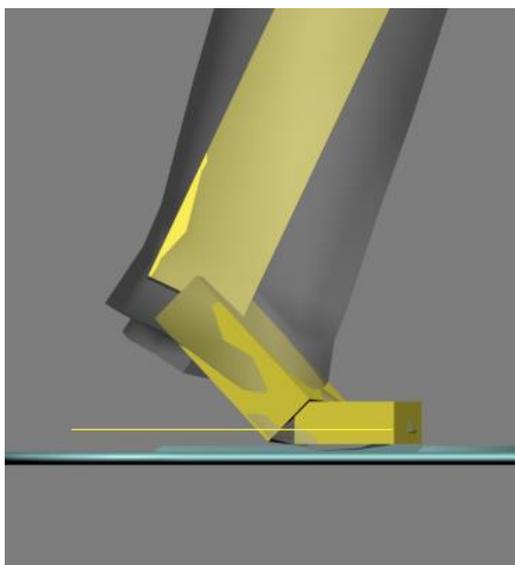
Adding Toes:

The process for adding toes repeats the steps of the fingers.

1. Select the Right Foot Bone. On the Modify tab change the Number of Digits to 1. Unlike the hand this only add 2 extra bones for the toes. In reality you have 3 flexible toe joints just like fingers on all the toes except the big toe and sometimes little toe.



2. Select the first digit bone connected to the Foot. Change the number of bones to 1. Move, Rotate, and Scale the bones into position. Unless your character is barefoot and needs to wiggle their toes, this would be ideal for a basic set up for toes or even shoes as it allows for bending at the ball if the foot on to the toes. (Think about walking, your foot never bends and flexes here.)

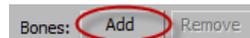
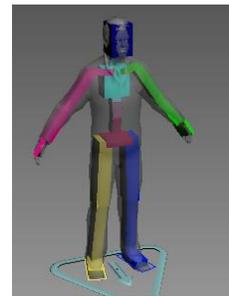
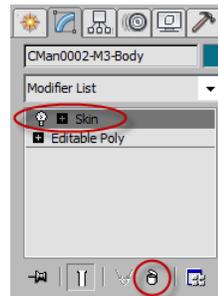


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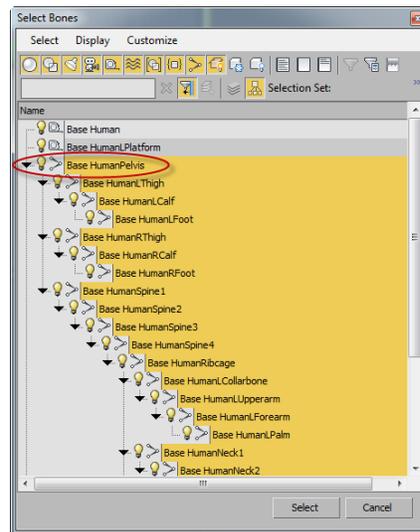
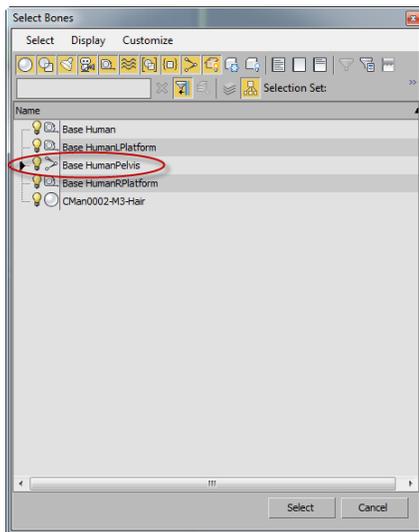
Skinning:

Skinning is the reverse of how it sounds. Here we'll ADD skin to the bones.

1. Earlier you froze your mesh objects for the Body and Hair. Unfreeze them now.
2. Select the Body mesh. On the Modify Tab you already have a Skin modifier attached to the mesh. Delete this modifier by clicking on the trash can icon so we can start with blank settings.
3. Add a new Skin modifier to the stack.
4. In the Skin parameters, under Bones press the Add button.



This opens the Select Bones dialogue box which is identical to the Select By Name dialogue box. If you look at the Base HumanPelvis you'll note that there is a black arrow next to the name. If you select the arrow you can expand out all of the hierarchical linked children objects.

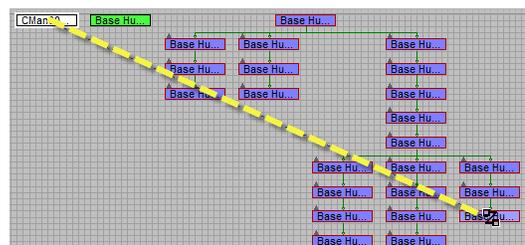


5. Click on the Base HumanPelvis bone. On the keyboard press CTRL-C (this is NOT copy) this will select ALL children objects linked to the pelvis. Now press the Select button at the bottom of the dialogue box.

On the Modify Tab, Skin parameters, all of your bones should now be in the list located under Bones.

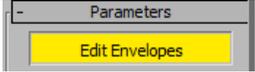
We could skin the hair to the bones as well. If the Character had long hair this might be a good idea, you may even want to add custom bones just for the hair. However in this case the hair is short so we'll take the simplest approach.

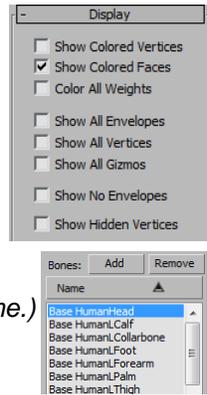
6. Open the Schematic View  and find out which box is the Hair object and which is the Base HumanHead bone.
7. Click the Link icon . Drag a link from the Hair to the Head. Now if the head moves the hair goes with it.



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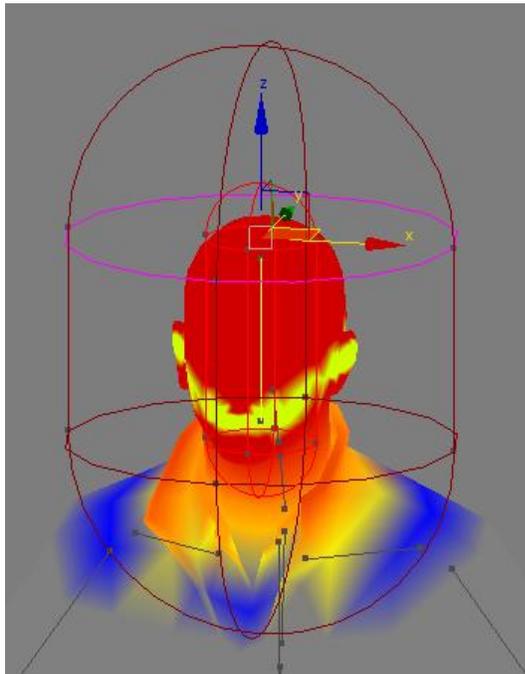
Editing Skin Weights:

1. Select all of the bones and hide them
2. Open the Material editor. From the pull down menu select Get All Scene Materials.
3. Select each of the three materials and turn OFF the Show Shaded Material in Viewport. 
4. Select the Body mesh, go to the Modify Tab, and select the Skin Modifier.
5. In the parameters, under Display turn OFF everything but the Show Colored Faces.
6. Turn on the Edit Envelopes button. 
7. Select the Head bone (skull)



(Note: You can use the list of bones in the parameters to easily select a bone by its name.)

At this point your character should suddenly look more like a space man.

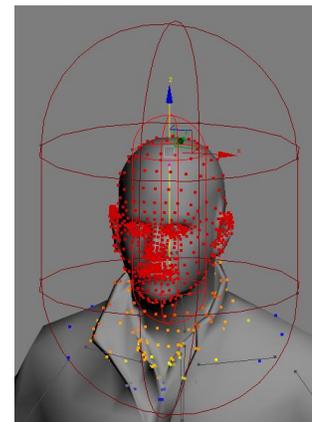


There are two ellipsoids or capsule shaped objects one inside the other. These are the Envelopes. The inner one represents the bone's area of absolute control. The outer envelope represents where the bone's area of influence ends. Everything in-between is a gradual change from 100% to 0% control. The Colors show the intensity of the bone's control over those faces. Red 100% to Blue near 0%. So here we can see that if the head moved it would affect the collar on the suit.

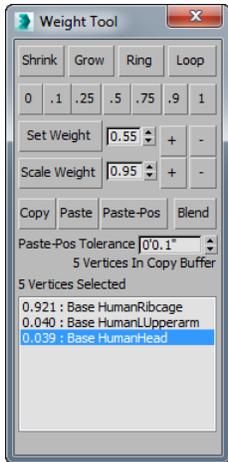
To modify the control of a bone the easiest thing to do is adjust the envelopes. The ellipsoid shapes have grip handles that you can select and manipulate their diameter around the bone. In the center of the ellipsoids is a straight line that represents the bone. This line has grip points on it so you can adjust its length. This will not change the length of the actual bone, just the envelope.

Under the Weight Properties parameters is the Weight Table. This will open a data base of all the points in the mesh and the amount of control each bone has. This should only be a last resort to control your mesh.

8. Change the Display parameters to only Show Colored Vertices. Here you can see the individual vertices that are being affected by the Head bone.
9. At the top of the parameters under Select, check the Vertices option.
10. Select some of the blue vertices. Then under the Weight Properties parameters click the Weight Tool button. 



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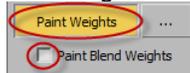
This will open the Weight Tool dialogue box with a list of all the bones that have influence on the vertices that you selected. The number just before the bone name is the percentage of control each bone has over the group of vertices. In a range from 0 to 1, with 1 being 100%. This can be a little confusing as the percentage is averaged from the entire group of vertices. Therefore the number is never truly accurate unless you only have one vertex selected.

Here you potentially could select the Base HumanHead bone from the list, then click the 0 (zero) button. This would remove the selected vertices from the influence of the Head bone. You could remove the entire suit collar this way. Or add varying degrees of control of vertices to other bones. While this method is very effective it's not very easy to see the results.

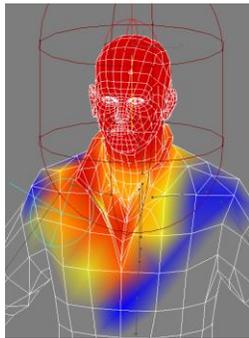
11. Close the Weight Tool dialogue box without making any changes.
12. Change the Display parameters to only Show Colored Faces.

13. In your viewport click on the Shade mode and Turn on Edged Faces.

14. Under Weight Properties, click the Paint Weights button, then uncheck Paint Blend Weights.



You should now see a large blue circle that will move across the mesh as you move your cursor. This is the paint brush.



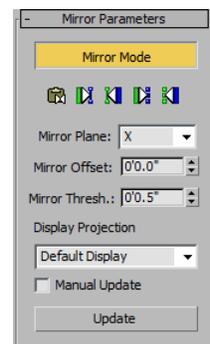
- Hold down CTRL and SHIFT on the keyboard then click and drag to change the size of the brush.
- Use the left mouse button to add weight to vertices. Use ALT left mouse button to remove weight.
- Recheck the Paint Blend Weights to smooth out (blend) transitions from 100% to 0%.
- The button with the tree dots is for the brush controls. 

With paint weights you can see the results as you work. This is most effective on high polygon models.

If your model is mostly symmetrical then you won't have to manually make both sides match. There are Mirror Parameters.

15. Turn off the Paint Weights mode. Uncheck all the Display parameters. And turn off Edge Faces from the viewport.

16. Under the Mirror Parameters click the Mirror Mode button. There should be a set of green dots (vertices) on one side of the character and a set of blue dots on the other (very hard to see). Any green dot has a symmetrical partner blue dot. Any red dots will be no symmetrical vertices. If the vertices are symmetrical then you can copy their weight settings from one side to the other. This means you only have to worry about setting up one side of your character. The buttons under Mirror mode are for copying and pasting from one side to the other. Green to blue OR blue to green. This can be by vertex or by bone.

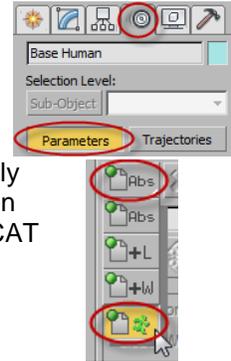


Autodesk 3D Studio

Built-in Walk Cycle:

CAT has a very unique feature that allows it to make a generic walk cycle on ANY rig setup no matter what shape it is or how many limbs it has.

1. Select the CAT Parent controller object and switch to the Motion Tab. Make sure the Parameters button is selected.



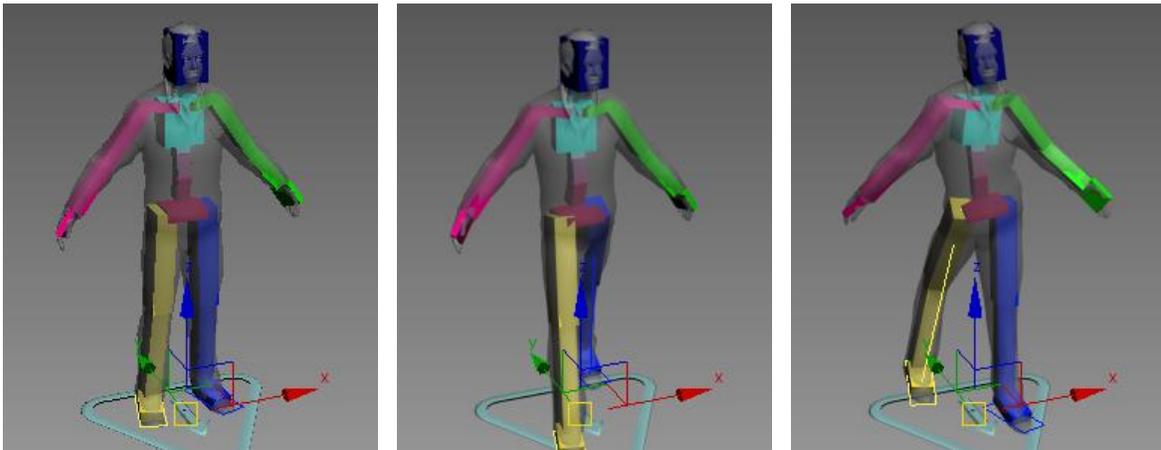
Under the Layer Manager there is a list of added layers that is currently blank. At the bottom of this list box is the Add Layer button. This button has four different options: Absolute, Adjust Local, Adjust World, and CAT Motion.

2. Click on the Add Layer and choose CAT Motion.

So far we've been working in CAT rig Setup mode that allows us to stretch and move the bones. Now we are going to Animation Mode which will make the CAT rig behave like a regular IK setup.

3. Press the Setup/Animation Mode button . The button will change icons to: . Notice the character and its bones jump into a new position. This is a step in the built in walk cycle.

4. Press play on the animation tools at the bottom right corner of the screen. Your character should start walking.



I did say Max could make it walk. I never said it would be pretty. Obviously the walk cycle needs some adjustments. Let's start with the knees. If you watch closely they seem to flip backwards for some frames and then jump to a forwards bend.

(Note: Typical CAT rigs are setup with a pre bent knee that keeps this knee flipping from occurring. However this is counterproductive to most modeling techniques.)

5. Select the Right Calf (shin).

Notice all the key frames set up for the bone. We could adjust the key frames, but it would only be a temporary fix for the keys we adjust.

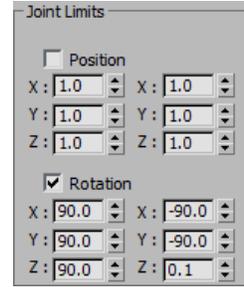


6. Switch to the Hierarchy Tab and press the Link Info button.



Autodesk 3D Studio

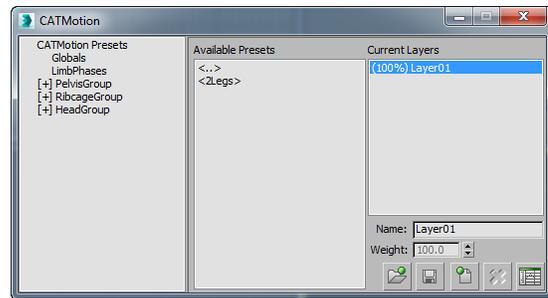
In the Link Info parameters is Joint Limits. Here we can specify a rotational limit for the joint. We could be very specific about how the knee rotates, but really we just need to keep it from flipping backwards.



7. Check the Rotation box to turn on the Limiters. Set all the limits on the left side to **positive 90**. Then set the right side X and Y to **negative 90**. Set the right side Z to **positive 0.1**. If the Z is set to zero you'll still get a slight backwards flip.
8. Repeat step 7 for the Left Calf bone.
9. Select the CAT Parent controller and press play on the animation tools.

Now it looks like your character has leg braces on. We still have work to do.

10. Let the animation keep playing so we can see our changes as we work. Click on the Motion Tab and in the parameters click on the CAT Motion Editor button . This opens the CAT Motion Editor dialogue box

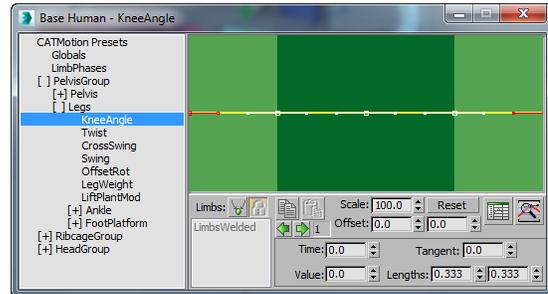


(Note: There is a limited number of cycles that Max will play before it stops the animation. You can hit the play button again to start it.)

11. On the left side of the dialogue box, expand the PelvisGroup, Legs, and select the KneeAngle.

On the right side graph you'll see 4 points, all are set to zero. We'll add a knee bend here.

12. Use the left and right arrows to cycle through the points.  1

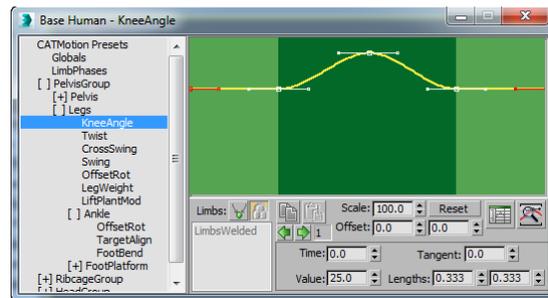


You can drag the points visually on the screen, but let's set some exact values.

13. Use the value box and set the points to the following:

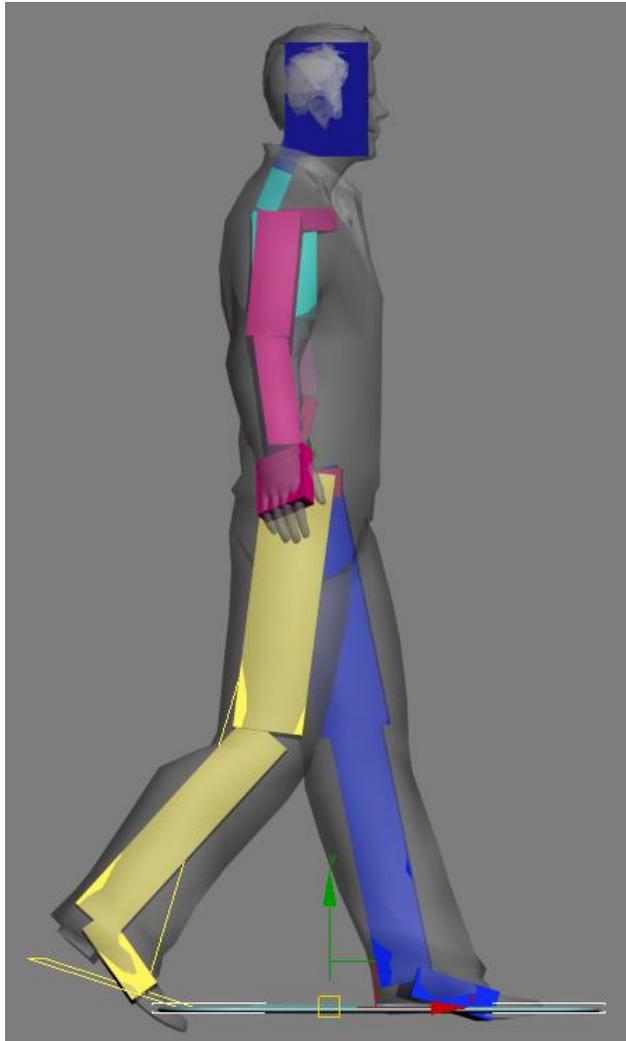
- Point #1 = 25
- Point #2 = 25
- Point #3 = 35
- Point #4 = 25

14. Press the Zoom tool to re-center the graph. 



(Note: If you mess up any part of the settings you can press the Reset button  on each graph.)

The walk cycle is getting better but still needs work. One of the main problems is that most of the movements are way over exaggerated. While this would be good for cartoon characters, it looks really bad on our character.



Go through all the objects in the list. Notice some items have rotations with Min value of -10 and a Max of +10. That's a total rotation of 20 degrees! We'll reset these graphs with more reasonable numbers. Make sure to realign the Bezier handles on points as you go.

15. Change the following to a Min -1 and Max +1:

- Pelvis
 - Twist
 - Roll
 - Weight Shift
- Ribcage
 - Twist
 - Roll
- Head
 - Twist
 - Roll
 - Lift
- Palm
 - HandTwist
 - HandFlopY
 - HandFlopX

16. Adjust these to the following settings:

- Arms
 - Bend Min -10 and Max +10
 - Twist Min -5 and Max +5
 - Swing Min -5 and Max +5
- Ankle
 - Target Align all values 1
- FootPlatform
 - Lift Max 15

(Note: the following can sometimes be performed with OffsetRot within the CAT Motion Editor)

17. Close the CAT Motion Editor dialogue. Stop the animation.

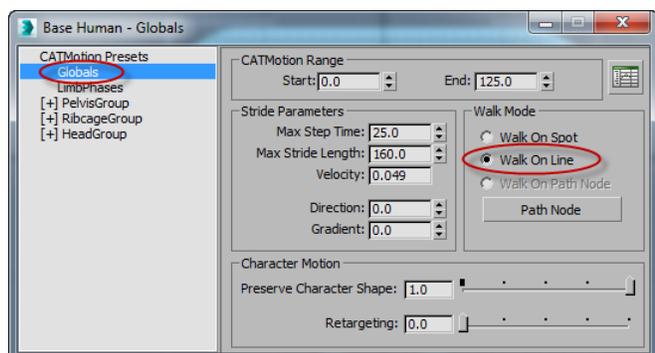
Part of the rest of our walk cycle problem is the initial position of the character. They are trying to walk while still in T-pose. We'll adjust the bones to a more natural position.

(Note: If you have problems picking the bones use the Scene Explorer, Select by Name, or even Schematic View to select them.)

18. In the front view select the Right arm bones and rotate them down so that they look like a more relaxed pose. Play the animation again.

Looking good. Now let's make him walk forward.

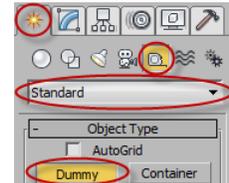
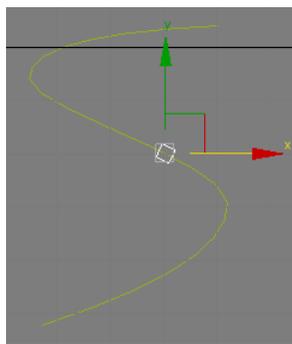
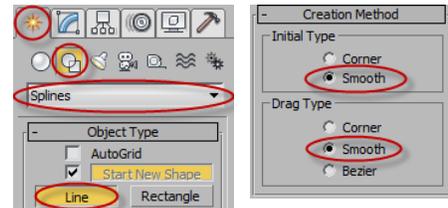
19. Reopen the CAT Motion Editor and go to the Globals item. Under Walk Mode click on Walk on Line.



Autodesk 3D Studio

Walk on a Path:

1. Switch to the Create Tab, Shapes, Splines, and choose the line button.
2. Change the Creation Method parameters Initial Type to Smooth and Drag Type to Smooth.
3. In the Top View create a large S shaped path.
4. Go to Helpers, Standard, and click on Dummy. A Dummy object is a non-rendered box object typically used for linking or tracking purposes. Here we'll use on to track the path.
5. Click and drag a dummy object on screen.

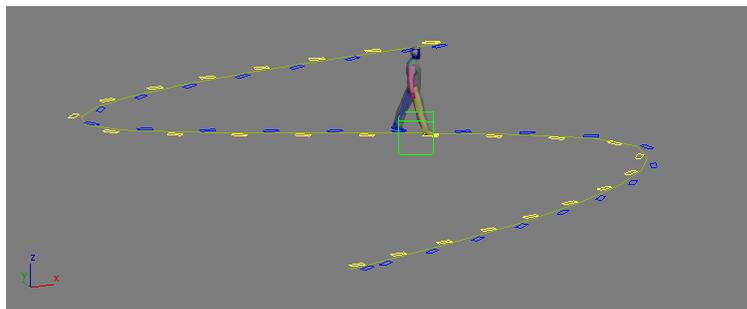


6. With the Dummy selected go to the Animation pull down menu at the top of the screen, then Constraints, Path Constraint. Drag a link to the S shape path you made.
7. Scrub through the animation by dragging the time slider. The dummy object should follow the path over the given time frame.
8. Step automatically opened the Motion Tab. At the bottom of the parameters are the Path Options, Check Follow. This will make the dummy turn as it follows the path.

9. Select the CAT Parent controller, on the Motion Tab click the CAT Motion Editor button. 
10. Go to the Globals item. Under Walk Mode click on Walk on the Path Node button. Then click on the dummy object.

This makes your character track to the dummy object that's tracked to the path. Unfortunately the character is probably on its side now and facing the wrong direction. Also note that the CAT Parent controller does not move.

11. Select Rotate and change the Reference Coordinate System to Local. Rotate the dummy object 90 degrees at a time until your character is facing the correct direction.



Try playing the animation. Is your character too fast? Too slow? This is due to the length of the spline you drew (distance) vs number of frames (time). Think Miles Per Hour. To fix this you need to adjust the amount of time it takes to travel the distance OR adjust the distance traveled in the amount of time provided.

- To change the length of the entire animation (the scene), use Time Configuration. 
- To change the length of the animation for the Dummy object, adjust the key frames on the timeline OR use the Curve Editor. 
- To change the length of the character animation, use the CAT Motion Editor under Globals 

Animate the character at a decent walking speed.

Render the animation and upload it and your Max file to the online course site.

More Help on CAT from Autodesk:

<http://download.autodesk.com/esd/3dsmax/cat-help-2010/>

Examples CAT Videos From Autodesk:

<http://download.autodesk.com/us/3dsmax/CAT-how-to-movies/index.html>

Autodesk YouTube CAT Videos:

<http://www.youtube.com/watch?v=xJyknUIQuXc&index=1&list=PLnKw1txyYzRII285axBmjwEcdTALQqIPC>

RENDERING

Please use another computer

This computer is currently processing
3D rendering class assignments for the
GIT-334 3D graphics class