Rigging

Adding an armature to a model is known as rigging and the hierarchy of bones is referred to as the “armature” or “rig”. Usually placement of the bones begins with the hip bone, which then becomes the route bone. I like to apply inverse kinematics only to the legs and leave the arms with forward kinematics. This accommodates the fact that the legs essentially move only in two plains (e.g., Y and Z) while the arms move in three plains (X, Y and Z).

- In Object Mode and Front View set the 3D Cursor to the origin (SHIFT + C-KEY).
- Add an armature (SHIFT + A-KEY > Armature > Single Bone).
- In the Properties Window’s header select the Armature Icon (the little Man) and in the Display Pane select “X-Ray”. This makes the bone(s) visible through the mesh.

- Switch to Edit Mode and the tail of the bone selected drag it down on the z-axis to reduce the size (G-KEY > Z-KEY > DRAG or use the Manipulator Widget).
- Select the bone and move it up on the z-axis until the head of the bone is at the bottom of the hip.
- Again scale the size of the bone so that the tail of the bone is at the top of the hip.
• Extrude a second bone from the tail of the first upwards on the z-axis (E-KEY > Z-KEY > DRAG) to the top of the torso, then a third bone upwards on the z-axis to the top of the head.

With the armature selected, if you select Toolshelf > Options you will see only one option listed “X-Axis Mirror”. Nevertheless this is a very useful option as it allow one to create the armature on one half of the model and have it mirrored over to the other half just as the Mirror Modifier does for vertices, edges and faces.

• Select X-axis Mirror (Toolshelf > Options > X-axis Mirror).
• Select the head of the torso bone and shift extrude to the right (SHIFT + E-KEY > DRAG).
This is actually going to be the upper arm bone so we would like the head of the bone to be positioned on the joint between the torso and the upper arm and the tail of the bone to be positioned at the elbow joint. To achieve this we need to detach the upper arm bone from the torso bone.

- Select the upper arm bone and disconnect from the torso bone (OPT + P-KEY > Disconnect Bone).
- Move the head to the joint between the torso and the upper arm and the tail of the bone to be positioned at the elbow joint.
• Select the tail of the upper arm bone and extrude (SHIFT + E-KEY > DRAG) and place the tail on the lower arm/hand joint.
• Select the tail of the lower arm bone and extrude (SHIFT + E-KEY) and place the tail at the end of the hand.
• Switch to Top View and make sure the bones are aligned with the arm.

Now for the legs.

• Select the tail of the hip bone and extrude to the right (SHIFT + E-KEY > DRAG).
• Select the upper arm bone and disconnect from the hip bone (OPT + P-KEY > Disconnect Bone).
• Position the head of the bone on the joint between the hip and the upper leg and the tail of the bone on the joint between the upper leg and lower leg.
• Select the tail of the upper leg bone and extrude (SHIFT + E-KEY > DRAG) and place the tail on the lower leg/foot joint.
• Select the tail of the lower leg bone and extrude (SHIFT + E-KEY) and place the tail at the end of the foot.
• Switch to Right View and align the bones.
  The foot bone should extend to the front of the foot.
  The knee joint should protrude forward.
• The hip bone should angle slightly forward while the torso bone angles slightly backwards.
  The head bone should align with the neck.
Save your work.

- Open the Browser Window (SHIFT + CMD + S-KEY).
- Press the NUMPAD-PLUS-KEY to increment the file number by 1 to Waldo07.blend.
- Press RETURN or ENTER or LMB click “Save as Blender File”.

A copy of Waldo07.blend is available here:

http://www.doug56.net/ProjectsCharacter04Rigging/

Naming Bones

The bones are going to be used to tell Trainz the location and the rotation of the respective body parts so they need to be named with the “b.r.” convention, that is, the names of the bones must begin with “b.r.”

- Select each bone in turn and name it according to the body part it will be associated with, e.g. Foot Left, name the bone “b.r.Foot Left”.

Parenting

Now we need to parent the body parts with the bone that is going to control it.

- With the armature still selected switch to Pose Mode.
- Select the mesh segment (e.g., Foot Left) then the bone (b.r.Foot Left) and parent (CTRL + P-KEY > Bone).
• Repeat for the remaining mesh segments.

Note: Make sure only the one bone to be parented is selected. Blender has a tendency to select more than one (i.e., the bone you now want to parent and the bone you just previously parented). Select the segment RMB then the bone (SHIFT + RMB) the deselect if two bones are selected (A-KEY) and reselect the bone to be parented (SHIFT + RMB) and parent (CTRL + P-KEY > Bone).

• Place the 3D Cursor at the origin (SHIFT + C-KEY).
• In Object Mode select each of the mesh segments and move the origin to the 3D Cursor (SHIFT + CTRL + OPT + select “Origin to 3D Cursor”).
Finally, having set up the bones to communicate to Trainz the location and rotation of each mesh segment we need to give Trainz a reference point for those locations and rotations. For example, it is one thing to say that at a particular point in time the earth is in a particular location and has a particular rotation but without a reference point it is meaningless. Are you talking about the earth’s rotation about itself, about the sun or about some other larger cosmic entity? To give Trainz a reference point we add an empty at the origin make the armature a child of that empty.

- With the 3D Cursor still at the origin, add an Empty (SHIFT + A-KEY > Empty > Plain Axis).
- Reduce the size of the empty to X = 0.1, y = 0.1 and z = 0.1 and apply these transformations (CTRL + A-KEY > Scale).
- Name the Empty “b.r.main”.
- Select the armature and then b.r.main and parent (CTRL + P-KEY > Objects).
Save your work.

- Open the Browser Window (SHIFT + CMD + S-KEY).
- Press the NUMPAD-PLUS-KEY to increment the file number by 1 to Waldo08.blend.
- Press RETURN or ENTER or LMB click “Save as Blender File”.

A copy of Waldo08.blend is available here

http://www.doug56.net/ProjectsCharacter04Rigging/

Add Inverse Kinematics

We will add Inverse Kinematics to the leg as it will facilitate animation.

- In Pose Mode and Right View select the b.r.Lower Leg (bone).
- In the Properties Window’s header select the Bone Constraints Icon (Bone and Chain).
- Select Add Bone Constraint and then select Inverse Kinematics.
- Switch to Edit Mode and deselect b.r.Lower Leg Left (A-KEY).
- Select the tail of the Lower Leg Left bone and extrude on the y-axis (E-KEY > Y-KEY > DRAG) to the right to create a helper bone that will be used to control the inverse kinematics (IK).
- Name this bone “b.r.IK Target Leg Left”.
- Since it is only a helper bone with it still selected clear the parent (OPT + P-KEY > Clear Parent).
- Also uncheck Deform in the Properties Window’s Bone Panel.
• Switch back to Pose Mode and select b.r.Lower Leg.
• In the Properties Window’s Bone Constraint panel select the Target field and enter “Armature”.
• Select the Bone field and enter “b.r.IK Target Leg Left”.

• Grab the b.r.IK Target Leg Left bone and move it around to see the inverse kinematics in action.
• To return the armature to the Rest Position select Pose Menu > Clear Transformations > All.
• Add Inverse Kinematics to the right leg.

Save your work.

• Open the Browser Window (SHIFT + CMD + S-KEY).
• Press the NUMPAD-PLUS-KEY to increment the file number by 1 to Waldo09.blend.
• Press RETURN or ENTER or LMB click “Save as Blender File”.

A copy of Waldo09.blend is available here:

http://www.doug56.net/ProjectsCharacter04Rigging/

**Pole Targets**

In order to be able to adjust the rotation of the knees we need to add another helper bone, a pole target.

• In Edit Mode, select the tail of the Upper Leg Left bone and extrude to the left (E-KEY > DRAG) a new bone.
• Name this bone “b.r.IK Pole Target Leg Left”.
• Since this is only a helper bone clear the parent (OPT + P-KEY > Clear Parent) and uncheck Deform in the Properties Window’s Bone Panel.

**NOTE:** For this bone to work it cannot be located at any time behind the knee.

• Select and move the pole target bone well in front of the knee.
• In Pose Mode select b.r.Lower Leg
• In the Properties Window’s Bone Constraint panel select the Pole Target field and enter “Armature”.
• In the Bone field that now pops up enter “b.r.IK Pole Target Leg Left”.

• Repeat the process for the right leg.
• Note that when you add b.r.IK Pole Target Leg Right to the Bone field the leg will flip 180°.

Notice that when you add b.r.IK Pole Target Leg Right bone to the Bone field the leg will flip 180°. However this is easily remedied.

• In the Pole Angle field enter “180”.

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Save your work.

- Open the Browser Window (SHIFT + CMD + S-KEY).
- Press the NUMPAD-PLUS-KEY to increment the file number by 1 to Waldo10.blend.
- Press RETURN or ENTER or LMB click “Save as Blender File”.

A copy of Waldo10.blend is available here:

http://www.doug56.net/ProjectsCharacter04Rigging/
Waldo is not only klutzy but often impatient.

https://youtu.be/Xrd-rRMZ2oo