Using Armatures to Deform Meshes

Blender’s animation capabilities are great for most object animation except when you want to animate something bending like a person in motion or a tree bending in the breeze. This calls for a mesh to deform which can’t be done with traditional modifiers. We can deform a mesh in 2 ways in Blender. One way is to create a skeleton and have it deform a mesh (armatures) and the other method is to move the mesh vertices in edit mode and create sliders that deform the mesh (vertex keys). This chapter deals with creating armatures. The armature feature in Blender is constantly under development. For this discussion, I will stick with the fundamentals. More information can be found at www.blender.org or at www.blenderartists.org.

The first thing you need to do is create a mesh that has a few groups of vertices where you would like the object to bend. Any mesh will work and to get additional vertices you can either extrude or subdivide. Be careful not to create too many vertices. It may slow your model down considerably. Let’s use a cylinder to create an arm. I will use a cylinder set at the default divisions of 32. Next, I will change to a front, ortho view and box select the top set of vertices and Extrude them up. I prefer to use extrude rather than subdivide to keep the vertex count down as low as possible. As I extrude the vertices, I am also using Scale to shape them.

Next, place the 3D cursor directly at the bottom of the shape you just made. Hit “Shift-A”, to add an “Armature-Single Bone”. You will immediately see a bone begin to form at the cursor location. Enter Edit Mode and type “G” to grab the top of the bone and lengthen it to a desired size. Move your cursor up to lengthen the bone and click where you would like the joint to be. To create another bone at the top of the first one, press “E” to extrude another bone from the first one. If you run out of room to drag the mouse up, just click wherever and hit “G” again to move the end. To always adjust bones, you must be in Edit mode. Also, make sure you have the end of the bone select and not the entire bone. When finished, press Tab to exit edit mode. Double check the armature to make sure that the ends and joint are well aligned. To add more bones, enter edit mode again to extrude with the end bone selected.

Your next step is to create a Child-Parent relationship between the mesh and the armature with the mesh being the Child and the armature being the Parent. While holding the “Shift” key, select the mesh first, then the armature. Press “Ctrl-P” to make parent. Select the option “Armature Deform” and “With Automatic Weights” so the computer will figure out which vertices to deform to which bones. If it’s not right, we can fix this later.
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To test the armature system you just created, select the armature only and switch from **Object** mode to **Pose** mode. Right-click on the top bone and rotate it. It should deform the mesh as you rotate the bone. By rotating the lower bone, you will rotate the entire mesh.

**RoboDude Says:**
If you ever need to return to edit mode for the mesh or the armature after posing, they will temporarily return to their unposed states.

Creating Complex Armature Chains:

Extruding bones as we did works well for simple chains, but if you want to make more complex chains and skeletons, you’ll need to know a few more things then just extruding from the end of a chain. You will notice that the 1st bone you created is the master parent for the system and you can also extrude from the bottom of that bone. The problem is that, in Pose mode, this bone will not be automatically parented to the master bone. You can also make entirely different armature chains, then **Join** them together using “**Ctrl-J**”. In pose mode, these will also not function with the entire system. So how do you correct these child-parent issues?

First, you need to know the **Name** of each bone. In Pose mode, you can RMB click on a bone and the name will display, but you can have all the bone names display on the screen if you turn on an option in the **Object Data** panel (now displayed as an armature). The example shown consists of 2 different armature objects that have been joined together in **Object** mode using “**Ctrl-J**”. When you enter Pose mode, they do not move together. In the **Display** panel, you will see an option to display the names on the screen. You will also see some options to change the way the bones look. To correct the parenting issue, go to the Bone panel, enter **Edit** mode and find the option for **Parent**. Select the bone you wish to parent to.
Animation Tips:
When animating an armature, there are a few techniques that can make your life easier and were discussed previously in the animation chapter, but will be reviewed here. Since you have so many bones to animate, it makes sense to use the Automatic key-frame feature. It is also helpful to use the Rotation transform manipulator and the time line to advance through time. It may be helpful to review the chapter on animation for assistance. Below are some of the basic setting that we use for animating armatures:

**Screen Layout:** Switch to animation

**Rotation Widget:** Makes rotation easier

**Time Line:** Can move to key-frames quickly with controls

**Transform Widgets:** Turned on, set to Rotation and Normal alignment. Used to rotate bones by grabbing the right axis.

**Automatic Key-frames:** Record button on and set for Available. Remember to turn it off when you don’t need it!

**RoboDude Asks:** Why doesn’t my armature animation start correctly on frame 1?
When working with automatic key-framing, don’t forget to move every bone a little at frame one to set the initial animation keys, then move up through time to make your next move. A lot of people forget to add keys to frame 1.
Chapter 17- Armatures

Creating Bone Vertex Groups

Using the Automatic Weights option works great for simple meshes and armatures, but when bones and mesh vertices are close together or far from the bone, Blender will have a difficult time deciding how to join them. In the example to the right, you can see that some vertices for one finger have been grouped with the bone beside it. We can alter these vertex groups.

RoboDude Says: Notice how you can see the bones through the mesh in solid view in the hand example? There is an X-Ray option in the Object Data-Display panel that makes viewing armatures easier!

With the bone Names turned on so you can see which ones you need to effect, select the mesh and enter Edit mode. Editing bone vertex groups is similar to making normal vertex groups except that Blender already named a vertex group to match every bone for you when you made the child-parent relationship. If you go to the Object Data panel (mesh selected in edit mode), you will see the list of groups in the Vertex Groups panel. You will also see the standard “Assign” and “Remove” buttons below the groups.

To fix the problem, you will first need to select the vertices you wish to change, then select the vertex group that they are wrongly assigned to. Hit the “Remove” button to remove them from that vertex group. In this case, they are wrongly assigned to “Bone.004”. Now select the vertex group they need to be assigned to (Bone.010) and hit the “Assign” button. Exit edit mode, select the armature and move the bones in pose mode to test your groups.

For vertices that are close to a joint, they can be shared between multiple groups. You can also use the “Weight” slider to adjust the bone influence for other effects, but normally, it is set to 1.000.

Need to take your posed armature back to its starting pose? Change it from “Pose Position” to “Rest Position” in the Object Data.
Using Inverse Kinematics (IK) and Constraints

Inverse Kinematics is used when you wish to manipulate a skeleton by simply grabbing (G key) the end bone of a chain and moving it with all of the connected bones following along. Inverse Kinematics is constantly under development and has a lot of options available depending on what you want them to do. Visit www.blender.org for more details and review the wiki documentation.

To use Inverse Kinematics, select the bone at the end of a chain, go to Bone Constraints and add an Inverse Kinematics constraint. You can control the number of bones in the chain (Chain Length) and even give it a Target to point to, like an empty. There are a few other options available including Influence (amount of effect). Once applied, you can use the “G” key to move the bone around while all those in the chain below it move in relationship to it.

RoboDude Says: Press “Ctrl-A” to reset an object’s rotation and scale. Works with individual bones in Pose mode. This helps a lot with these constraints!

Using Rotation Constraints:
When animating an object (like a finger), you may want to limit the direction and angle the object can bend or some “unnatural” things may occur when you try to add animation keys. Using Limit Rotation constraints can help with that. For the example to the right, I’ve applied a rotation constraint to the top 2 bones of the finger limiting the Y and Z axis to a limit of 0 degrees while the X axis can rotate from 0 to -60 degrees. This works because I switched the “Convert” from “World Space” to “Local Space”.

Copy Rotation:
Copy Rotation can make animating chains easier. In the example, I’ve created a single bone armature (not a bone in the existing armature) and child-parented it to the hand armature. This bone can be placed anywhere you wish. I have mine above the finger that it will control. Set it’s rotation limits with the Rotation constraint discussed above, then add a “Copy Rotation” constraint to each bone that will copy it’s movement. Select the control bone for the Target. In my case, I needed to Invert the motion to work correctly.
Create a Hand With Armatures

In this exercise, you will be creating a simple hand using meshes and armatures. Start a new Blender file and call it “Hand”. As discussed at the beginning of this chapter, make a simple finger using a cylinder or filled circle. Extrude it to have 2 joints and looks something like this:

Now duplicate (Shift-D) the finger 4 times, scaling and rotating them into the shape of a hand. Don’t worry if it doesn’t look perfect - this is just a simple exercise. Try for something like the image to the left.

In order to add the palm of the hand, I used a UV Sphere and scaled it in the “Y” direction to make it narrow and used Proportional Editing to shape it to fit the fingers. Try shaping yours into something like this.

After shaping, select all of the meshes and Join them together (Ctrl-J).

It’s now time to add the Armature. We will only be animating the fingers opening and closing for this exercise so we only need bones in the fingers. Place your 3D Cursor at the base of one finger. As discussed in the chapter, add an Armature, then enter Edit Mode and pull the top end of the bone to align with a joint. Extrude (E) 2 more bones to fill the finger. Exit Edit Mode and return to Object Mode.

Now Duplicate the armature (Shift-D) and place it in the next finger. Enter Edit Mode and move the bone joints to match the mesh finger joints. Exit Edit Mode and continue duplicating and adjusting armatures until all fingers are finished. When finished, use Ctrl-J to joint all the armatures together.
It's now time to create the child-parent relationship for the mesh to the armature. Use "Armature Deform" and "Automatic Weights" as discussed in the chapter when using "Ctrl-P" to make the relationship. Remember to select the Mesh first. It will also be helpful to turn on "Names" and "X-Ray" in the Object Data panel. Feel free to change the display type in that panel as well if you wish.

Enter Pose Mode and test your armature out to see if it works well or if you need to adjust vertex groups. If it needs adjustment, follow the steps of re-assigning vertices to the various bone groups discussed in the chapter.

When everything looks good, create a simple 200 frame movie of the hand moving.

Challenge Exercise:

Add constraints to limit rotation or control armatures with rotation copy constraints.

**Call the instructor when finished**
Chapter 1- The Blender Interface

In 1997, Robin Williams starred in a remake of the 1961 movie “The Absent-Minded Professor” called “Flubber”. In the remake, Flubber is a green gelatinous material with a mind of its own.

Search YouTube for some video clips of the Flubber character to get a sense of this project. Some possible video clips could be:

- [https://youtu.be/KyPqOf_Pgiw](https://youtu.be/KyPqOf_Pgiw) MAMBO! Of Walt Disney’s FLUBBER Movie

Note: These links were active at the time of publishing and have been active for years. You may need to search for other links.

For this challenge task, you will create a Flubber character with armatures and create a short 200 frame animation with appropriate background, objects, and lighting of your choice.

Back in Chapter 12 you were introduced to Meta Shapes. Meta Shapes are the perfect element to use to create the body of your Flubber character since they act like fluids and “pull” together. By applying appropriate materials with reflection, refraction, and transparency, you can achieve a very convincing Flubber. For a refresher on Meta Shapes, refer back to Chapter 12.

Creating the Character:

Start with a new Blender scene and create a Meta Ball from the Add Object- Add Metaball-Ball in the Front view. This will act as the belly of the Flubber character.

Duplicate the Meta ball and continue to shape a character of your choice. It may be best to keep the character simple, with only 10-15 Meta shapes.
Adding an Armature:

After you finish shaping the character, add an Armature - Single Bone to the character's belly. Continue to extrude and shape the skeleton of your character, using the information provided in the chapter, until you have something similar to the image below.

With the armature selected, enter Pose Mode, select a Meta Shape, then the bone you wish to control it. Child-parent the Meta Shape to the bone using the Bone option.

Continue until all Meta Shapes are Child-parented to the bones. Test your rigging to make sure everything works.

Create your scene and animations using the key frame techniques discussed earlier.

**Call the instructor when finished**
Chapter 17 Reflection

Chapter 17 Reflection and Wrap-up:

Character Rigging

This chapter dealt with the basics of all character rigging. Every program is a bit different, but all operate the same. Take a few moments to reflect on what you learned.

1. After completing these activities, what did you find to be the most difficult aspect of your work and why? Explain.

2. Internet research the job of a Character Rigger. What do they do and who do they work with? What does the job pay and how plentiful are these jobs? What did you learn from your research? Explain.

3. Depending on the detail in your character, rigging can be a difficult job trying to assign vertices and weights to everything. How should characters differ between characters designed for animation and characters designed for games? Research and explain your findings.