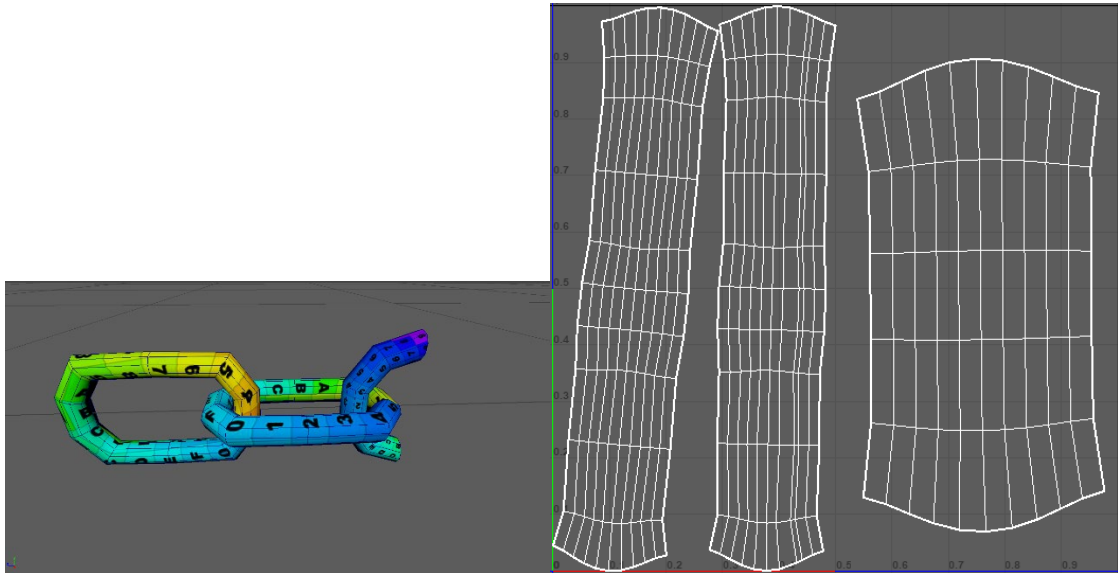# Making the Chain:

Modeling/UVing a Repetitive Object and Rigging with Dynamics

## Ashley Lupariello

Modeling and UVing the Chain

1. Begin by modeling and UVing the elements that will be repeated.


2. Once you have the model ready, create the path to repeat the model along. In the example of the chain, a straight line measured to be the needed length and snapped to the grid is used to make rigging easier. Holding down the hotkey X or pressing this icon: will help snap to grid, holding down Shift will continue laying down control points in a straight line.
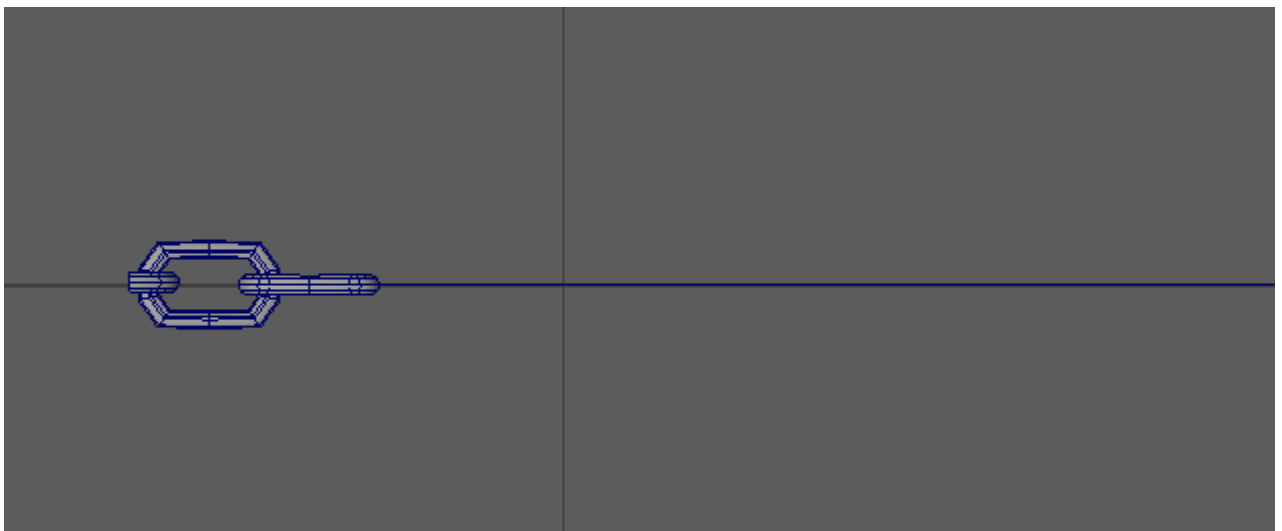
3. Combine the elements that are repeating so they are one model. Then select the model and curve.
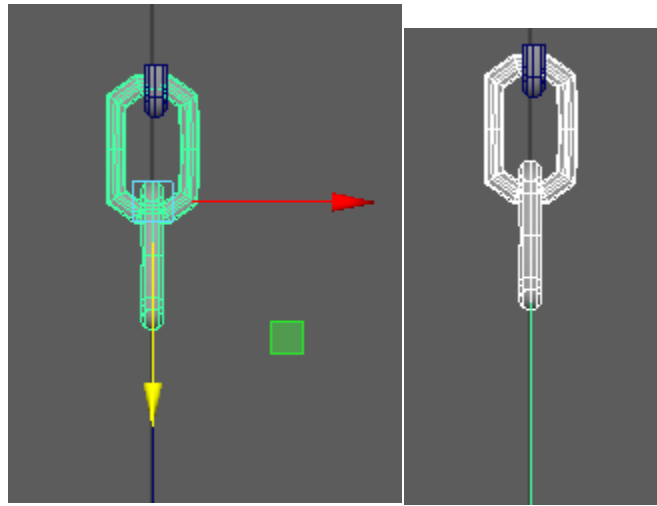
4. Switch to the animation menu set, and click Constrain>Motion Paths> Attach to Motion Path. If the object rotates, then you'll need to go back and change the axes settings in the Attach to Motion Path option box. For the Chain, the front axis was changed from X to Z based on the direction the chain was modeled in. The model should now move along the path.
5. To get the object evenly spaced, select the model and go to Windows>Animation Editors>Graph Editor. Then select all of the animation curves, and select Tangents>Linear.
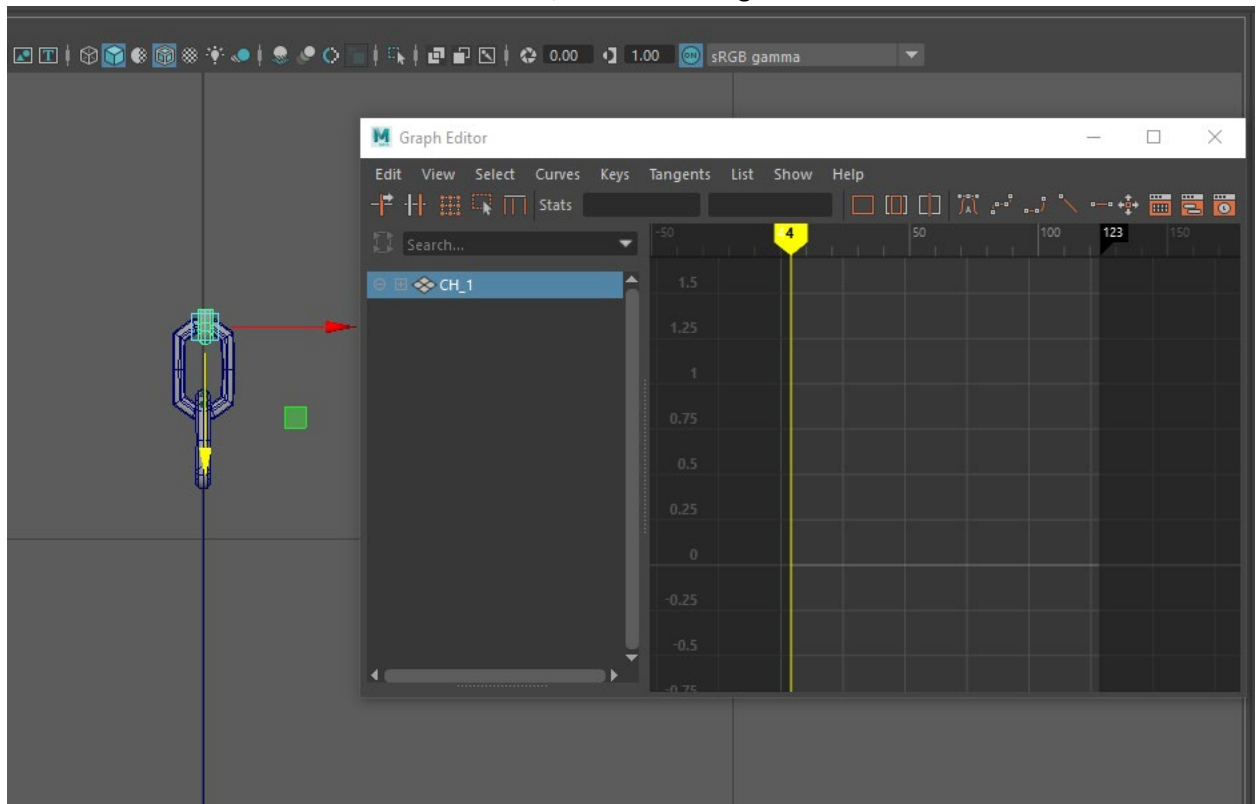
6. Still in the animation menu set and with the model still selected, Go to Visualize>Create Animation Snapshot> □. Make sure the time slider is extended so the animation plays fully, and then select in the options box Time Slider. Apply. If the spacing is off, undo and change the Increment value- the bigger the increment, the farther apart the repeating model will be spaced.
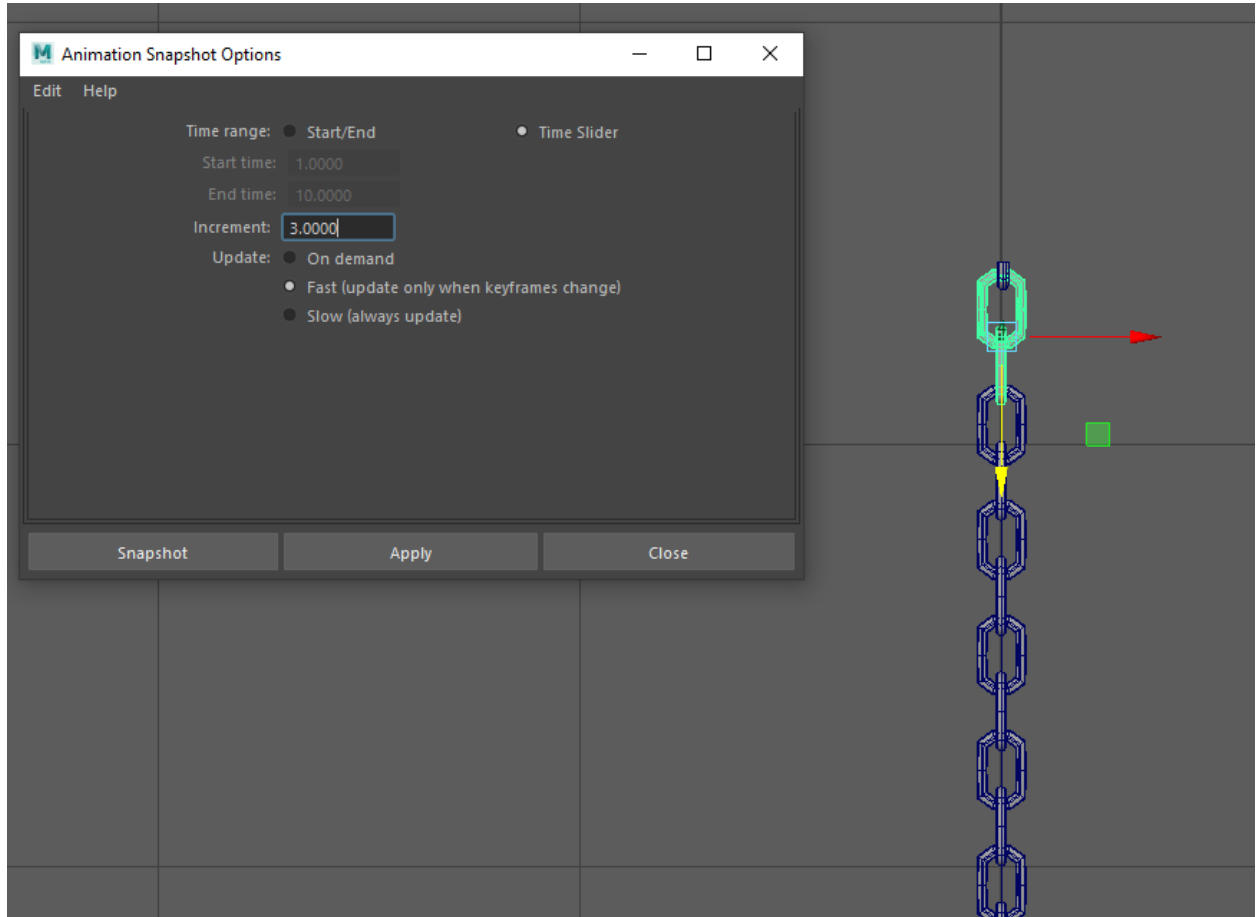

7. Cleanup the outliner by clicking Mesh>Separate to get the individual pieces, rename them, and follow standard model cleanup procedures. In preparation for rigging, the chain links were named CH_1, CH_2… sequentially from beginning to end and grouped in CH.

Rigging the Chain

1. Create a new file and reference in the model. This way the model can be updated if necessary.
2. Create an all_anim control for the rig by either creating a NURBS curve or importing a premade controller. Name it based on your team's naming convention system.
3. Create a joint chain for your model. Since the chain needed to bend wherever two links connected, there is a joint at each end with joints in-between where two links connected.
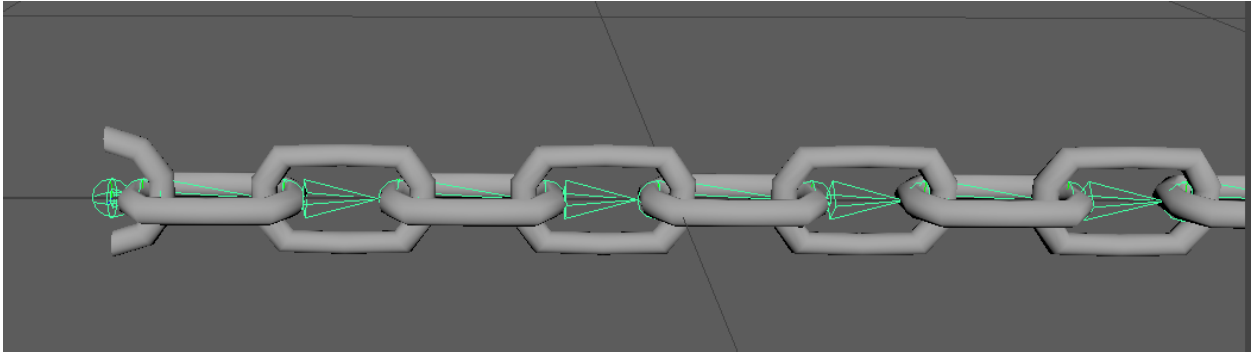
4. Duplicate the joint chain twice. There are now 3 joint chains, one to drive the model, one for a regular FK or IK control setup, and another for a dynamic simulation. Name them accordingly. For the chain, the were geo_jnt, ik_jnt, and dyn_jnt.

5. Create the FK or IK setup depending on your needs. For the chain, since stickiness is needed, IK would be the best, and an IK spline handle was used. An IK spline handle can be created either using an existing curve or by auto creating a curve when making the spline handle. The amount of control points on the curve will later equate to the amount of controls on the object. 5 controls for the chain were used, which was done by going to the Rigging menu set and selecting Skeleton>Create IK Spline Handle> □ and selecting:
   a. Auto Create Curve
   b. Auto Simplify Curve
   c. Number of Spans: 2 (the final number is always +3, giving us 5 control points)
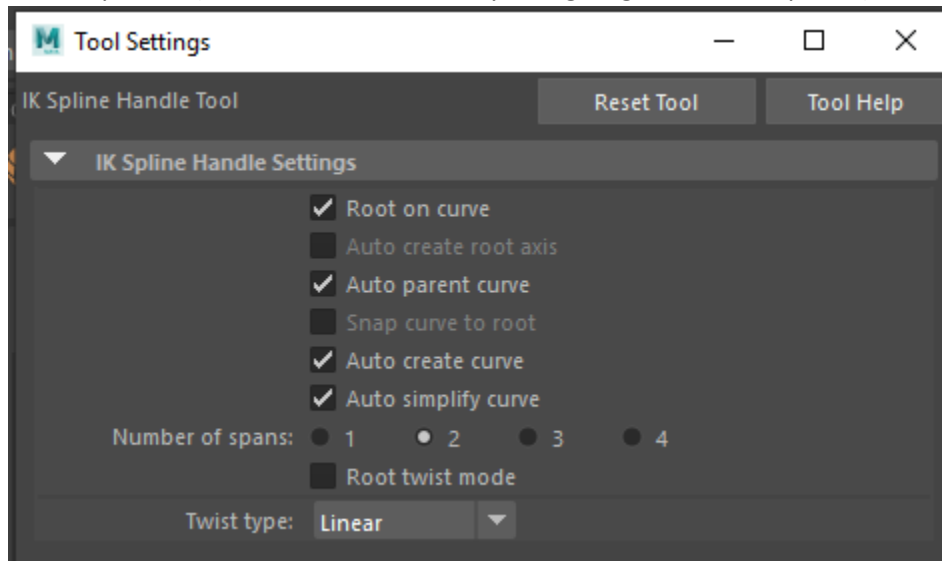
6. Create controls for the FK/IK system and place accordingly. For the chain, V was used to snap them into place at the joint nearest each corresponding control point on the IK spline handle curve.
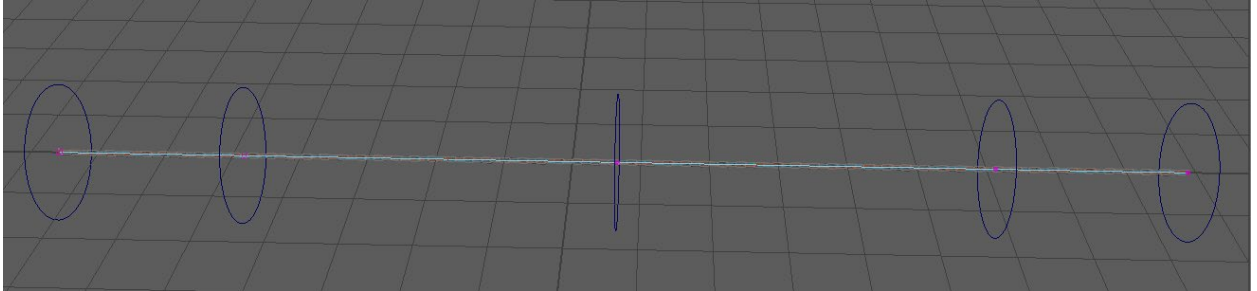
7. Begin to set up the dynamics system. This requires a curve, which can be created, or if an IK spline handle is used, that curve can be duplicated, and the duplicate can be used. The amount of control points must equal the amount of controls being used in the FK/IK section and should be spaced out similarly to the controls curves, as they will control both the normal FK/IK system and the dynamic system.

8. With the curve for the dynamic system selected, create an IK Spline Handle by going to Skeleton>Create IK Spline Handle> □ and uncheck Auto create Curve. Create the IK Spline Handle with the dynamic joint chain by Shift selecting the first joint, last joint, and then the curve.

9. Make the joint chain dynamic by selecting the input curve, and then in the FX menu set select nHair>Make Selected Curves Dynamic.

10. Now that we have the joint chains set up, they need to be set up such that the FK/IK chain and the dynamic chain are parented to the controls, and the geo joint chain is parented to both the FK/IK chain and the dynamic chain. If an IK Spline Handle is used for the FK/IK chain, select that curve, and select the output curve (NOT the input curve) for the dynamic joint chain and go to Select>Cluster Curve. This creates clusters to control the curve control points.

11. Parent (Rigging menu set>Constrain>Parent) the clusters to the corresponding control curves. If an FK system is being used for the FK/IK chain, follow the workflow for creating an FK control system as well.

12. Since the chain needs to be rigid, each chain link needs to be parent constrained to the corresponding joint. If you have a model that can be skinned such as a rope, skin the model to the geo joint chain by selecting both, and in the Rigging menu set, use Skin>Bind Skin. Because the chain is so long, the process of parent constraining the geometry to the geo joint chain was automated via script as seen in step 13.

13. The geo joint chain needs to be parent constrained to both the FK/IK joint chain and the dynamic joint chain. Because the chain is so long, automating these two steps sped up the rigging process. It goes through each joint in the chain and parents each chain in the model to the corresponding joint in the geo_jnt, and parents each corresponding joint in the geo_jnt chain to the ik_jnt and dyn_jnt chains. So, CH:CH_1 gains a parent constraint to geo_jnt1, and geo_jnt1 gains parent constraints to ik_jnt1 and dyn_jnt1. The weight was coded as 0.5 for both ik_jnt and dyn_jnt on geo_jnt, but it'd be more efficient to initially set the FK/IK influence as 1 and dynamic influence as 0 for step 22. The geo parent constraint on the model needs to have full weight.

```
import maya.cmds as cmds

for x in range(1,126):
    xStr = str(x)
    cmds.parentConstraint('geo_jnt' + xStr, 'CH:CH_' + xStr, w = 1, mo =True)
    cmds.parentConstraint('ik_jnt' + xStr, 'geo_jnt' + xStr, w = 0.5, mo =True)
    cmds.parentConstraint('dyn_jnt' + xStr, 'geo_jnt' + xStr, w = 0.5, mo =True)


cmds.parentConstraint('geo_jnt126', 'CH:CH_125', w = 1, mo =True)
```

14. Create the controller for controlling the dynamics. A smaller NURBS Circle was made for the chain and snapped to the first control. Group the dynamic control and parent constrain the group to the first control so that it follows it.
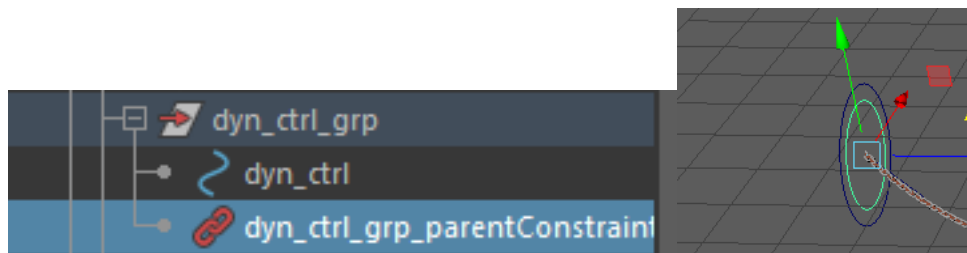

15. Parent constrain the controls so that they follow the all anim. The chain and the controls will now move with the all anim. Group the controls for the chain and the group containing the dynamic control, and parent constrain the new group to the all anim.
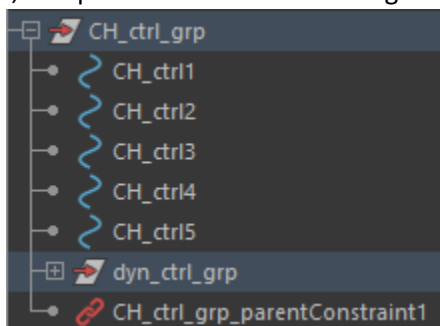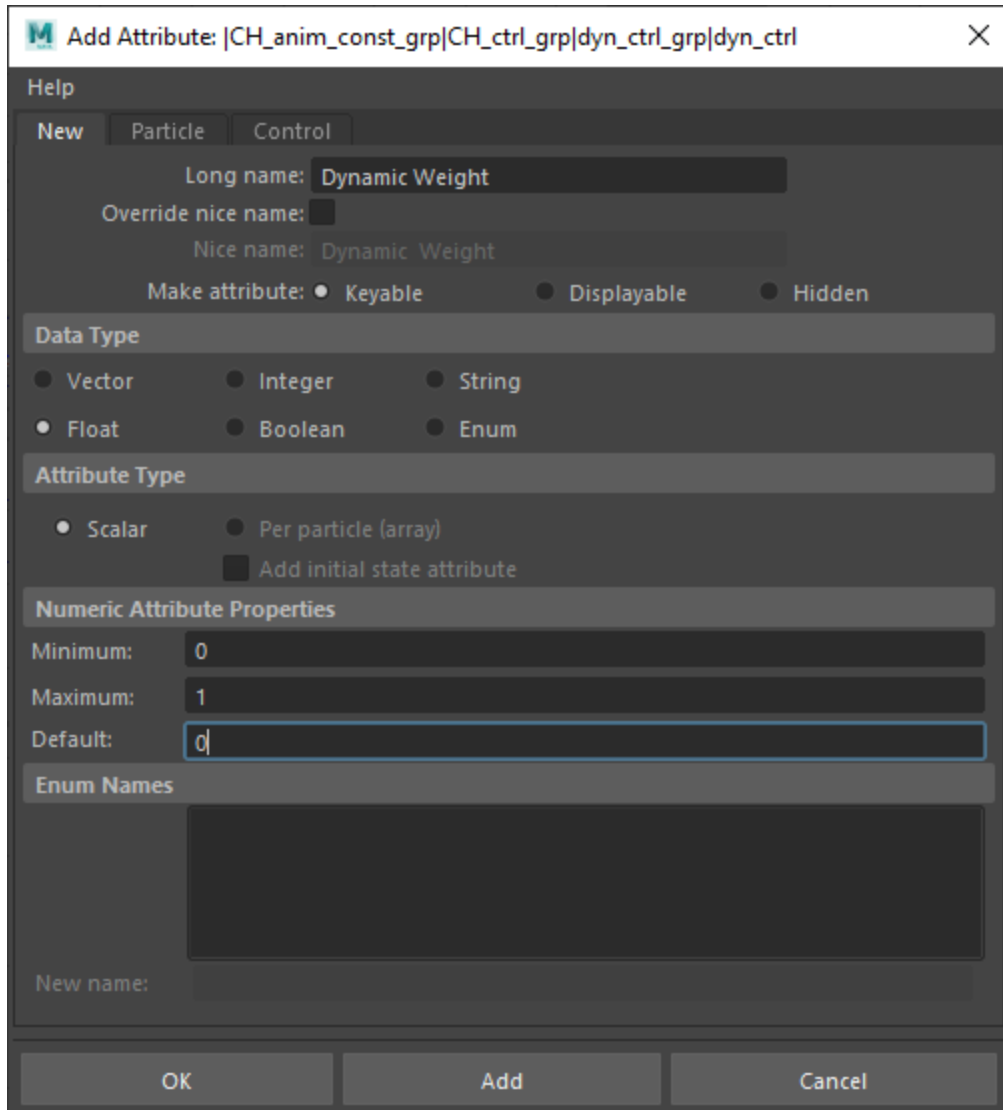

16. The Dynamic switch control needs its functionality. Create an attribute from either the Channel Box Editor (Edit>Add Attribute) or the Attribute Editor (Attributes>Add Attributes), name it Dynamics On Off Switch, and change the type to Boolean.
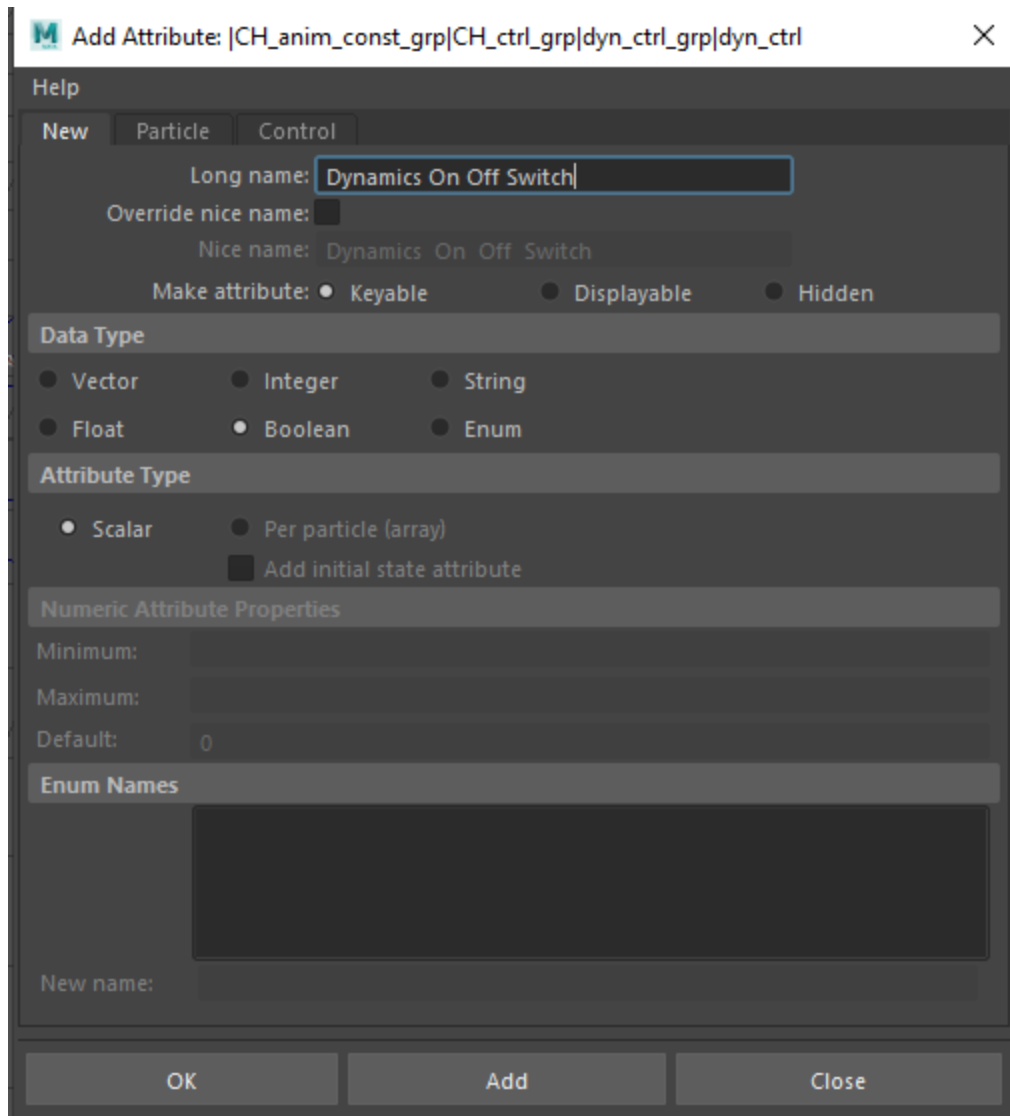
17. Add the functionality by switching to the Animation menu set and select Key>Set Driven Key>Set…>□ select Dynamics On Off Switch in the channel box editor and in the set driven key menu select Load Driver. Then select the hair system shape in the Outliner by selecting in the Outliner Display>Shapes and then selecting the hair system shape. Then Load Driven.
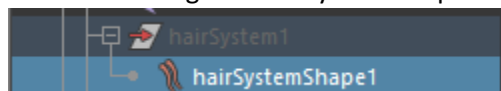
18. Dynamics On Off Switch should already be set to off. In the Attribute Editor, Set Simulation Method to Off and in the set driven key box select Key.
19. Change Dynamics On Off Switch to on. Then go to the hair system shape, and in the Attribute Editor change Simulation Method to All Follicles, then, in the set driven key box select Key.
20. On the dynamic control, create an attribute titled Dynamics Weight, change the type to Float, and set the maximum to 1, minimum to 0, and default to 0 so that dynamics are automatically off when animators begin animation.

Add Attribute: |CH_anim_const_grp|CH_ctrl_grp|dyn_ctrl_grp|dyn_ctrl ✕

Help

| New | Particle | Control |

Long name: Dynamic Weight

Override nice name: ☐

Nice name: Dynamic Weight

Make attribute: ● Keyable ● Displayable ● Hidden

Data Type

● Vector ● Integer ● String
● Float ● Boolean ● Enum

Attribute Type

● Scalar ● Per particle (array)
☐ Add initial state attribute

Numeric Attribute Properties

Minimum: 0

Maximum: 1

Default: 0

Enum Names

New name:

| OK | Add | Cancel |

21. Tangents need to be set to Linear before adding the functionality. This can be done by going to Windows>Settings/Preferences>Preferences, and then selecting Animation and changing Default In Tangent and Default Out Tangent to Linear. Press Save.
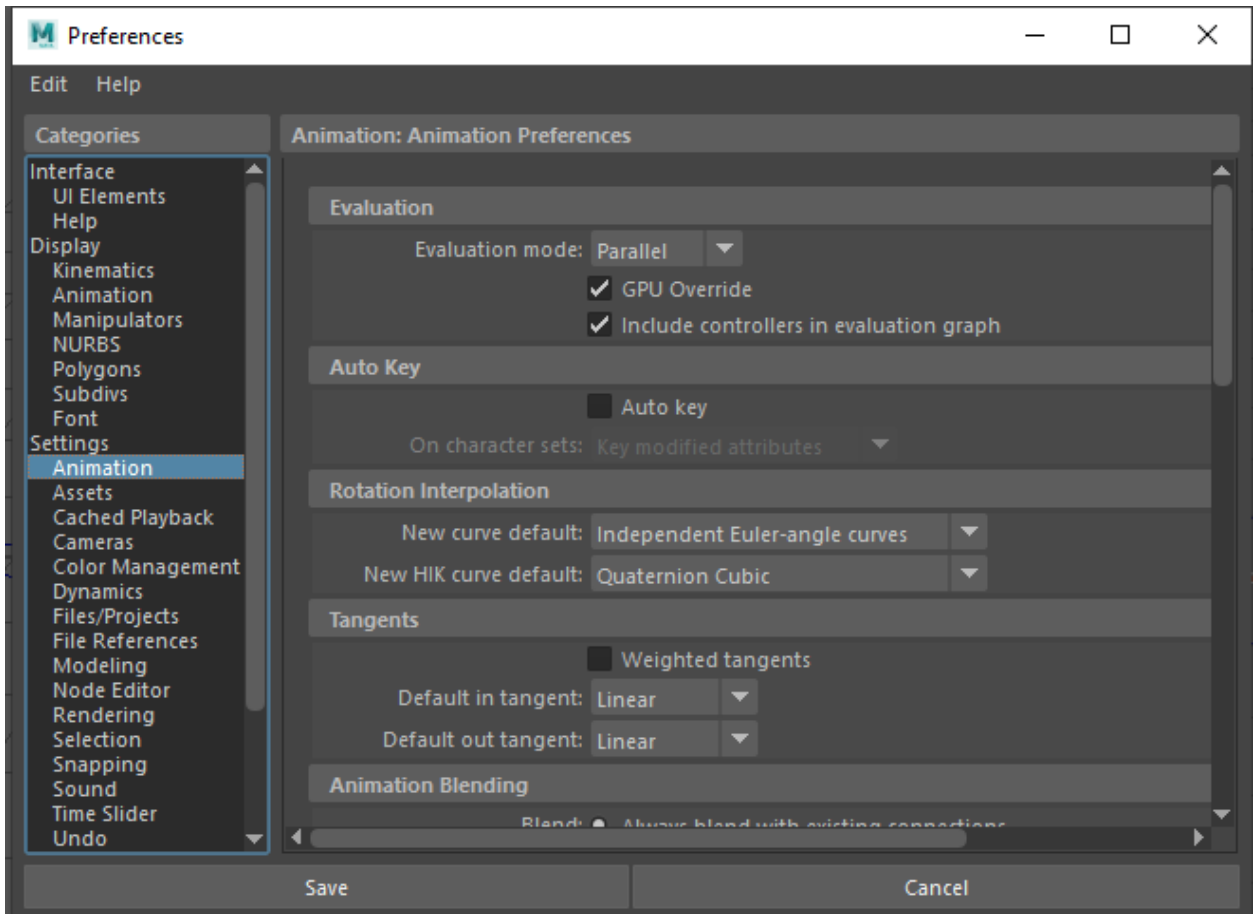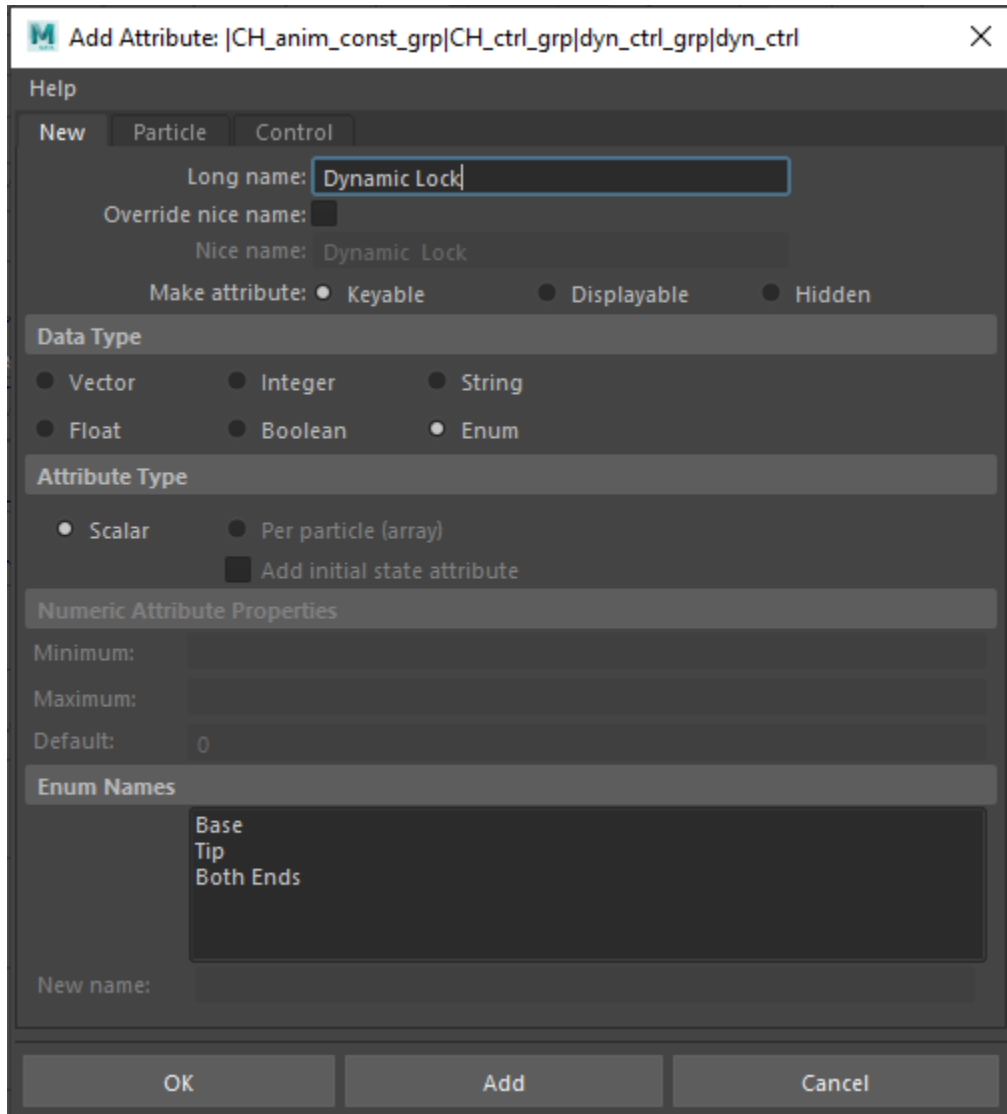
22. Set Driven Key with Dynamics Weight as the driver and all parent constraints on each geo_joint chain. The IK parent constraint weights need to be set to 1 and the dynamic parent constraint weights need to be set to 0. Since the joint chains were named at the time of applying the constraints, it should be easy to see which is which. Once these values are set, go through each parent constraint in the driven section, and for each, select the weight attributes, press Key.


23. Switch Dynamics Weight to 1 and switch the values of the weights on the geo joint parent constraints such that the IK constraint weights are 0 and the Dynamic constraint weights are 1. Then go through each parent constraint in the driven, and for each, select the weight attributes, and press Key. These 2 steps can be automated via scripts in MEL (could not get the Python command to work in Maya 2019.1).
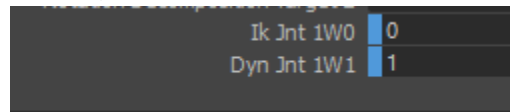
24. Create an attribute on the dynamic control named Dynamic Lock with the type set to Enum. Type in each row of the Enum Names section the following names: Base, Tip, and Both Ends.

25. Set the values for these settings by using Set Driven Key with Dynamic Lock as the driver. Select the follicle shape and load as driven. Key such that Dynamic Lock is Base when Point Lock on follicle shape is Base, Dynamic Lock is Tip when Point Lock on follicle shape is Tip, and Dynamic Lock is Both Ends when Point Lock on follicle shape is Both Ends. For the chain, it is pinned to both ends for most of the film, so the Dynamic Lock attribute is set to Both Ends so that it is the default- set the attribute to whichever is appropriate for the model.
26. Clean up the outliner. Group the all anim and name it the [asset name]_const_grp.
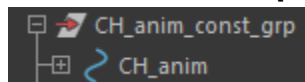
27. Group the IK curve clusters (if applicable) and then select that group and all IK elements, and group into ik_grp (if FK use fk_grp).

28. Group the IK curve clusters (if applicable) and then select that group and all dynamic elements, and group into dyn_grp.
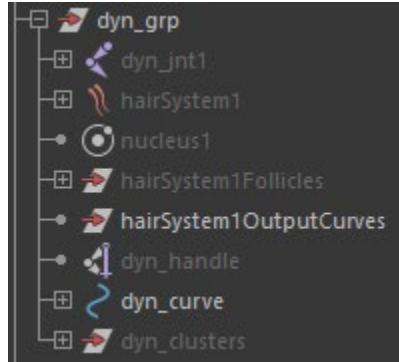
29. Group the geometry group and geo joint chain into geo_grp.
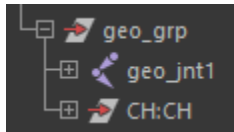
30. Hide all elements that don't need to be seen- joint chains, curves, hair system, nucleus, etc.
31. Select the control group, ik/fk group, dynamic group, and geometry group, and then the const_grp. Press P to Parent.
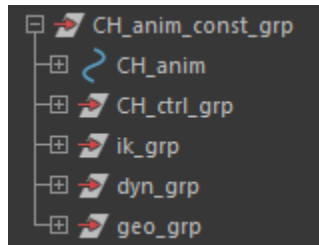
32. Done! Now you should have a rigged model that can both be posed and keyframed and incorporate dynamic simulation into its movement.