# TUTORIAL – BASIC RIGGING

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**Bones:**
Before creating joints, open the joint option box and make sure the orient value is set to "None". The orientation will be globally adjusted when we do "Orient Joint" on the whole skeleton.

- Create the leg
    - In the orthogonal side view, place the following joints: Hip, Knee, Ankle, Foot Ball, Toe.
    - To make manipulation easier later, build in a slight bend in the knee.
- Create the spine & head
    - In the orthogonal side view, create joints in the following order: Root, Spine (usually 3-4 joints are sufficient), Neck (usually 1-2 joints), Head.
- Create the arm and hand
    - In the orthogonal front view, create joints in the following order: Shoulder, Elbow, Wrist, Palm. Build in a slight bend at the elbow.
    - Create three joints for each of the fingers, and two joints for the thumb.
    - Parent the fingers to the palm (select the finger base, then the palm, and hit "p").
    - For a more sophisticated rig, you may also need to set up a clavicle bone between the end of the spine and the shoulder bone. Create the arm as above but with the Clavicle joint before the Shoulder joint, and run an IK from it to the shoulder. The rest of the steps for setting up the arm remain the same.
- Name the joints
    - Prefix the name of each bone for the leg and arm with "Left" or "Right".
    - You can also use Modify->Search and Replace Names to modify multiple names in a hierarchy.
- Mirror Joint at hip and shoulder
    - YZ Plane
    - Replace Left with Right
- Cleanup steps before IK
    - Freeze Transformations
    - Orient Joint
    - Set Preferred Angle

**IK:**
Open the IK option box and make sure "Sticky" is enabled.

- Leg
    - Create an IK between the hip joint and the ankle joint.
    - Notice that this is insufficient control: as you move the IK, the foot doesn't stay still.
- Inverse Foot
    - Create a new joint at the heel, then place joints at toe, ball, and ankle in that order (hold down "v" to snap to joints)
    - For easier selection, create two temporary layers to separate the skeleton and the inverse foot.
    - Template the inverse foot layer.
    - Create IK from ankle to foot ball and from foot ball to toe
    - Untemplate the inverse foot layer and template the skeleton layer.
    - Parent the toe IK to the inverse toe joint
    - Parent the foot ball IK to the inverse foot ball joint
    - Parent the ankle IK to the inverse ankle joint
    - Now, to move the foot, translate the inverse heel joint. To rotate the foot, rotate the inverse toe and the inverse foot ball for now (we will build driven key controls later).
- Arm & Wrist
    - Create IK from shoulder to wrist.
    - Create IK from wrist to hand.
    - Parent the hand IK to the wrist IK, or hold off until later when we set up helper curves.
- Spine
    - Create IK Spline between the bottom spine joint (NOT the root!) and the top spine joint (just below the neck). Set the number of spans to 3 or 4 for greater flexibility.
    - Turn on component selection (F9), and make sure "NURBS CVs" is selected.
    - Select the CVs that make up the curve (marquee twice over the curve).
    - Go to Deform->Create Cluster.
    - Select the CVs again.
    - Go to Window->General Editors->Component Editor, and open the Weighted Deformers tab.

- Set the weight at cv[0] to 0. Set the other weights to increment gradually. For example, with 6 cvs, your weights might be: 0.0, 0.1, 0.2, 0.4, 0.8, 1.0.

- Exit component selection mode (F8).

- Press Insert and move the pivot of the cluster to the base of the spine.

- Now when you rotate the cluster, the spine will smoothly curve from bottom to top.

- Aim constraints
  - Make a locator (or any other shape of your choosing) and position it in front of the knee, far enough so that it remains in front of the knee even when you lift the foot.

  - Duplicate the locator and symmetrically place it in front of the other knee.

  - Select both locators and Freeze Transformations.

  - Select the left locator, then the left ankle IK, and go to Constrain->Pole Vector. Repeat with the right leg. Now when you move the locator, the knee will always be oriented towards it.

  - Repeat the above steps to make elbow aim constraints.

**Helper Shapes:**

The following steps are a matter of style. You can manipulate the skeleton with what you already have, but I find it easier to set up helper shapes and driven keys for easier, more centralized control. Remember when creating the helper curves to Freeze Transforms on them before you do any parenting.

- Feet
  - Create a NURBS curve around the foot. (Use the CV Curve tool, or create a circle and distort it to fit around the foot geometry.) Make sure that its pivot is at the heel, and that it is larger than the character geometry.

  - Freeze Transformations on the curve once it's at the correct position. Duplicate the curve, mirror and translate it to the other heel, and freeze its transformations as well. All of the following steps will have to be repeated for the mirrored curve.

  - Parent the inverse heel to the curve. Now you can hide the bones and just move the curve to manipulate the foot.

  - Go to Modify->Add Attribute. Create two new attributes: ToeRotate and BallRotate. For each of these, the settings should be as follows: data type = float, attribute type = scalar, minimum = -10, maximum = 10, default = 0. Click "Add" when finished to add that attribute to the curve.

  - Go to Animate->Set Driven Key->Set [Options].

  - Select the curve and click on "Load Driver". Select its ToeRotate attribute.
  - Select the inverse toe joint and click on "Load Driven". Select its Rotate X attribute (make sure the axis is correct by rotating it in the perspective view).

  - Make sure both the ToeRotate and the toe joint are in the neutral position and press the Key button in the Set Driven Key window.

  - Select the driver (curve) and move its ToeRotate attribute to one of the extremes (10).

- Select the driven (inverse toe joint) and rotate it to its extreme position (about 60 degrees).
- Press Key.
- Select the driver and move its ToeRotate attribute to the other extreme (-10).
- Select the driven and rotate it to the other extreme position (-60 degrees).
- Press Key.
- Select the ToeRotate attribute name in the channel box and MMB-drag in the perspective view to scrub the value between -10 and 10, and make sure the extremes and the neutral position have been keyed correctly.
- Repeat the previous steps for the BallRotate attribute and the inverse foot ball joint.
- Repeat for the other foot.
- Optionally, create a locator between the feet and parent both foot curves to it. Move this locator to translate both feet at once.

- Hands
  - Create a curve centered at the wrist joint. Name it LeftHand.
  - Create a smaller curve, also centered at the wrist.
  - Parent the wrist IK to the wrist curve.
  - Parent the palm IK to the palm curve.
  - Parent the palm curve and the elbow aim locator to the wrist curve. Now you can move and rotate the wrist curve to manipulate the whole arm, and rotate the palm curve to manipulate wrist orientation.
  - Go to Modify->Add Attribute, and add the following attributes to the wrist curve: FingerNBend (one for each finger), FingerNSpread (for spreading motion, or alternatively a single attribute to spread all the fingers at once), ThumbBend, ThumbSpread, WristTwist, WristBend, WristWave. (You can omit the last three if you prefer to use the palm curve to rotate the wrist, but I prefer to have rig controls concentrated at as few shapes as possible.)
  - Set the driven keys to connect the above attributes to finger joints and the palm curve. (For bending the fingers, you'll need to connect the attribute to all three finger joints at once.)

- Head
  - Create a curve centered at the base of the head.
  - Add attributes for rotating the head about each of the three axes. Use Set Driven Key to connect them.
    - NOTE: if you have extensive neck movement about all three axes, you may find yourself in a gimbal lock position, where two of the axes overlap and you lose the rotation capability in that direction. One way to avoid this is to set up two groups between the neck and the shoulders in the hierarchy, and use those two groups and the neck joint to rotate one different axis each. (With this setup, make sure the group you use to rotate about the y-axis is above the other two axes in the

hierarchy.) This is a common method to get around the gimbal lock problem and can be used for the neck, the shoulders, and the wrists.

- Create two locators (or curves) and position them in front of the character's eyes. Select the eye geometry and press CTRL-G (group) to create a group above the eye. Select the locator followed by the eye group and go to Constrain->Aim. (The reason for the group is so that you can rotate the eyeball inside that group to make sure it's pointing in the right direction, which you can't do as easily with the group once it's been constrained.) Do this for each eye.

- Create another locator or shape, position it between the eye locators, and parent them both to it. Now you have a way to make the character look somewhere with both eyes at once.

- If you have a jaw bone, it can also help to create a shape to open/close the jaw.

- Parent all of the head controls you created to the neck curve.

- Torso
  - Create a curve centered at the hips. Name it Hips.

  - Add the attributes to the Hips curve to control the rotation of the spine cluster in each of the three directions. (Rotating the spine from here is easier than finding and selecting the cluster each time you need it.)

  - Parent the root of the skeleton to the Hips curve.

  - Create a curve centered at the top of the spine. Name it Shoulders.

  - Parent the head curve to the Shoulders curve. If you have clavicle IK handles, parent them to the Shoulders curve as well.

  - Parent the Shoulders curve to the spine's spline IK handle. Now when you rotate the character's spine, the shoulders and head will move with it.

  - Create yet another curve and make it large enough to encompass the whole figure. Name it Rig. This will allow you to position and orient the entire character at once. Parent the Hips and both Feet curves to the Rig curve. (If you created a locator to which both feet are parented, parent that locator to the Rig instead.) The Arm curves can be parented to either the Hips curve or the Rig curve, depending on what kind of motion your character needs.

- At this point, if you select the Rig curve, all of the other curves should be parented underneath it.

**Useful links:**

http://www.rigging101.com/

http://www.goldenxp.com/tutorials/ragdoll/index.htm
http://www.thegnomonworkshop.com/tutorials/arm_ik_fk/arm_ik_fk.html
http://www.mindspring.com/~jkemp/cord.html
http://web.alfredstate.edu/ciat/tutorials/SkeletonSetup.htm