# Muscle Deformation Techniques

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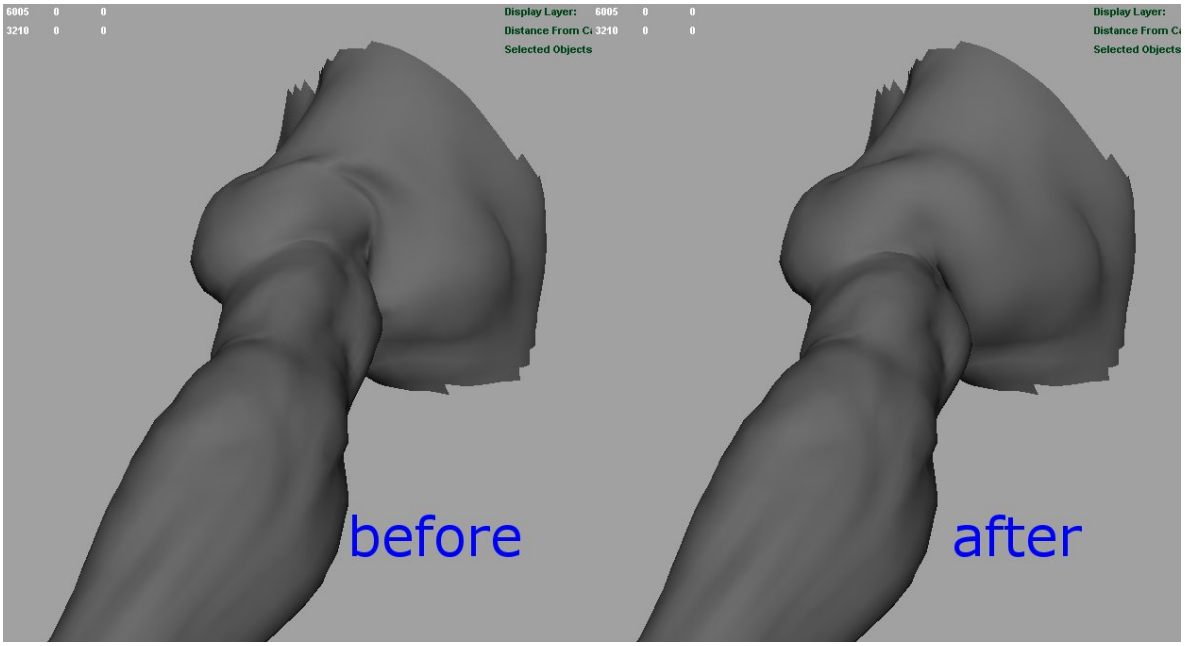
## BlendShape correctives and pose drivers (Pose Space Deformation)




Maya file:01_correctiveBlendShapes/corBs_setup.ma

We can achieve impressive and very accurate results using this simple but still powerfull setup. Basically all we need is a blendShape deformer.

The idea behind this setup is to sculpt our deformed geometry into the desired shape and convert this to Front Of Chain blendShape target.
Once we have this target generated, we need to make a pose driving setup, so the blendShape target is only applied in our pose, within some falloff.

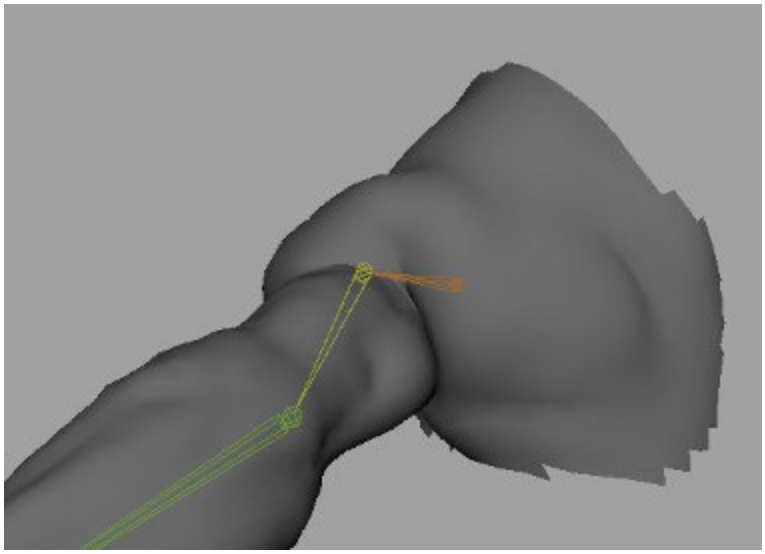
Let`s break this all down.

### Converting sculpted mesh to a blendShape target

By theory, we can achieve any sculpted shape using a front of chain blendShape*. It`s all about finding the correct vector for each point so after all deformations are applied, this vector offset ends up at the right place.

** unless there is a deformer that would limit adding up blendShape values downstream of the deformation stack, sliding deformer, like sculpt or another blendShape*

For less extreme deformations, the corrective blendShape can even be modelled manually, just by checking how it looks when blendShape is applied in the pose, because the undeformed shape would look very similar to skinned deformed shape.



More extreme deformations and higher mesh resolutions are easier to be computed mathematicly. It`s important to know, that local space of a deformed point is different then the one of undeformed mesh. It takes on rotations of skin joints and any other deformers. Different techniques can find the coordinates of a local space of the deformed point and then match them back to the world-axis based point of the target mesh. One of the available solutions is an algorithm from Christian Breitling called **BSpirit Corrective Shape**. It`s limited to work only with skinCluster as far as I know (skinCluster component mode doesn`t work as it`s using joint matrices). Another one would be cvShapeInverter. from Chad Vernon which was made as python plugin.
I used his plugin compiled for Maya 2008, which makes the target shape in real-time, but the tool can be used in later versions of Maya as well using his MEL script that does the same, it`s just slower. Here is the link to his website with free download of his tool. Feel free to read on more information:

http://www.b-ling.com/

http://www.chadvernon.com/blog/resources/cvshapeinverter/

As other similar tools, this also creates a duplicate of your skinned mesh, which you can easily sculpt (and move its points easily in world coordinates (which you couldn`t on deformed mesh).

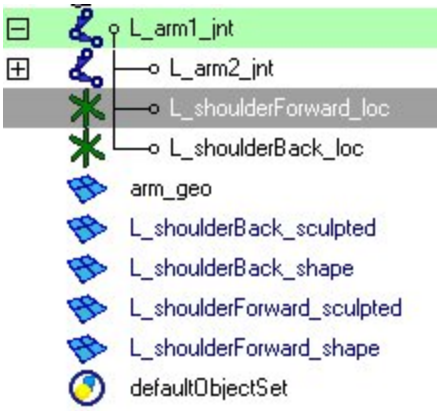
Then use any techniques to sculpt the mesh area to desired pose: Mesh Sculpt tool, Soft Selection (surface mode can be handy), Lattice, cluster, etc. When you are happy with the shape, you can then generate target shape using BSpirit or shapeInverter tool.
This target shape is already converted to world axis coordinates so it can be applied as front of chain blendShape.

In the example scene I have created 2 such corrective shapes and applied them as a blendShape, but I had to control their value depending on the pose. And this takes us to the second point - how to drive the target shape values based on the pose.

## Driving target blendShape by a pose setup

We need to drive the value of the blendShape based on the pose that it was made for. There can be different systems driving the shape target value. These can be usually based on the angle between the pose reference object (locator) and the current angle of a joint. Or you can use distance measurement nodes attached to different parts of skeleton, sometimes it`s ok just having set driven key on joint with 1-axis rotation freedom, for example for elbow, knee or fingers. In this tutorial, I will describe more the angle comparison technique as it`s very robust and quite simple to setup.

We need to compare vectors (axis) of our joint (“L_arm2_jnt”) and a reference object. The reference object can be a locator matching the rotation/translation of the joint, which you parent on the same hierarchy level as the joint. So they will be under the same parent (“L_arm1_jnt”). No need for constraints, it will just sit there.

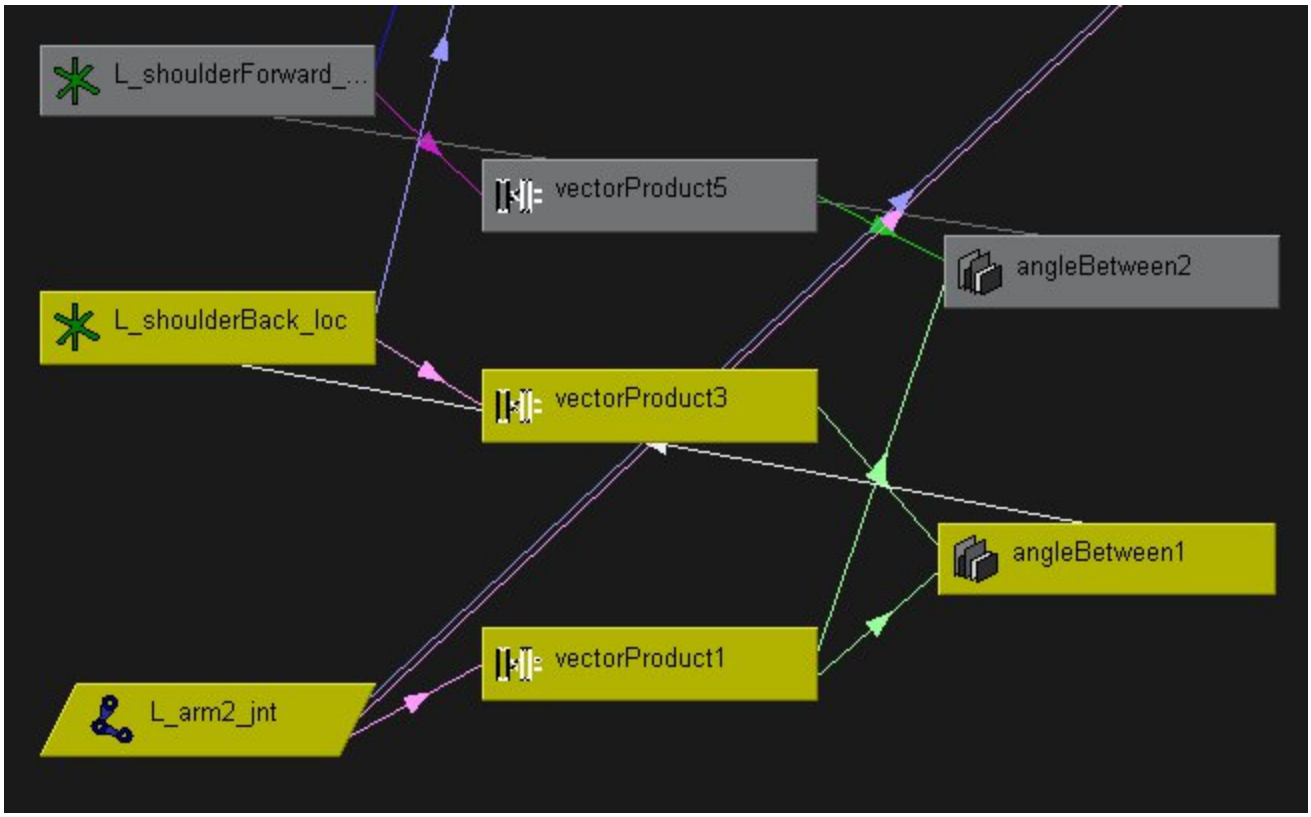



We will compare the primary axis (length axis of a joint) as it`s having biggest influence on the pose. For this, Maya has a node called angleBetween that takes 2 vectors and outputs a float value which is the angle difference. So when poses match, we should have zero angle. We could also make set driven key for this zero angle and make value 1 on our blendShape target.

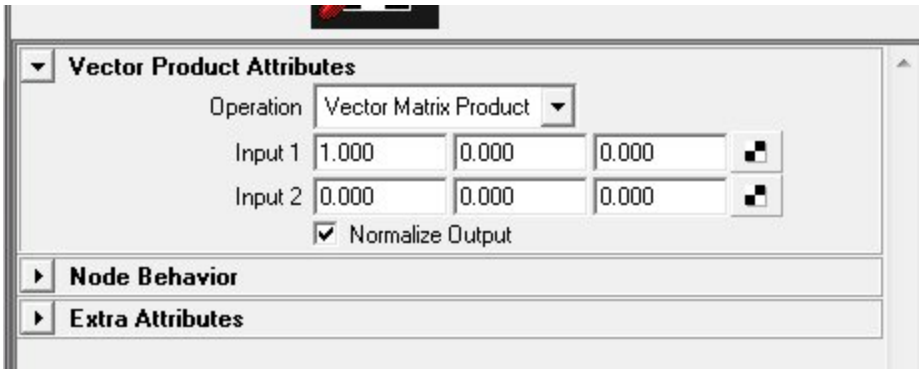
Then for the falloff angle, which can be 60 degress or any angle preferred, the pose will be zero. You can also adjust the curve in the graph Editor.

I should mention that for full pose match we should also compare angle between one more axis, so get the twist component of the pose, but for this example I will leave it at that.

This is the angle between DG graph:




We are extracting the vectors of primary axis from both the joint and reference locator. The vector product node used here is very useful, so let`s show how to set this up.



You can do couple of different operations, like dot product or vector product and you use both vector inputs. In the case of Vector Matrix Product, second input is ignored and we need to inputs object`s World Matrix instead. First input shows a vector we want to multiply by that matrix. In this case I used <<1,0,0>> because X is primary axis of the pose joint. When we create both Vector Product nodes, their vector ouput gets connected to angleBetween.

NOTE: This pose driving setup can also be scripted for quick creation of pose drivers for your rig.

## When should we use correctives (Pose Space Deformation)?

This technique should NOT be used to fix bad skinning. It should come after very clean skin weights or other type of deformations and only then it`s ok to apply this finishing setup. Remember that if you change your weights, the corrective blendShape will change too, and might not look right anymore and then you would have to make some or all corrective blendShapes again.

As a conclusion, we see that potential of this technique and its accuracy is huge. It is actually being used a lot in the industry either for simple muscle setups or to achieve exact shapes, that would be otherwise difficult to do.