

Game Developers Conference®

February 28 - March 4, 2011
Moscone Center, San Francisco

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GDC®



Wednesday, March 30, 2011

GDC 2011. Jeremy Ernst. Fast and Efficient Facial Rigging(in Gears of War 3)

Fast and Efficient Facial Rigging

in Gears of War 3

Character Rigger:

- creates animation control rigs
- creates animation pipeline toolsets
- skin weights character models
- set up character assets in game

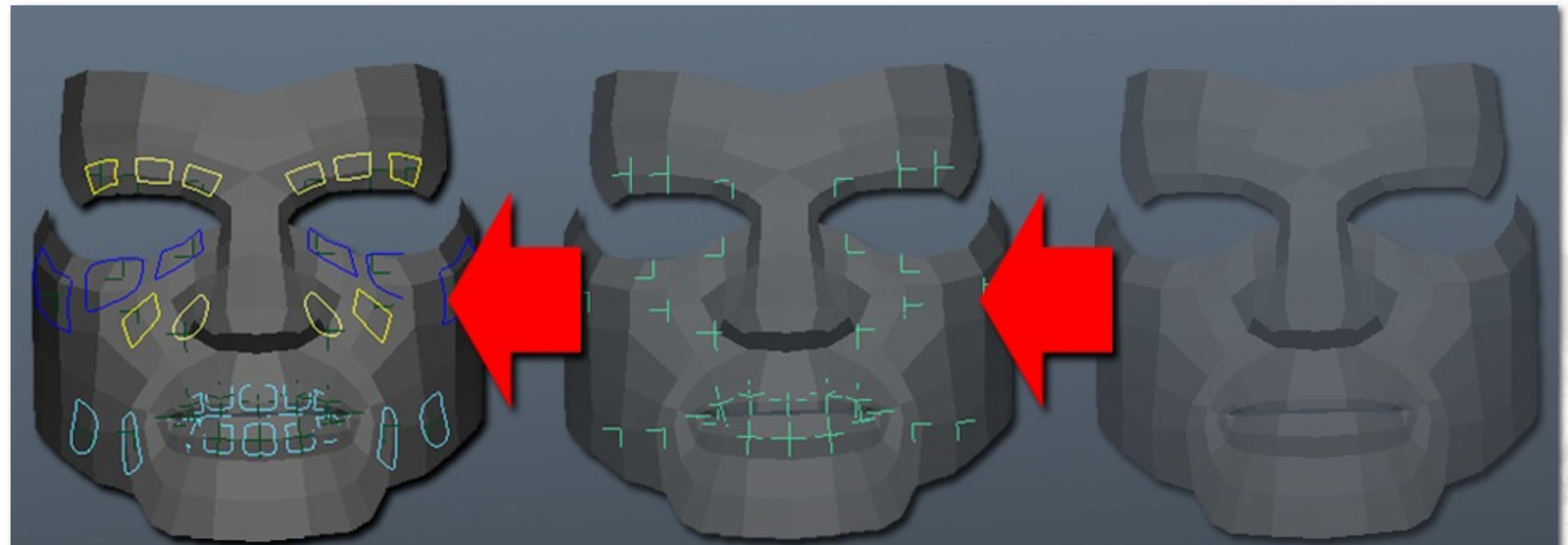


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My name is Jeremy Ernst and I am the character rigger/technical animator at Epic Games. TAs are an interesting position, since we tend to bridge the gaps in a pipeline between art and code. I do a fair bit of programming, for various pipeline tools as well as rigging tools. If I'm not coding, I'm rigging, skin weighting, or solving problems.

Fast and Efficient Facial Rigging in Gears of War 3



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This talk is about the facial rigging pipeline toolset I created for production on Gears of War 3. It is not a talk about the Unreal Engine, and it does expect a certain level of familiarity with common rigging terminology.

Developing the Face Rig

Development Challenges:

More characters than ever!

Double the amount of cinematics



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When developing this toolset, there were two main development challenges for me to consider.

We have more characters than ever in this game. Delta squad grew pretty big in the story, and we also have four player co-op. Also, the scope of our cinematics increased drastically. Not only in length, but in the amount of minimum characters in each one. So I needed to make a toolset that allowed the animators to work quickly, but achieve high quality results.

Developing the Face Rig

Easy to Animate

Establish good workflow with outsourcers

Transferable Rig and Data



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So these were the 3 main things I wanted to achieve with this facial rigging toolset.

Easy to animate is self-explanatory, but also hard to do. Establishing a solid workflow with outsourcers is important as well. The biggest point there is consistency. Making sure that all of your internal animators stay on character with their posing, as well as the external animators. If you can build an easy way to deal with this into the rig, you increase the chances of getting back high quality data.

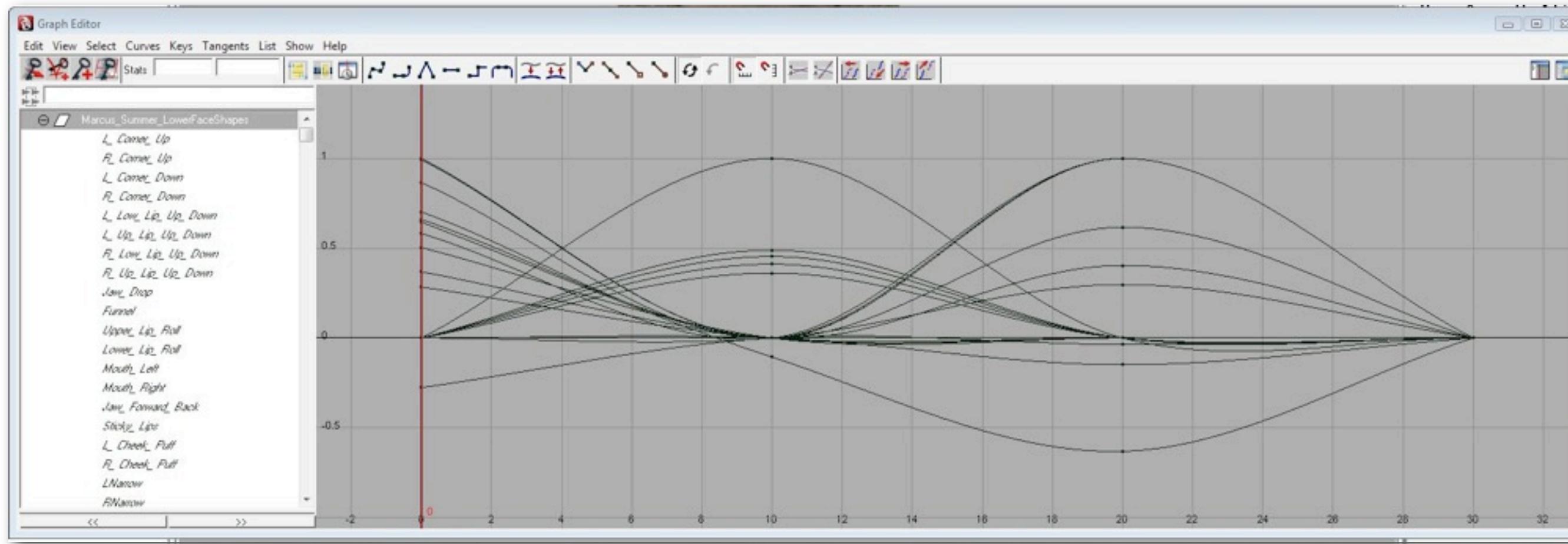
Making the rig transferable is important too, as I don't want to have to replicate my work over and over. But, scripting wasn't going to work 100% for this rig, and you'll see why.

Easy to Animate

Animate Attributes, not Transformations

Nice, Clean, Curve data(1 channel/attribute)

So Clean!



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So, the first step in getting this rig easy to animate was to have them animating attributes as much as possible, instead of individual joint transformations. That is going to give you nice, clean curves in your graph editor as well. Also, less curves to deal with, since you'd only have 1 channel per attribute instead of 6 per joint.

Easy to Animate

Animate Attributes, not Transformations

Nice, Clean, Curve data

Offset Rig - A Combination Rig

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But, it became apparent that animating only attributes would not offer enough control. You could probably add a lot more attributes until this was possible, but then you start to veer off making it easy to animate as well. So I added the offset rig, which allows the animator more control, but in a unique way.

Establishing a Good Workflow with Outsourcers

Getting back cleaner data

Staying on character with posing

Good ways to send all the files needed



Establishing a Good Workflow with Outsourcers



<http://www.sminstall.com/>

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One of the things I started doing internally was packaging all of the scripts, icons and such into executables instead of just putting them up in source control and hoping everyone read the emails or copied files to the correct directories. This becomes even trickier when a producer just sends a .zip of all your files to some outsourcers. Executables made life in this regard a breeze. I used “Smart Install Maker” (link in slide), to build the executables quickly and easily.

Transferable Rig and Data

Making the rig only once

Creating the pose library only once

Allowing for LOD animation

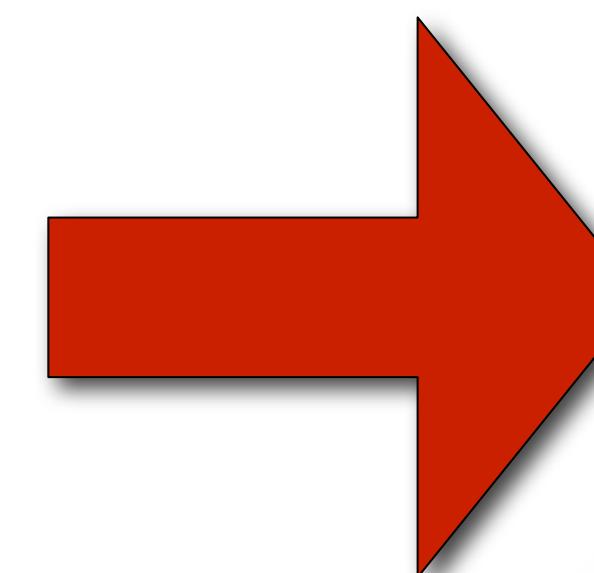


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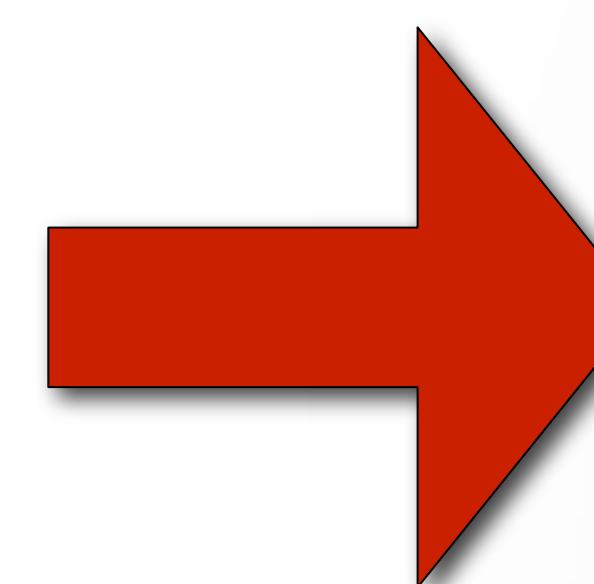
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I mentioned that I wanted the animator to animate attributes earlier for ease of use, and that means using pose libraries for the characters. But I didn't want to have to remake those either. As you'll see later, the solution for making the rig only once also solves making the poses only once as well. Allowing for LOD animation refers to more or less how we did things in Gears 2 vs Gears 3. In Gears 3, we have a game mesh and a cine mesh. They are the same mesh, but are just weighted differently to allow for applying the same animation on either. This way, we can still be smart about how many weighted bones we have in-game, but when we need the extra deformation for close-up cinematics, we can load in those weights.

Inspirations



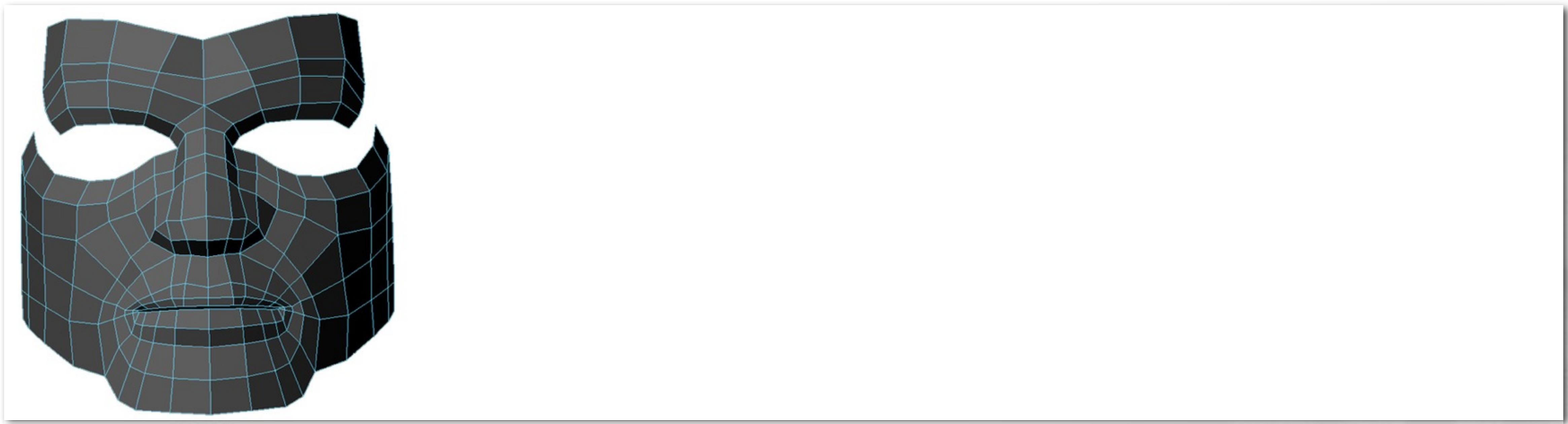
Awesome CG
Society article!



Metal Gear Solid 4
XSI article. Good
starting point!

The Rig

Layers of the Rig:



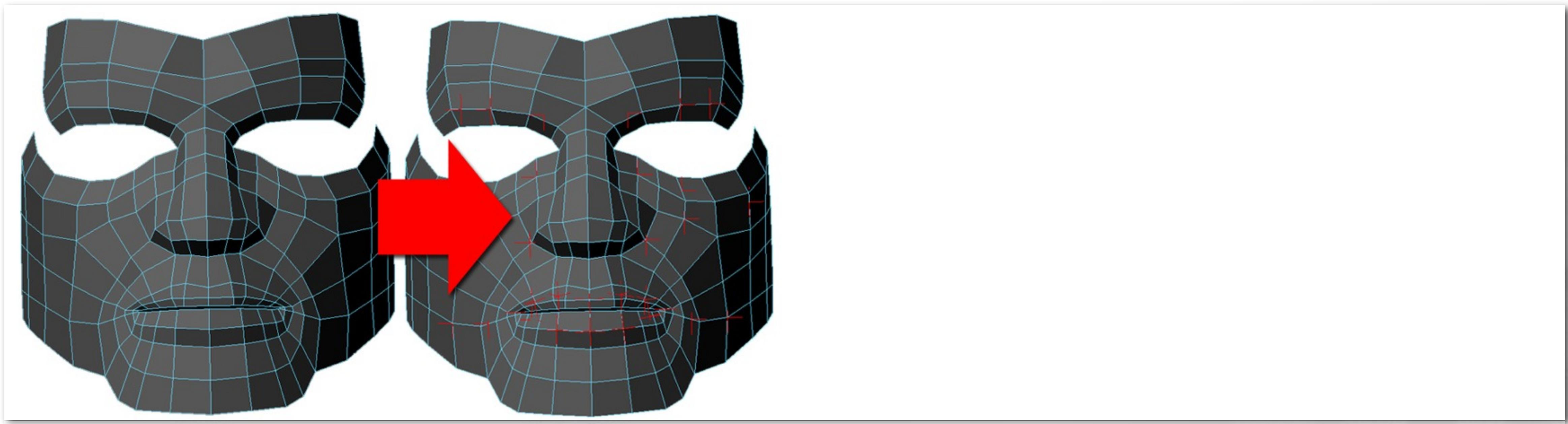
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The rig is made up of 4 main layers. The first is the Cage. This is a low poly piece of geometry that defines most of the area of the face that deforms. It is very low poly so that we could make morphs and iterate on them quickly. All of our animatable attributes would be morph targets made on this cage.

The Rig

Layers of the Rig:



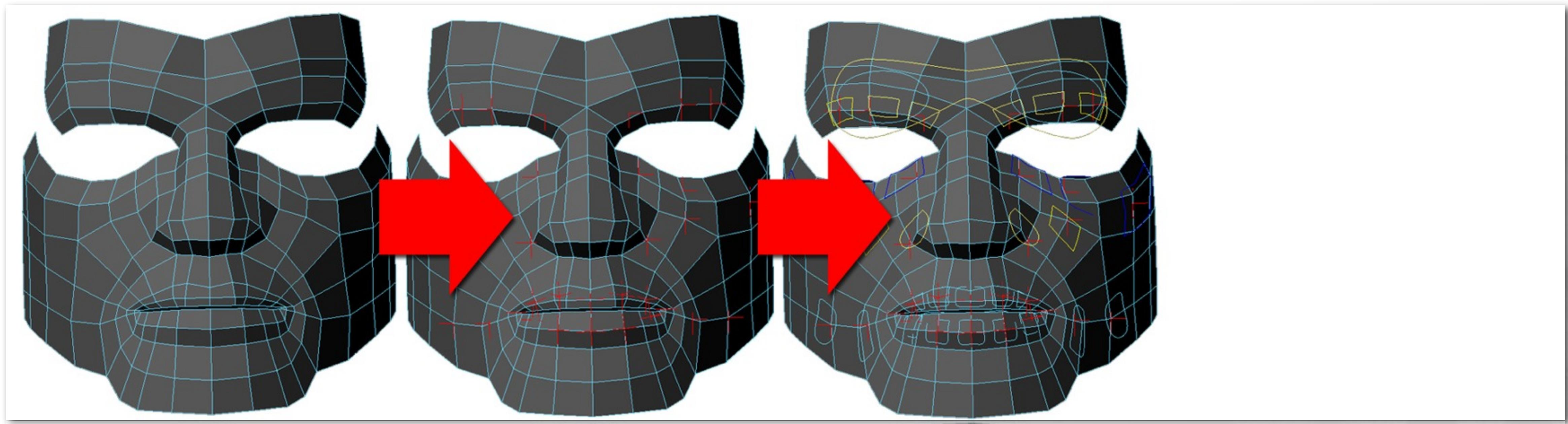
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The next layer are locators that are pinned to the surface of the cage. This way, whenever the cage morphs, the locators move with the geometry. Think of this almost like mocap. I'm tracking areas of the face for movement with these locators.

The Rig

Layers of the Rig:



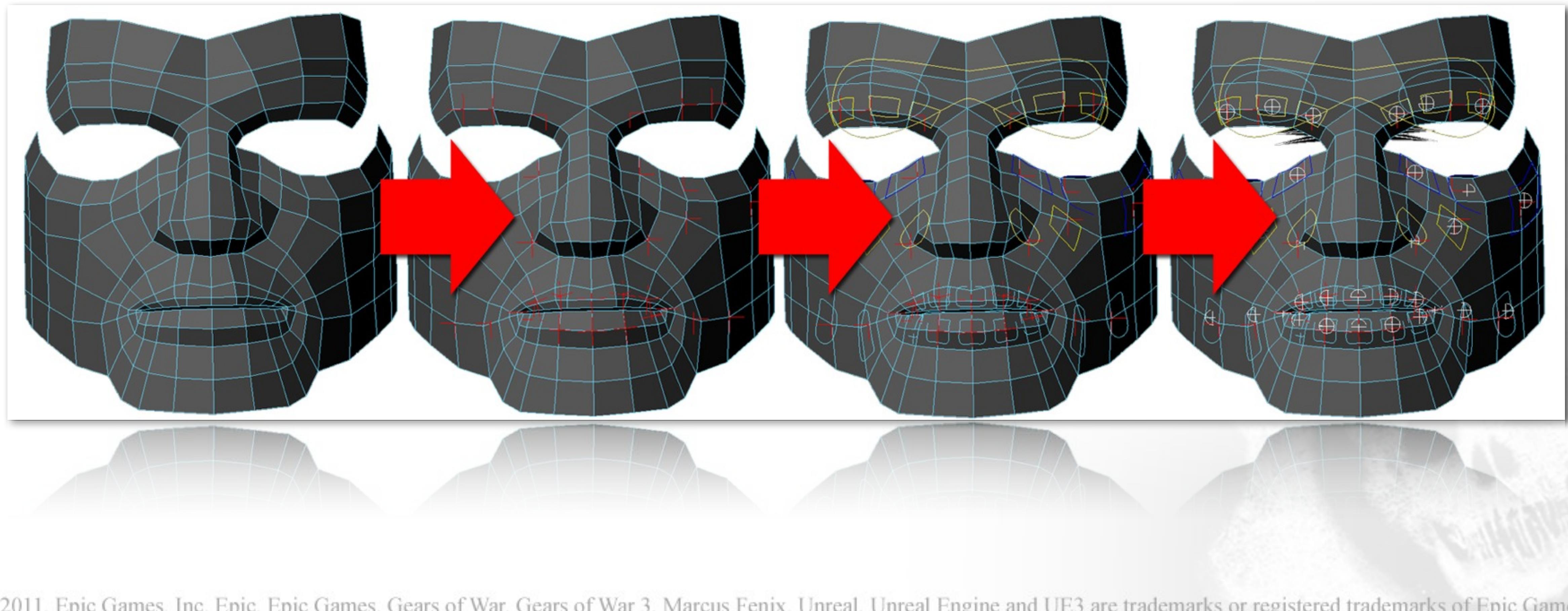
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The third layer is the Offset Rig, which was mentioned earlier. This offset rig follows the locators. So when a locator moves, the corresponding offset control will move to. Hence the name, offset. If you wanted to tweak a pose, you would be offsetting from that pose with these controls.

The Rig

Layers of the Rig:



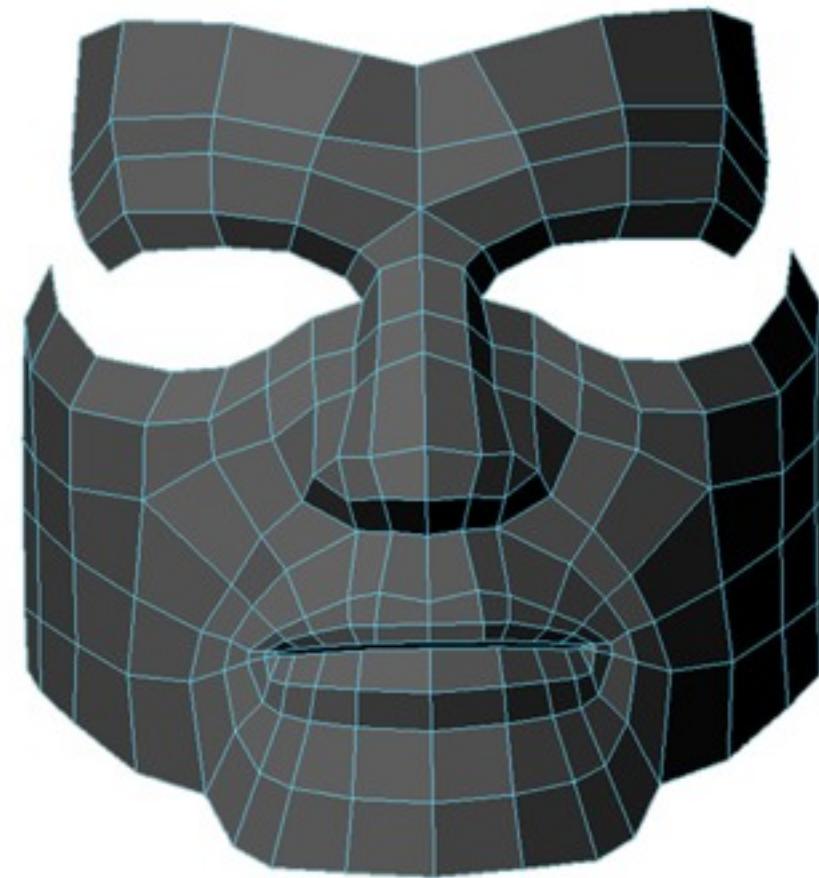
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Lastly are the joints that the actual model is weighted to. These are constrained to the offset rig controls.

The Rig

Breakdown:



The F.A.C.S Morph Targets



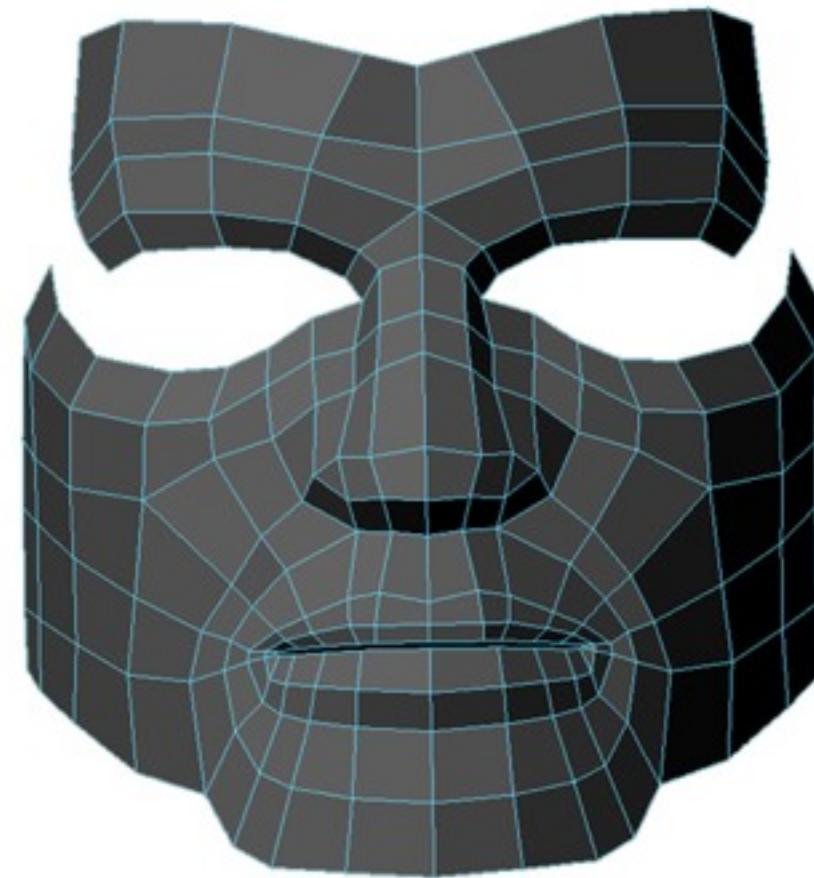
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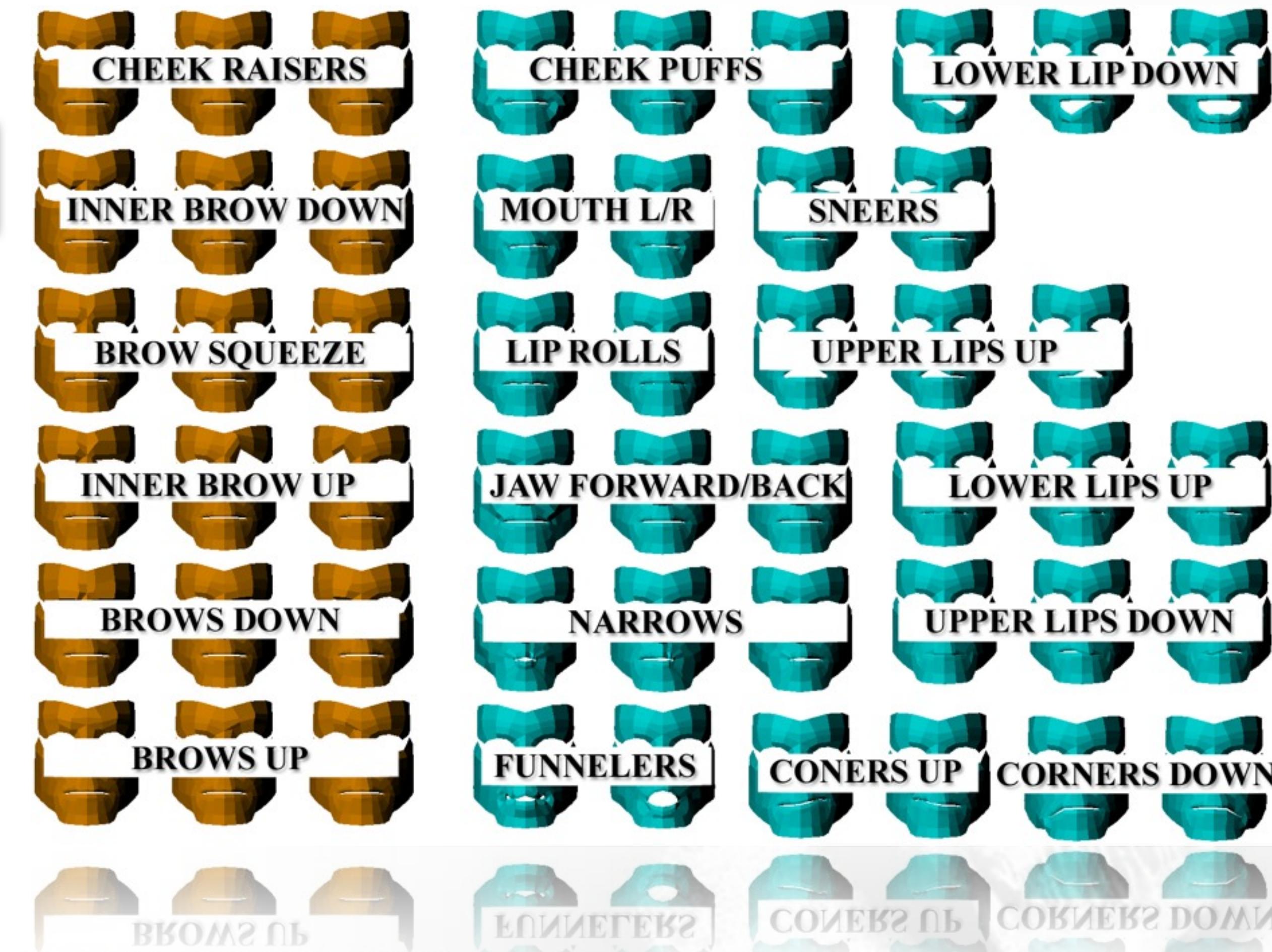
I looked heavily to the facial action coding system(F.A.C.S) for building my pose library. If you aren't familiar with it, you should definitely look it up. The essence is, there are 32 action units of the face that can achieve the entirety of the range of (e)motion of the face. An action unit is defined as a contraction or relaxation of 1 or more muscles in the face.

The Rig

Breakdown:



The F.A.C.S Morph Targets



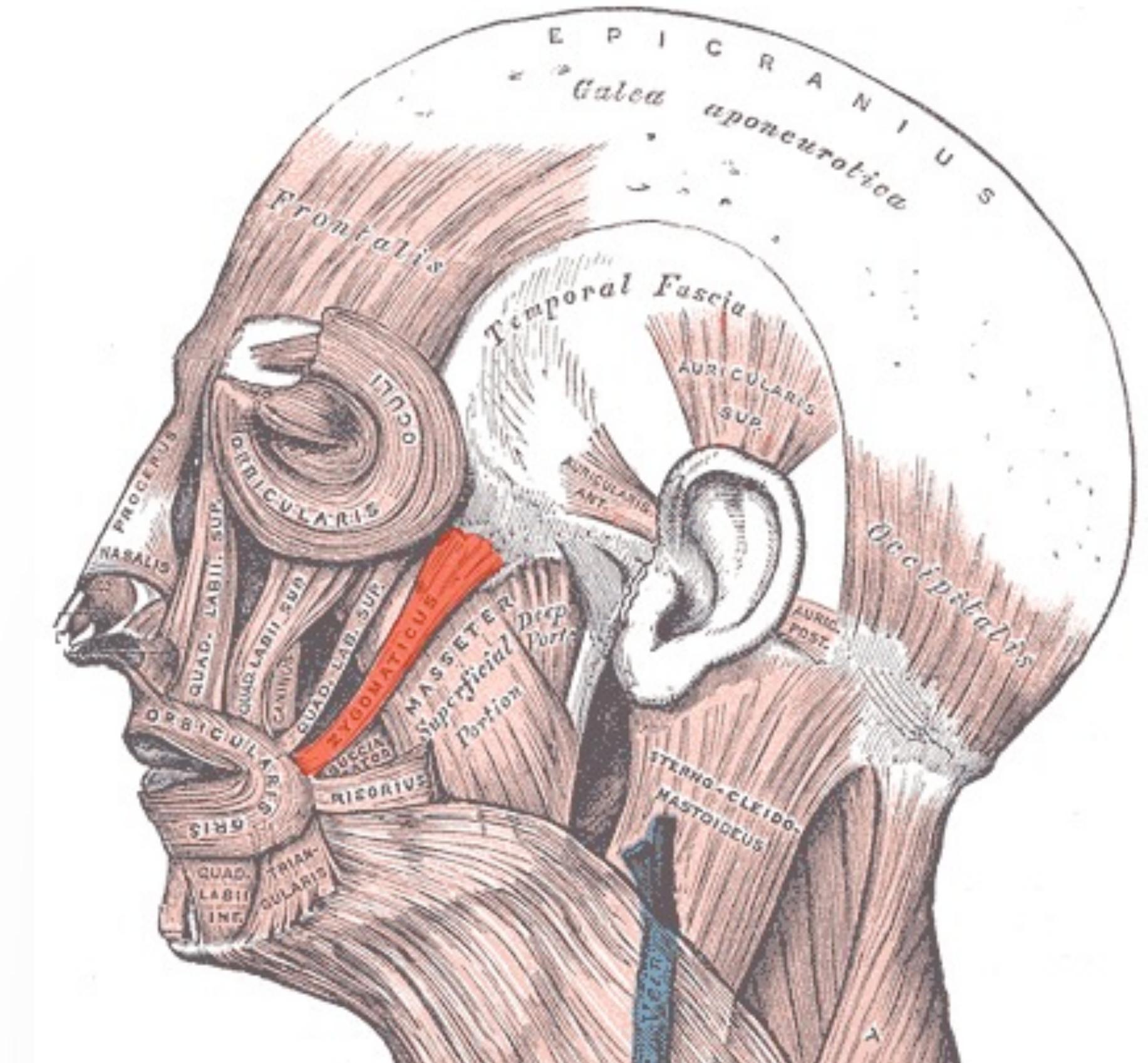
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The facial action coding system was not developed for artists though :)
So I went and renamed a bunch of the shapes to be more user friendly and more visually clear.

The Rig

Facial Action Coding System Examples:



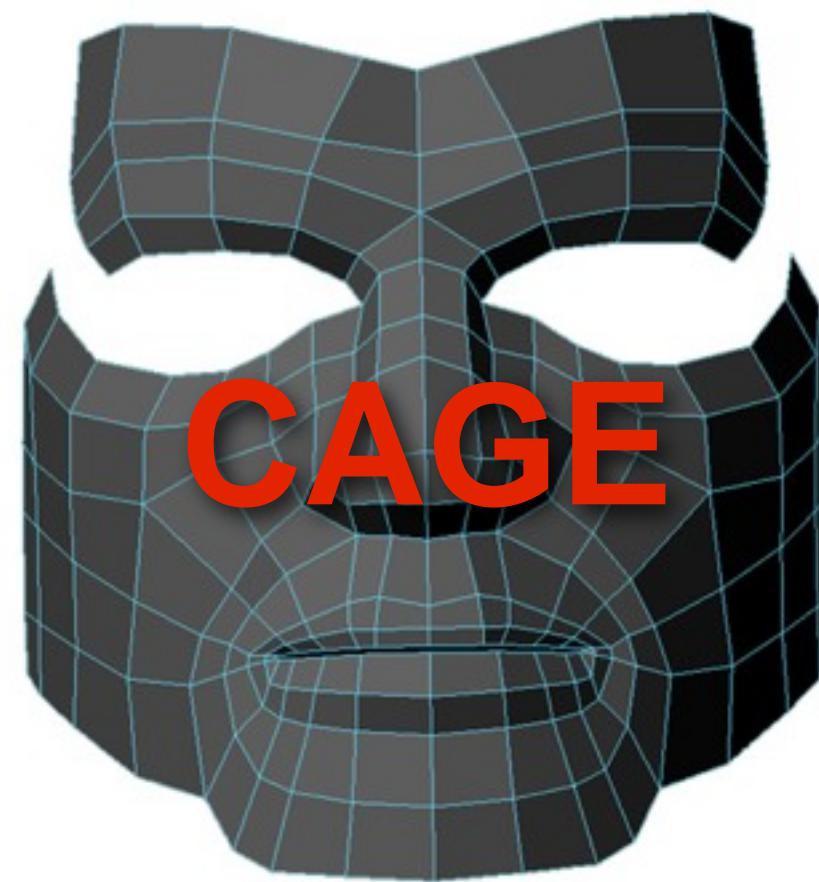
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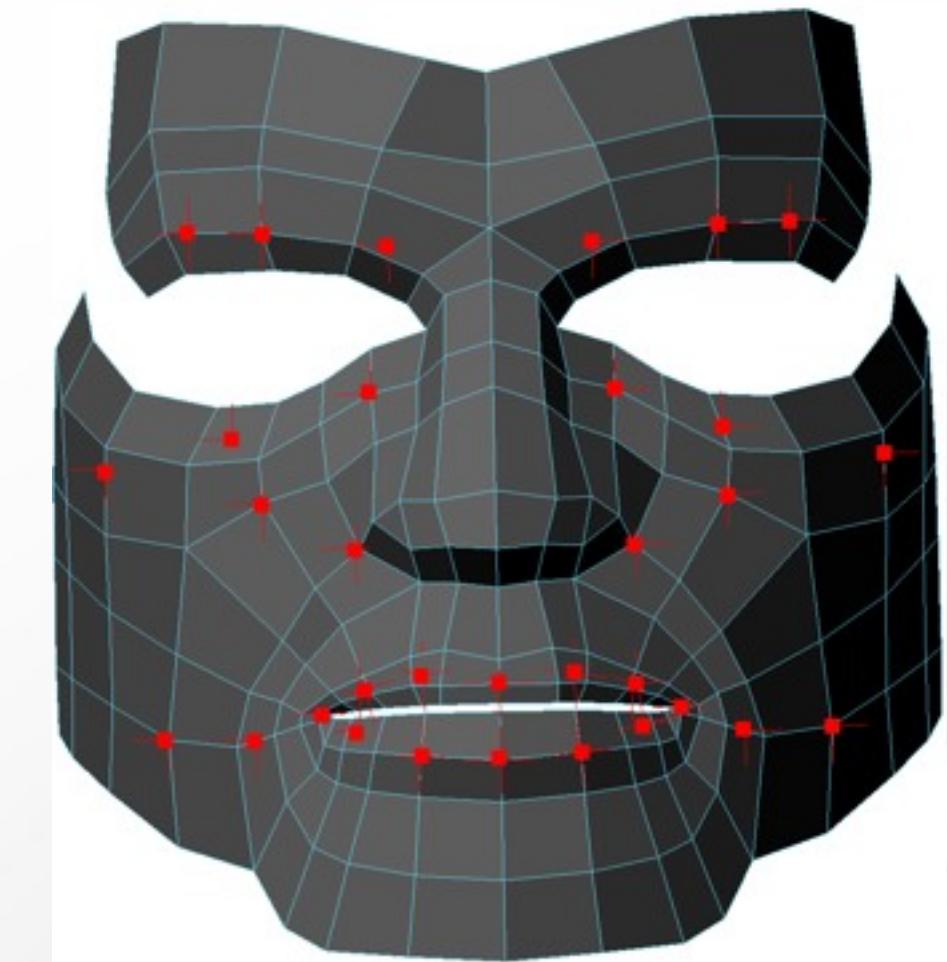
Here is an example of the lip corner puller action unit on Marcus. You can see that with the anatomical diagram, the zygomaticus major muscle contracts to pull the corner of the mouth up.

The Rig

Breakdown:



Morphs Drive Locators



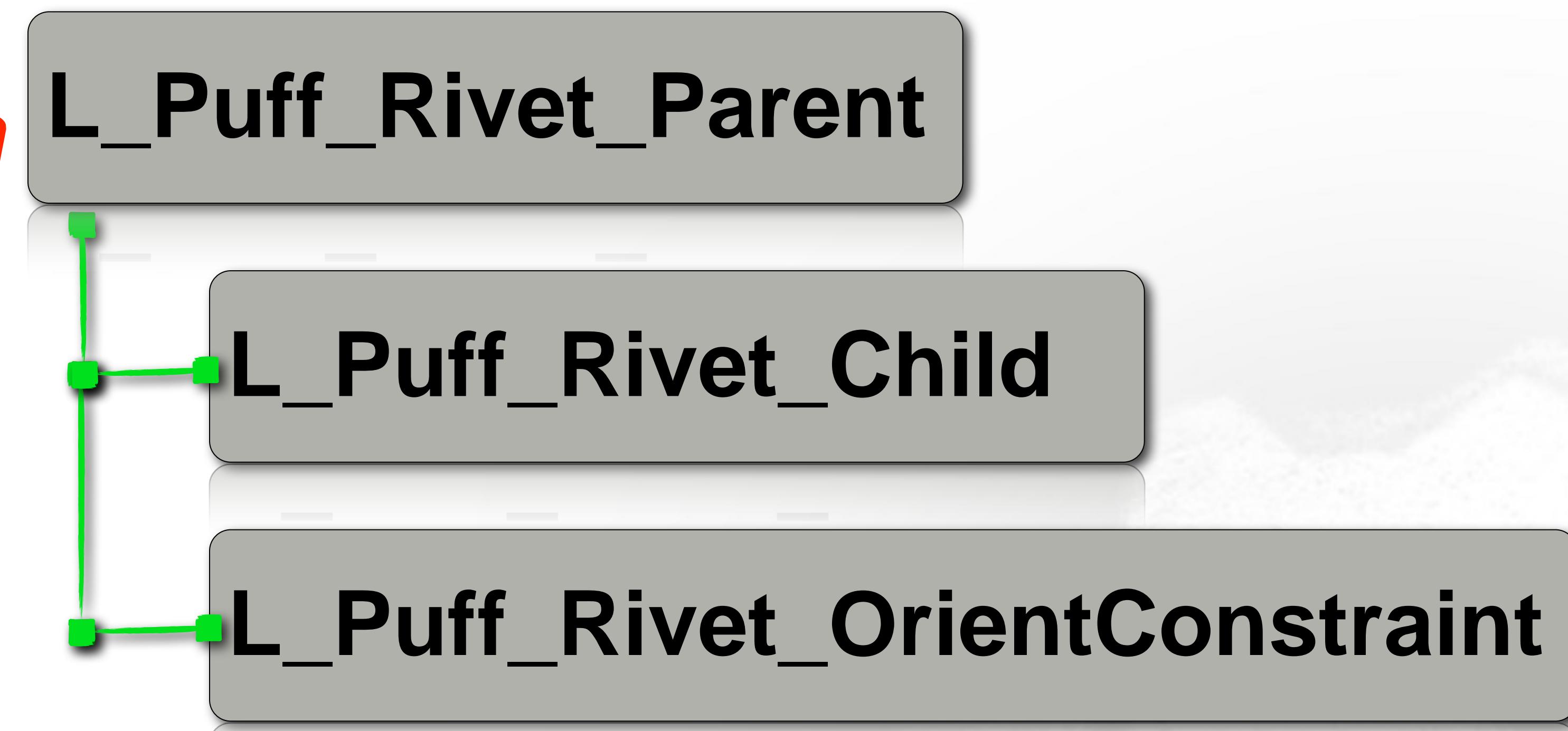
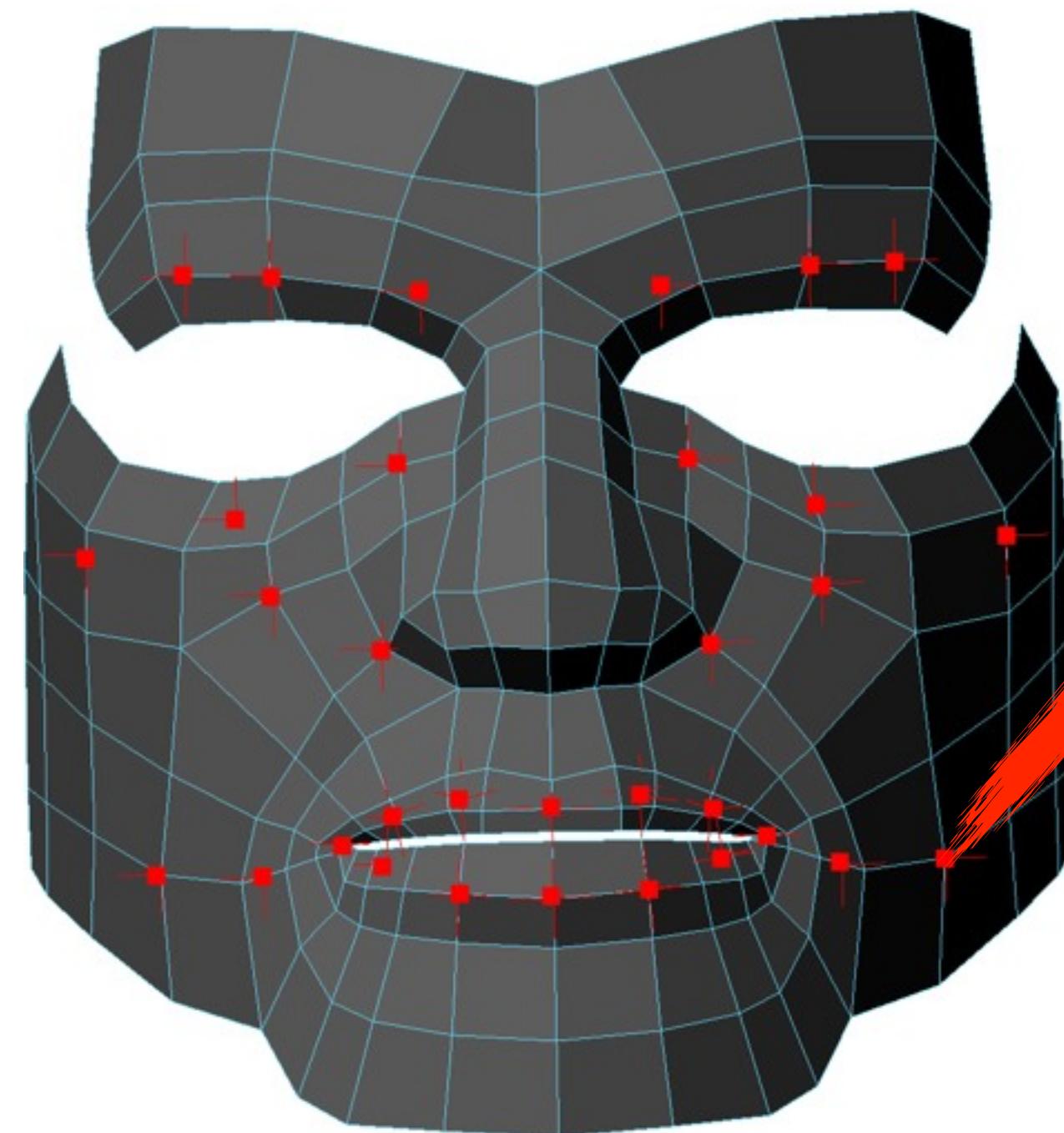
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This is just to reiterate that the morphs on the cage, will drive the motion of the locators. The locators are there to track the motion on key points on the face(the same key points where joints are placed).

The Rig

Breakdown:



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Here is a breakdown of one of the locators. You'll see that the hierarchy is composed of a parent and child locator. The parent locator is the one that is pinned to the geometry, but it has to be orient constrained to the head bone, or else when the head turns, the face will stay behind. The child locator is there to get any set driven keys the setup might need to things like lip roll, since tracking position doesn't help much with getting roll affects with limited number of joints.

Joint Placement



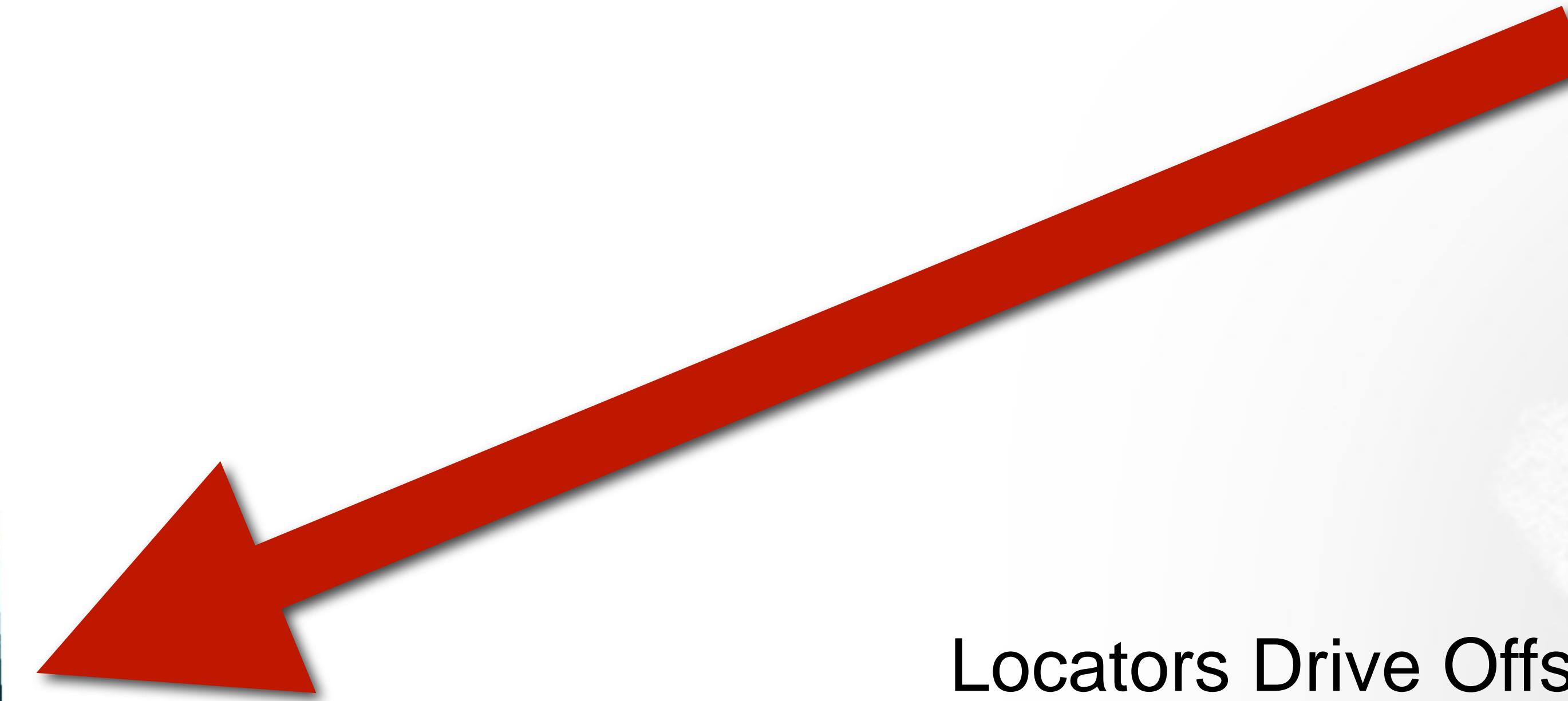
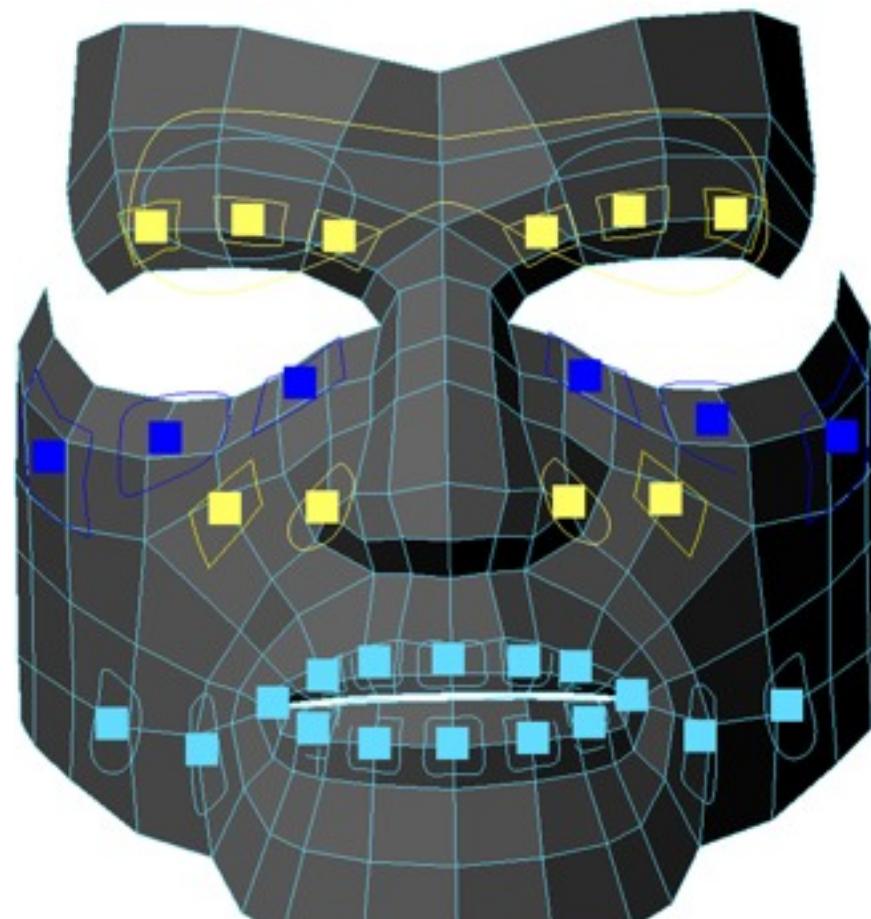
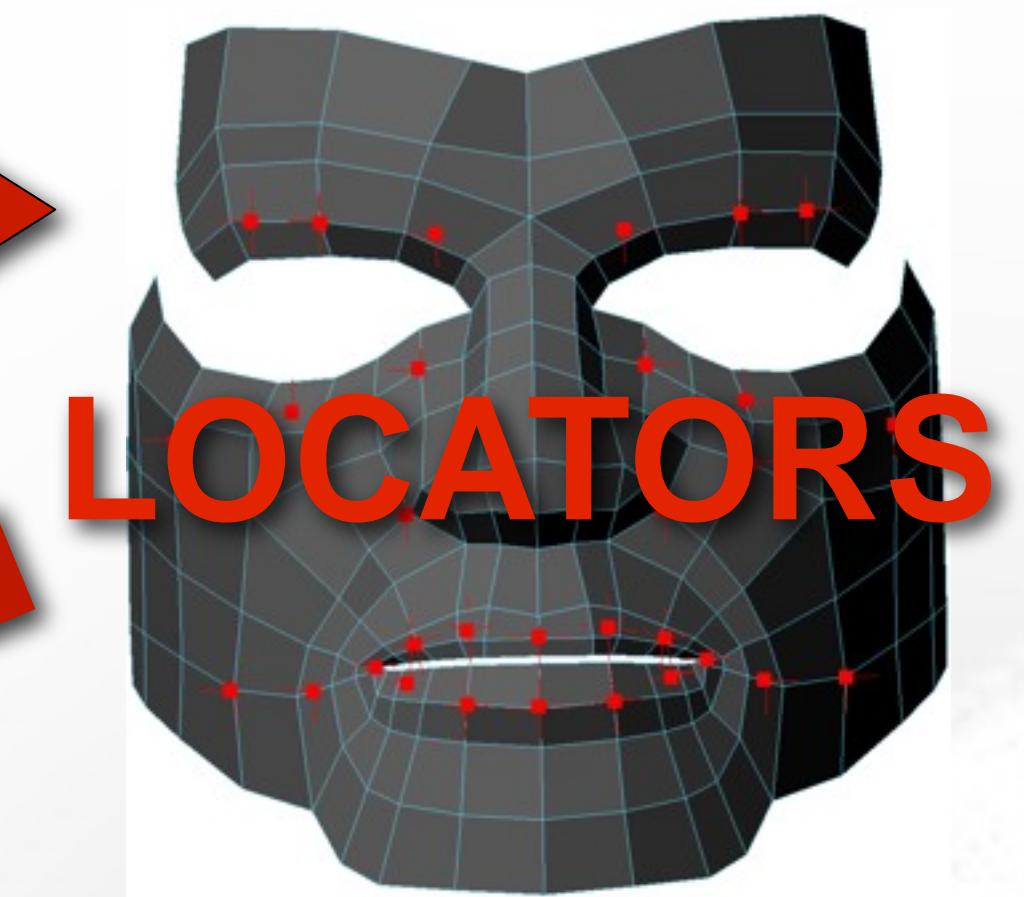
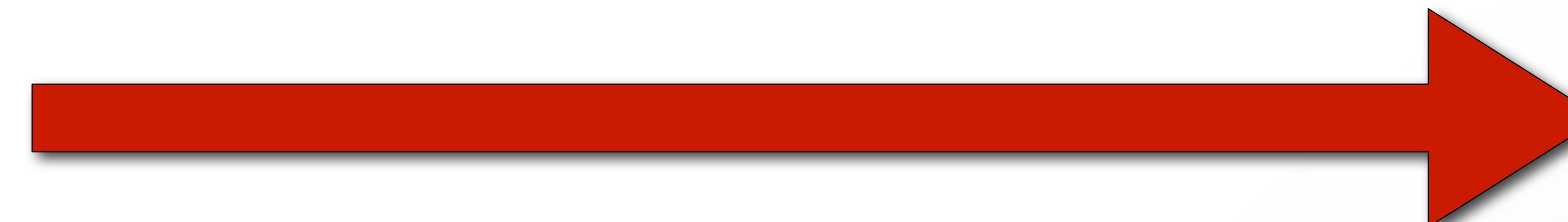
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That brings me to joint placement. Since I've been using the analogy that the locators could be thought of as motion capture tracking, I actually looked a lot at facial mocap setups to see where they placed their markers. I thought that if mocap studios thought an area was important enough to receive a marker, it would probably hold true for my setup as well.

The Rig

Breakdown:



Locators Drive Offset Rig Controls

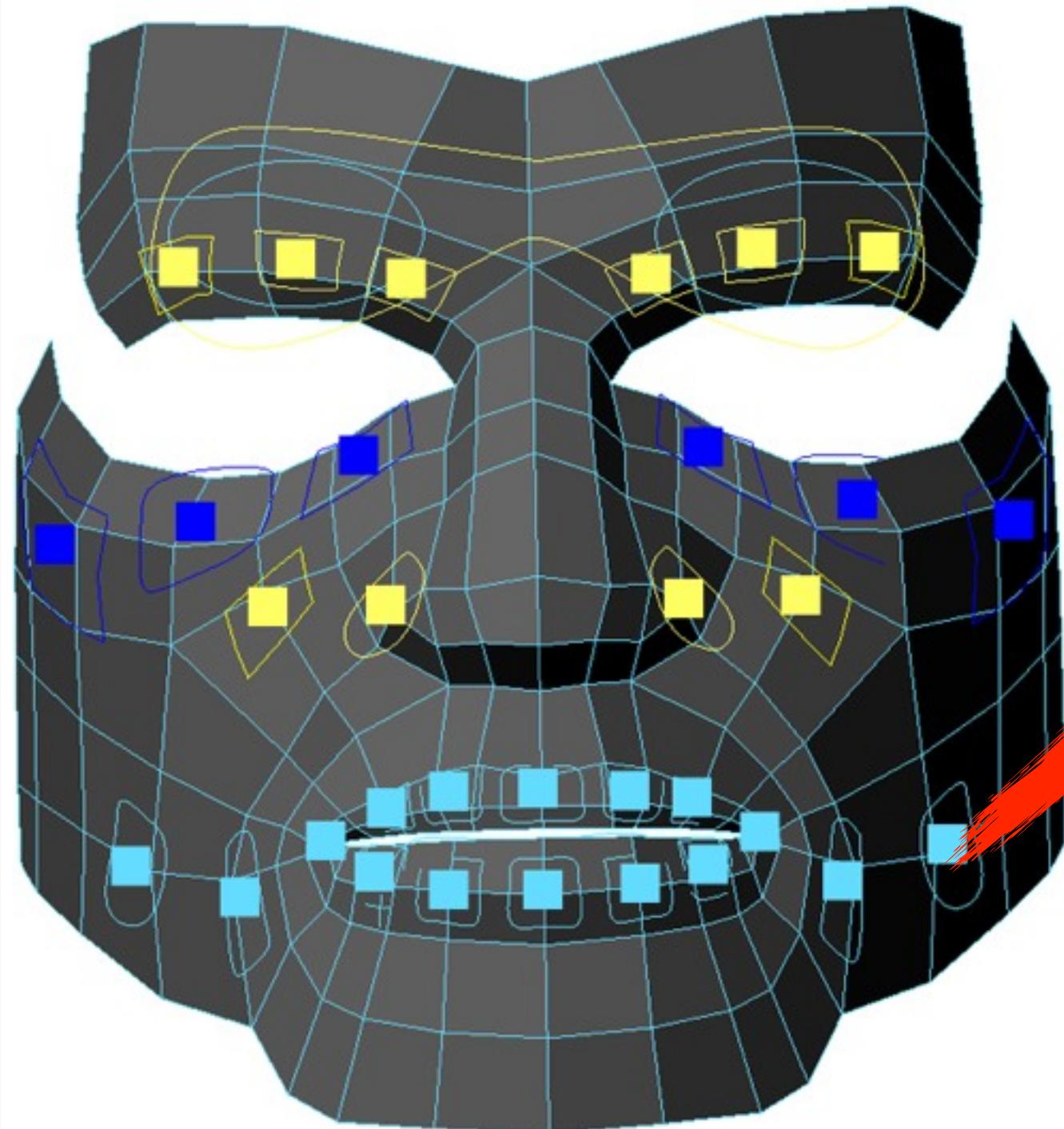
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When the locators move, any associated offset controls will move as well. This is how we actually get a true offset from the pose with the offset rig.

The Rig

Breakdown:



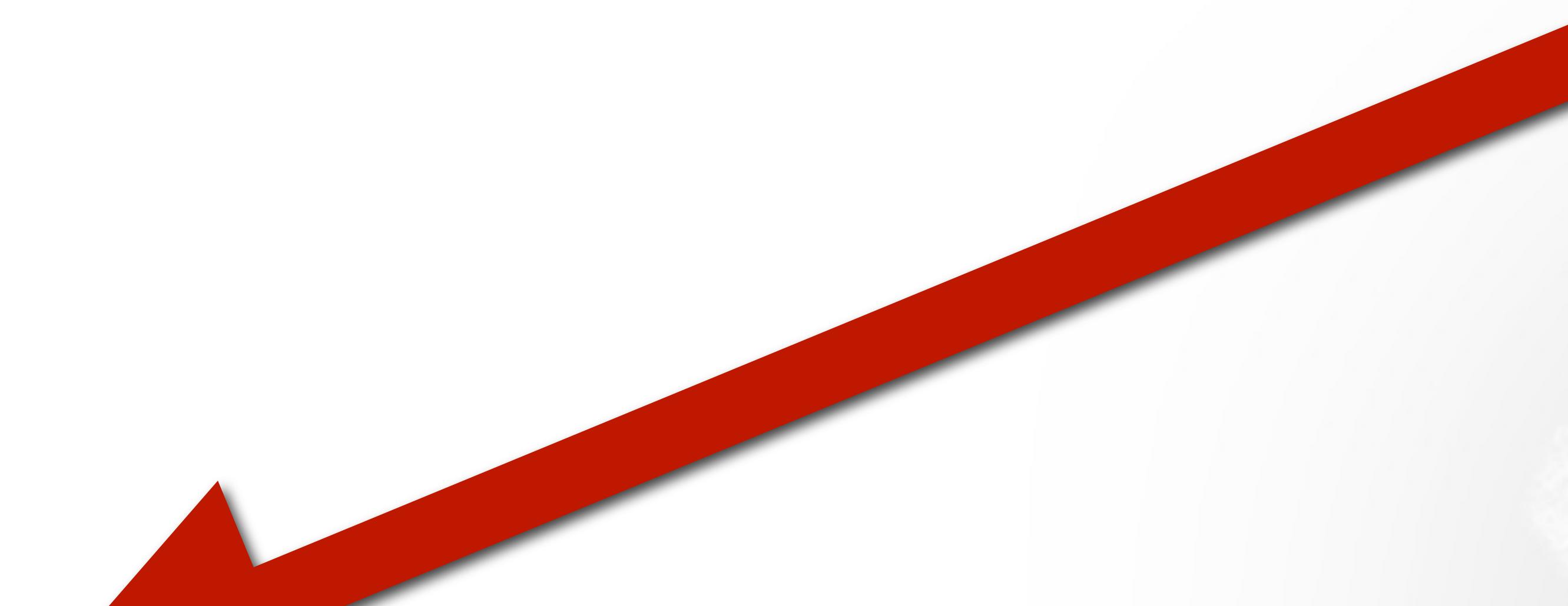
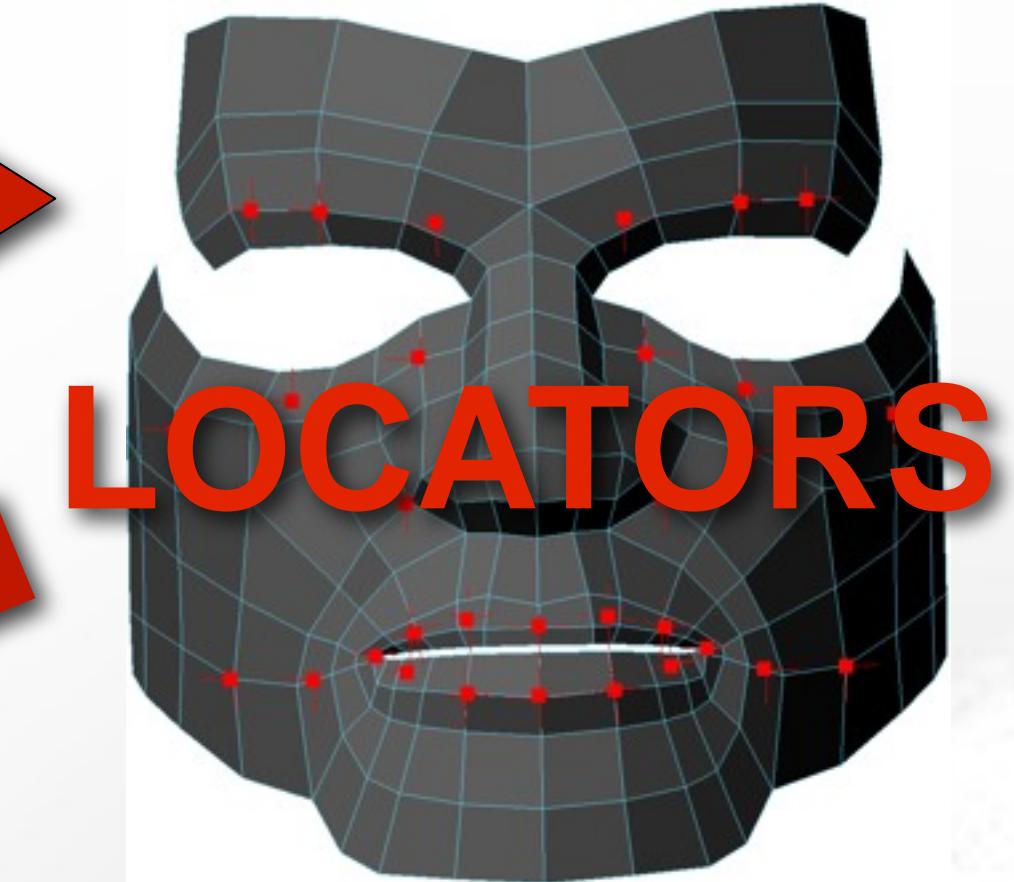
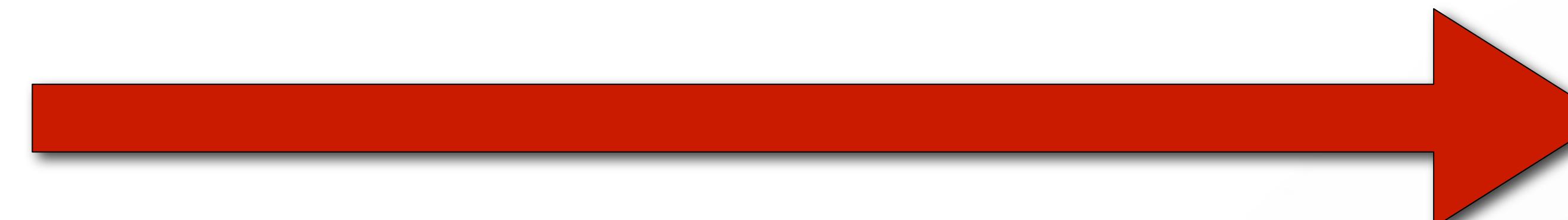
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Let's look at the same area as we did on the locator. The hierarchy is very similar for the offset controls. The GRP node is the parent node that is in the same space as the final joint, and it is also what is parent constrained to the locator. The child of the GRP node is actually the animation control that the animator sees and will animate.

The Rig

Breakdown:



Offsets drive final result



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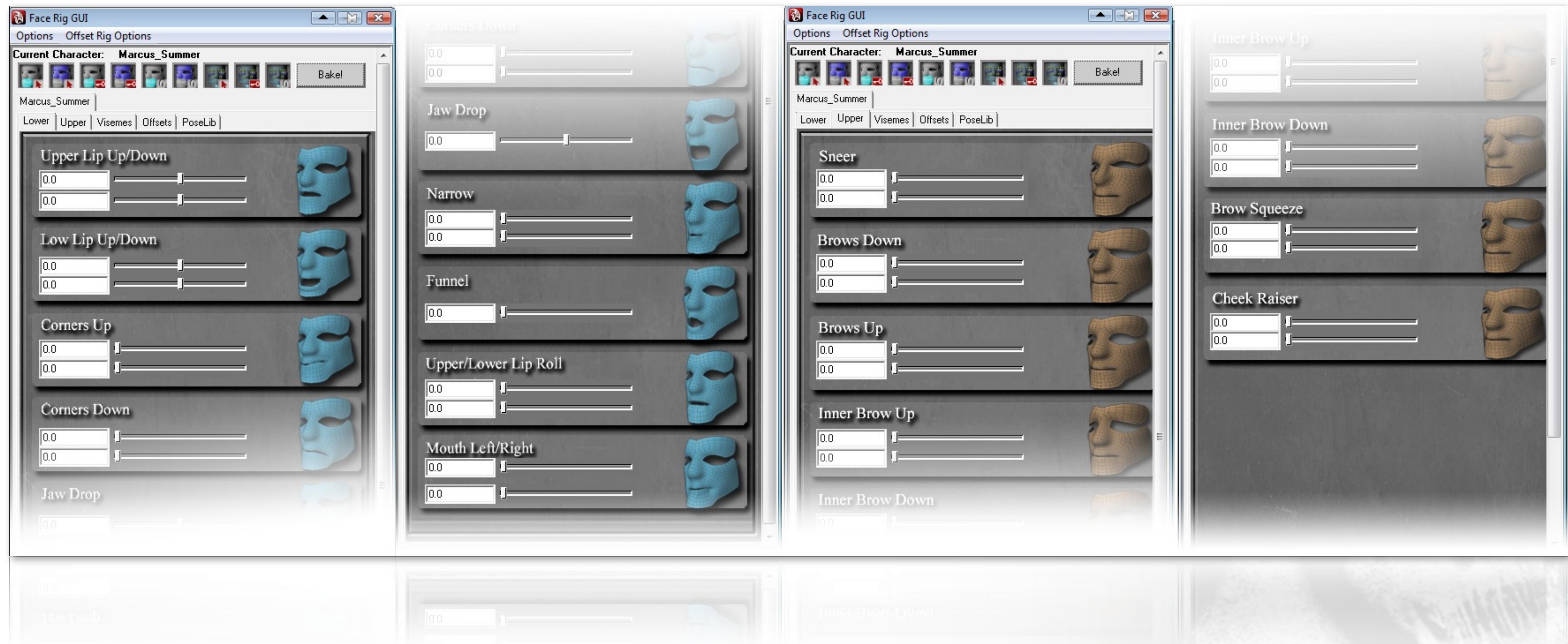
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And lastly, the final joints that the mesh is weighted to, those are parent constrained to the offset rig controls. So when you manipulate an offset control, you are directly controlling the joint. That pretty much wraps all the layers of the rig. But the really cool stuff is still coming up.

The User Interface

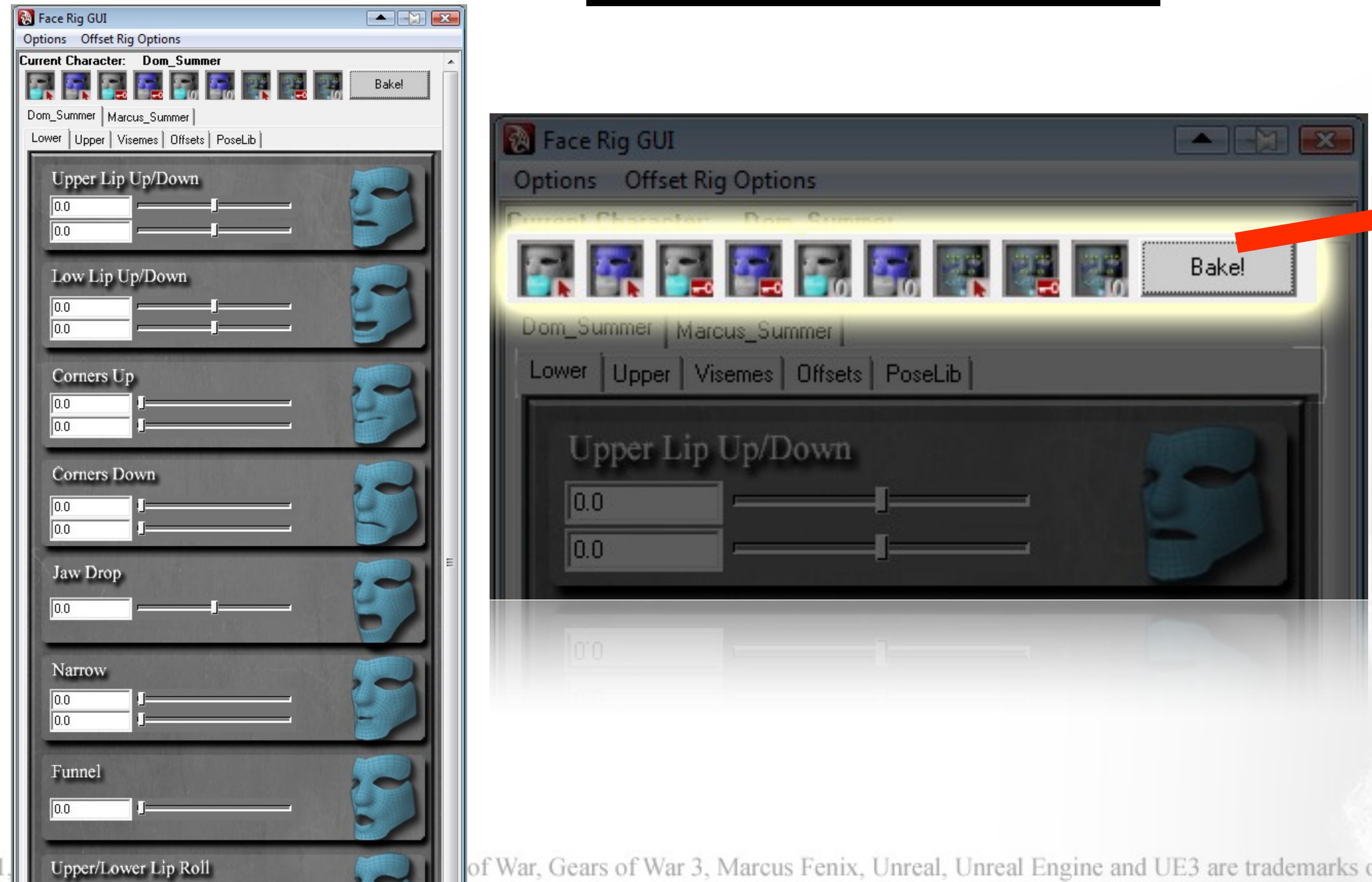


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A quick look at the UI that was built for this facial rig.

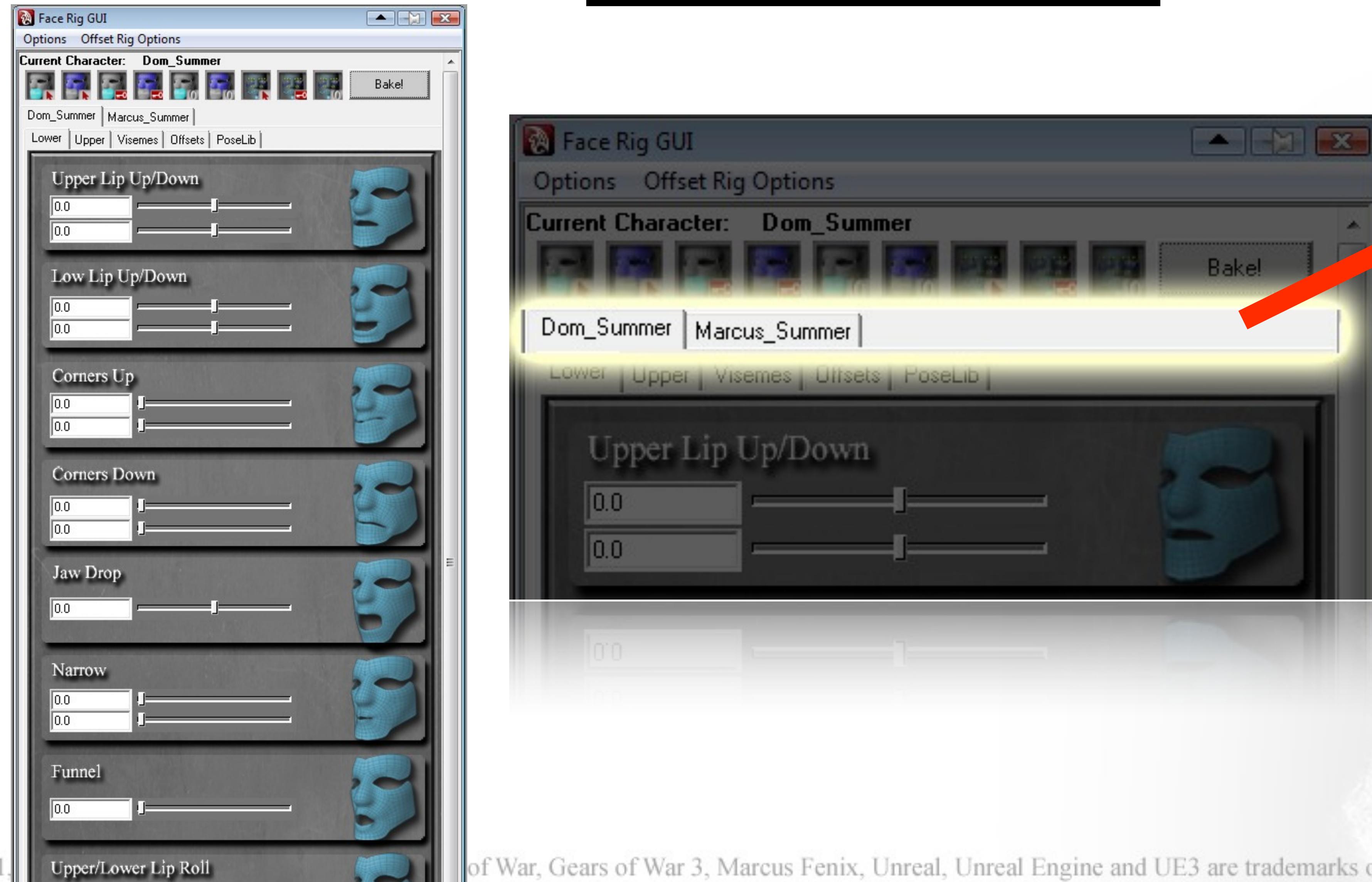
The User Interface



Buttons for Selecting, Keying, and Resetting morph targets and the offset anim controls.

This top row of buttons allows the user to quickly select, key or reset the shapes or offset rig controls. It also has a Bake button to prepare the rig for export into the game engine.

The User Interface



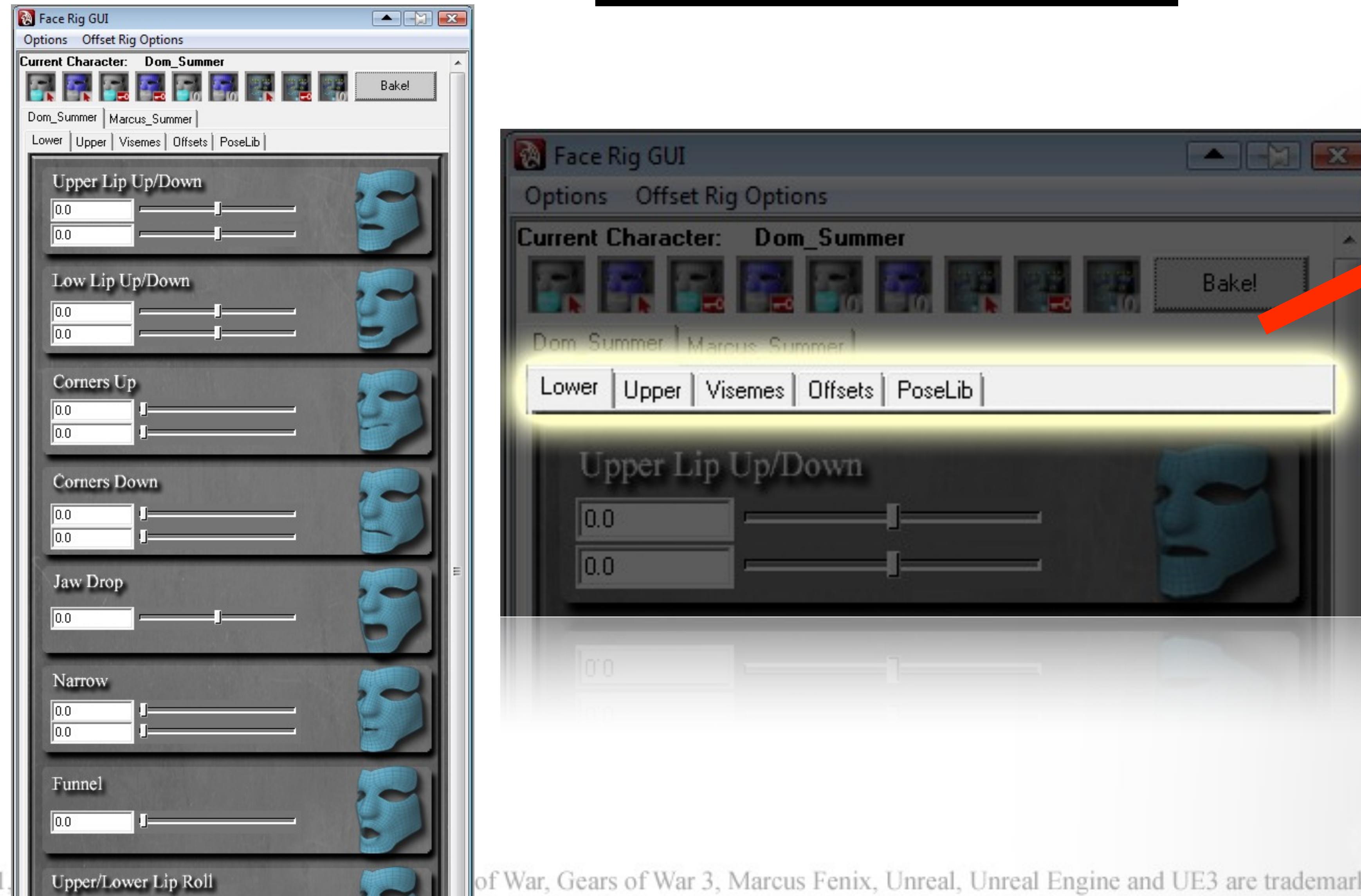
Tabs are created for each character in the scene. Each character tab holds the same sub-tabs

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When the user launches the user interface, it creates a tab for each character in the scene that has a valid face rig. This means that there is only one UI no matter how many characters you have in your scene.

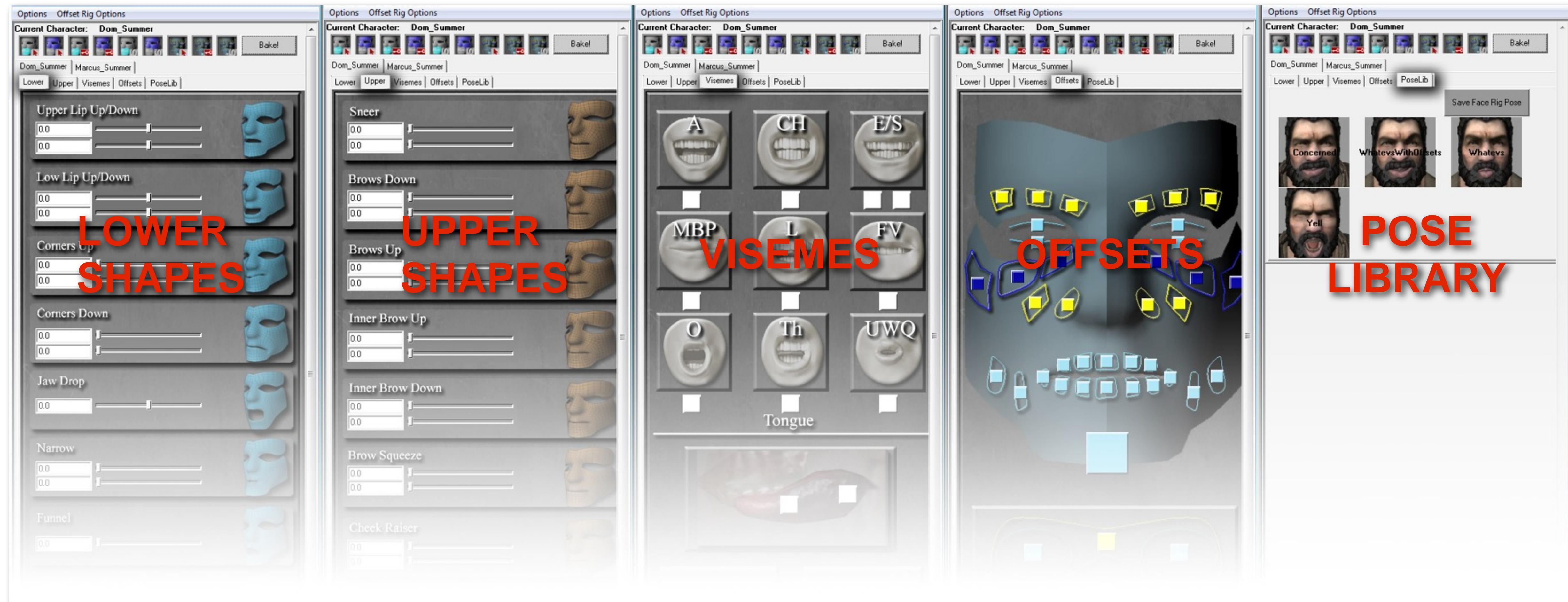
The User Interface



Every character tab contains this set of sub-tabs. Tabs for animating the upper and lower face shapes, as well as a picker for the offset rig.

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The User Interface



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here are all of the sub-tabs laid out.



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for this video example going over the pose library tool, please visit:

<http://dl.dropbox.com/u/10939513/PoseLibTool.mov>

Easily Transferable



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So now we get to how to transfer this rig to other characters.

Easily Transferable

Steps for Transferring Rig:



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The steps for transferring the rig are very easy. The premise is this, if I create a new cage with the same vert order that matches a new model's face, then I can simply add that as a morph target to the original face rig file and crank it up and viola, the whole rig was just transferred with only needing to make one morph target. By doing it this way, I transfer not only the rig, but the pose library itself. Since the character specific cage morph will be left cranked on for that character, all of the FACS shapes(the cage morphs) will also be additive to that morph, which means the poses will look correct for that character.



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Please visit the links below for video demonstrations of transferring the rig:

<http://dl.dropbox.com/u/10939513/cagefit.mov>

<http://dl.dropbox.com/u/10939513/cagefit2.mov>



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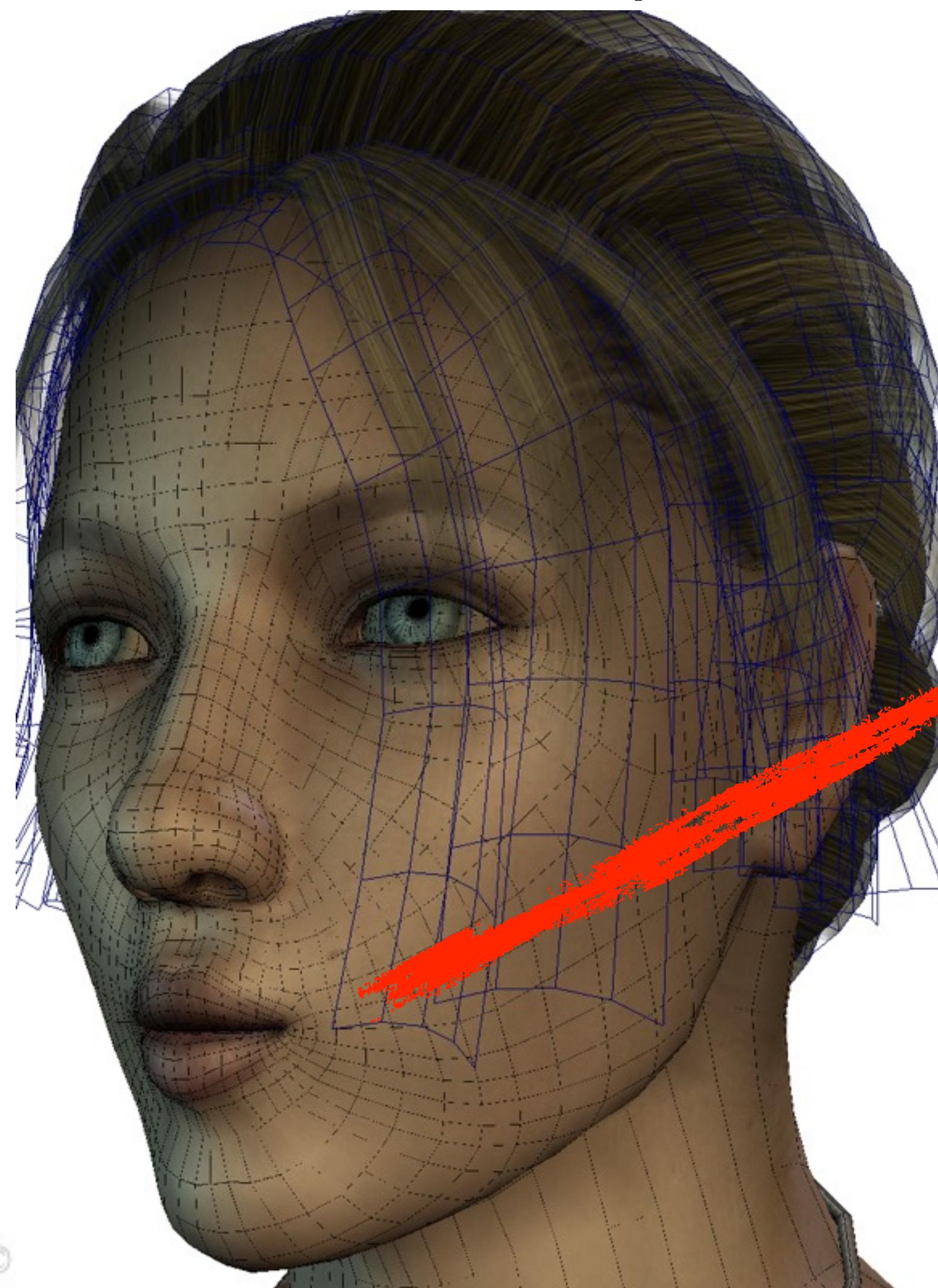
This is a video example of how data can also be transferred from character to character with this setup. Because the animator is animating attributes and offsets, which are relative values and not hard world space or parent space transformations, the data can be shared between characters easily. In this video, Anya is hooked up to Marcus's UI nodes so anytime I animate a slider on Marcus, Anya animates as well. And since the pose library gets fitted to Anya when I make her unique cage morph, even the poses look correct for her.

Video here:

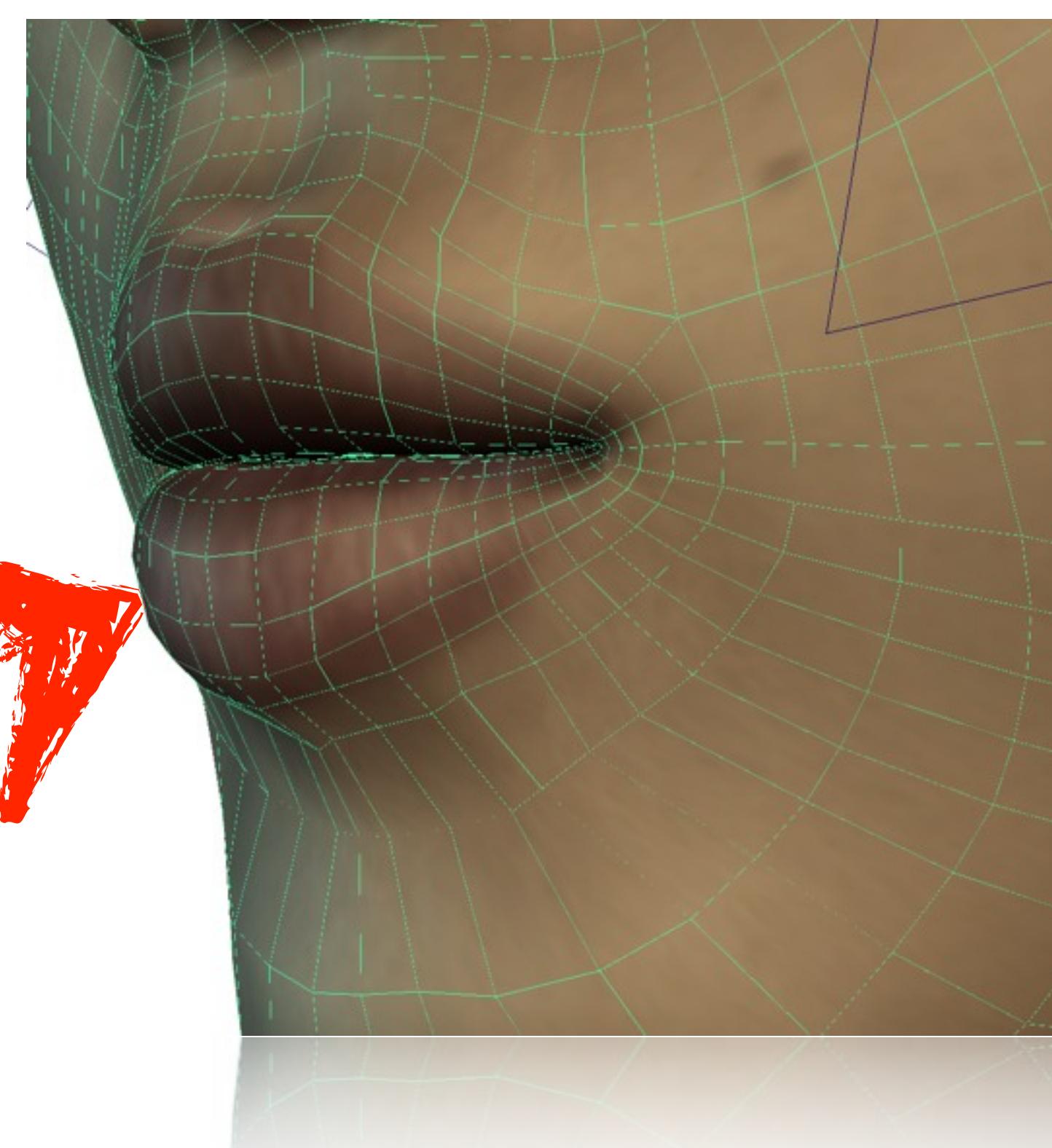
http://dl.dropbox.com/u/10939513/transferData_Marcus_Anya.mov

Polish

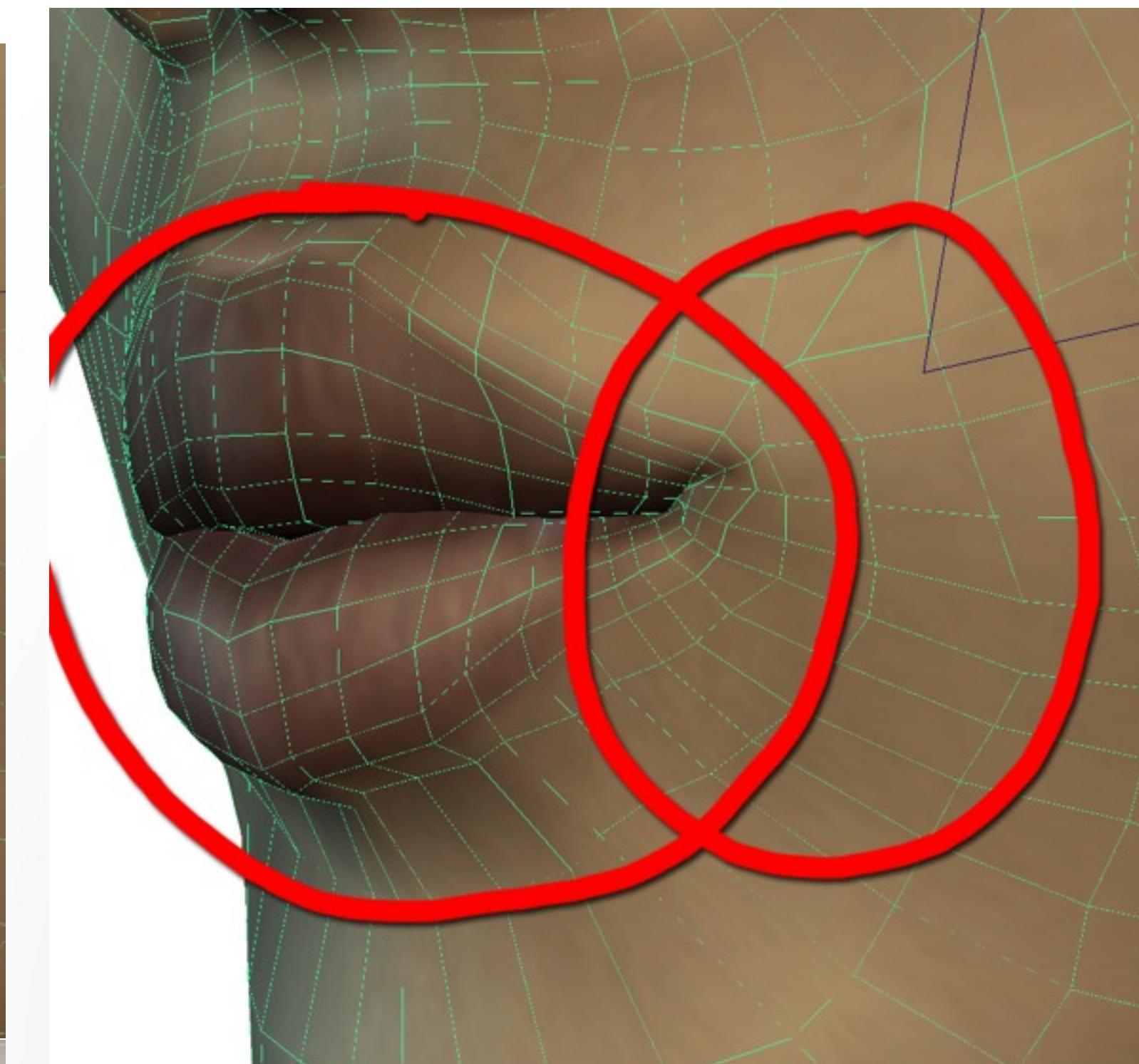
Corrective Morphs:



With the corrective



Without the corrective



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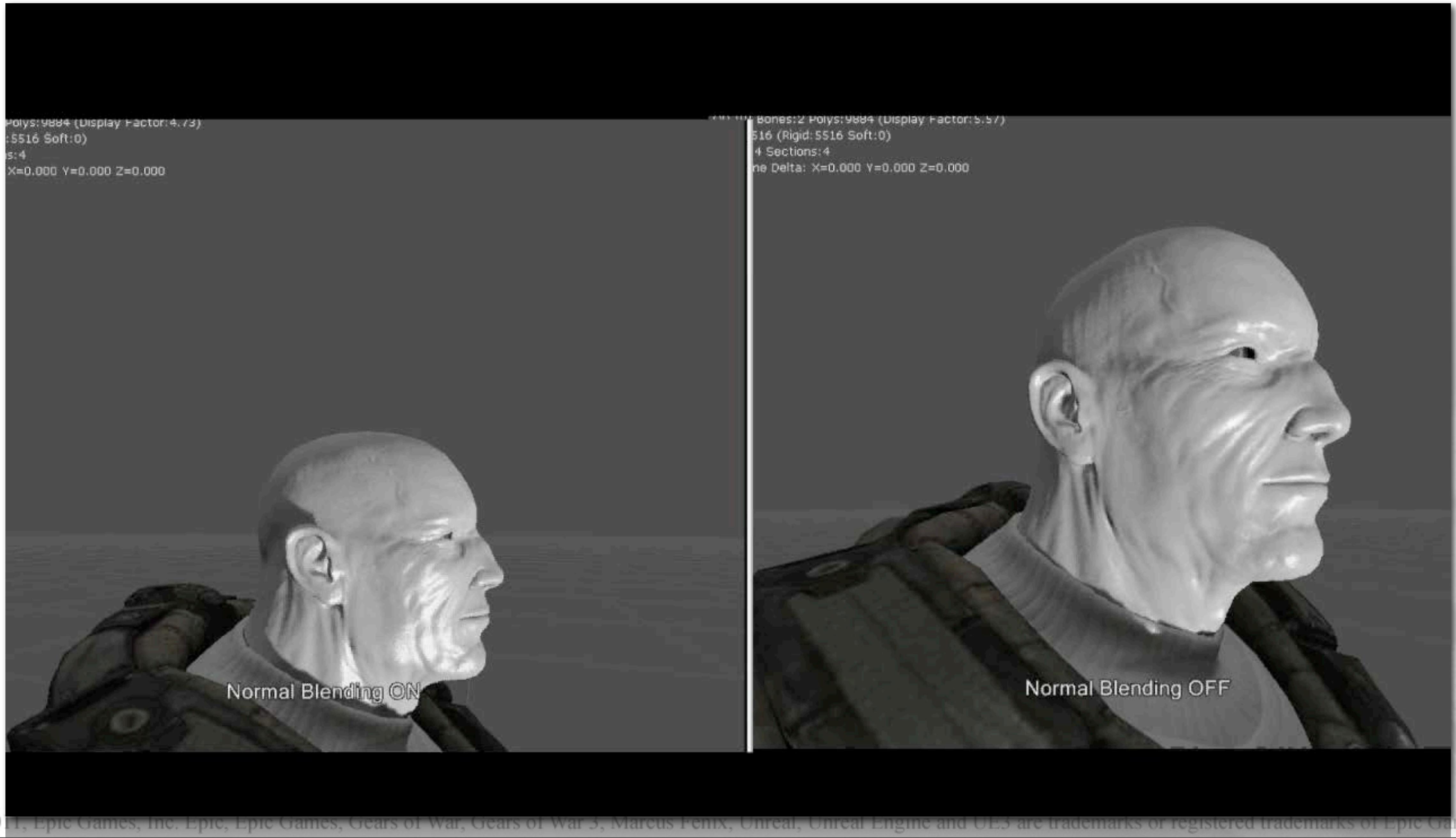
When it comes to polish for our facial animation, we went ahead and used corrective shapes for some of the trickier spots for joint based deformation. The two most common shapes we made were for the lip pucker and the mouth open poses.



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We also created wrinkle maps(normal maps that blend in on key poses to wrinkle or stretch the skin) for our characters as well.



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video of wrinkle maps demonstration here:

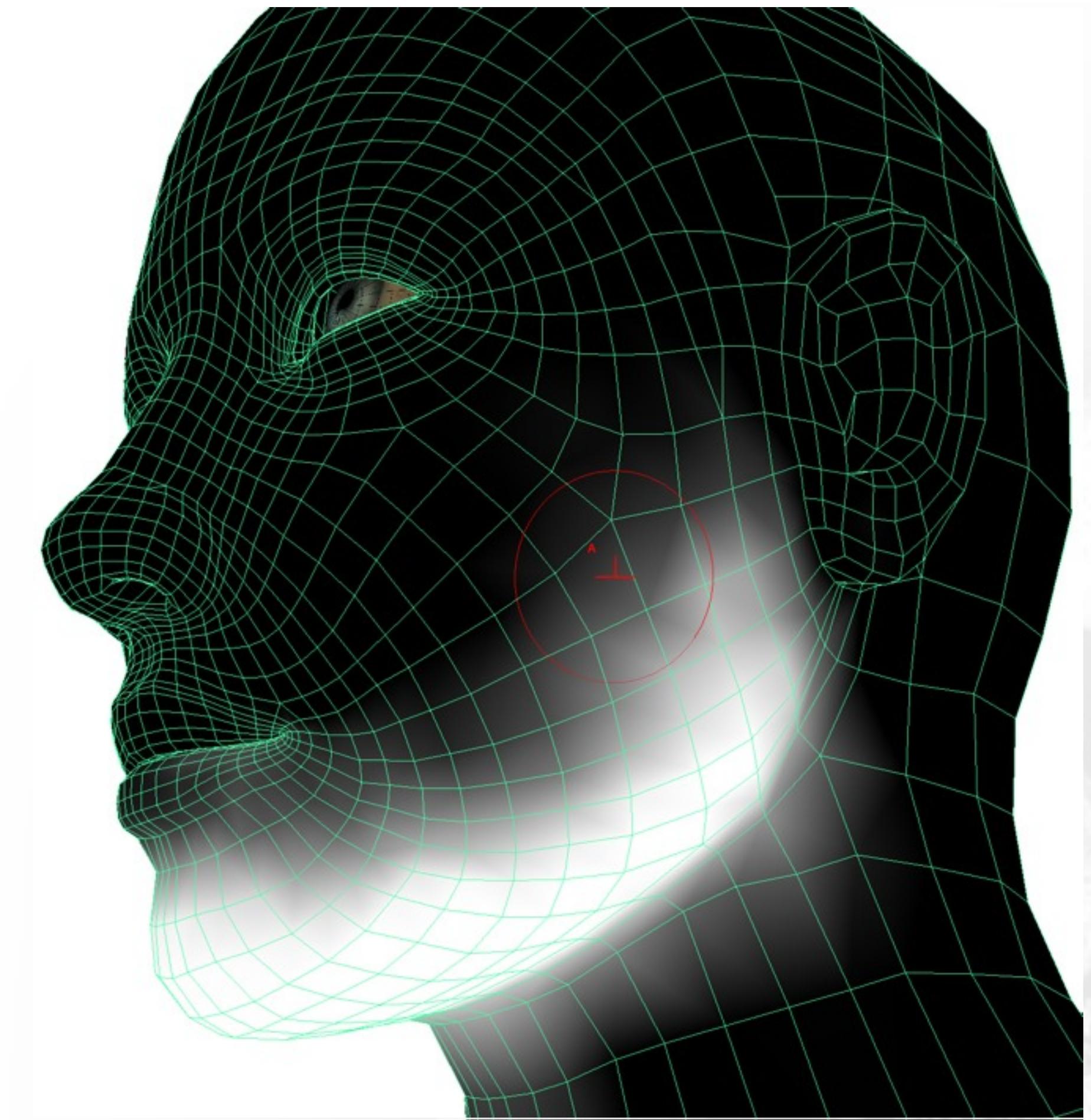
<http://dl.dropbox.com/u/10939513/NormalBlends.avi>

Room for Improvement

→ Skin weighting was a bottleneck

→ Corrective morphs were a bottleneck

→ Future Proofing



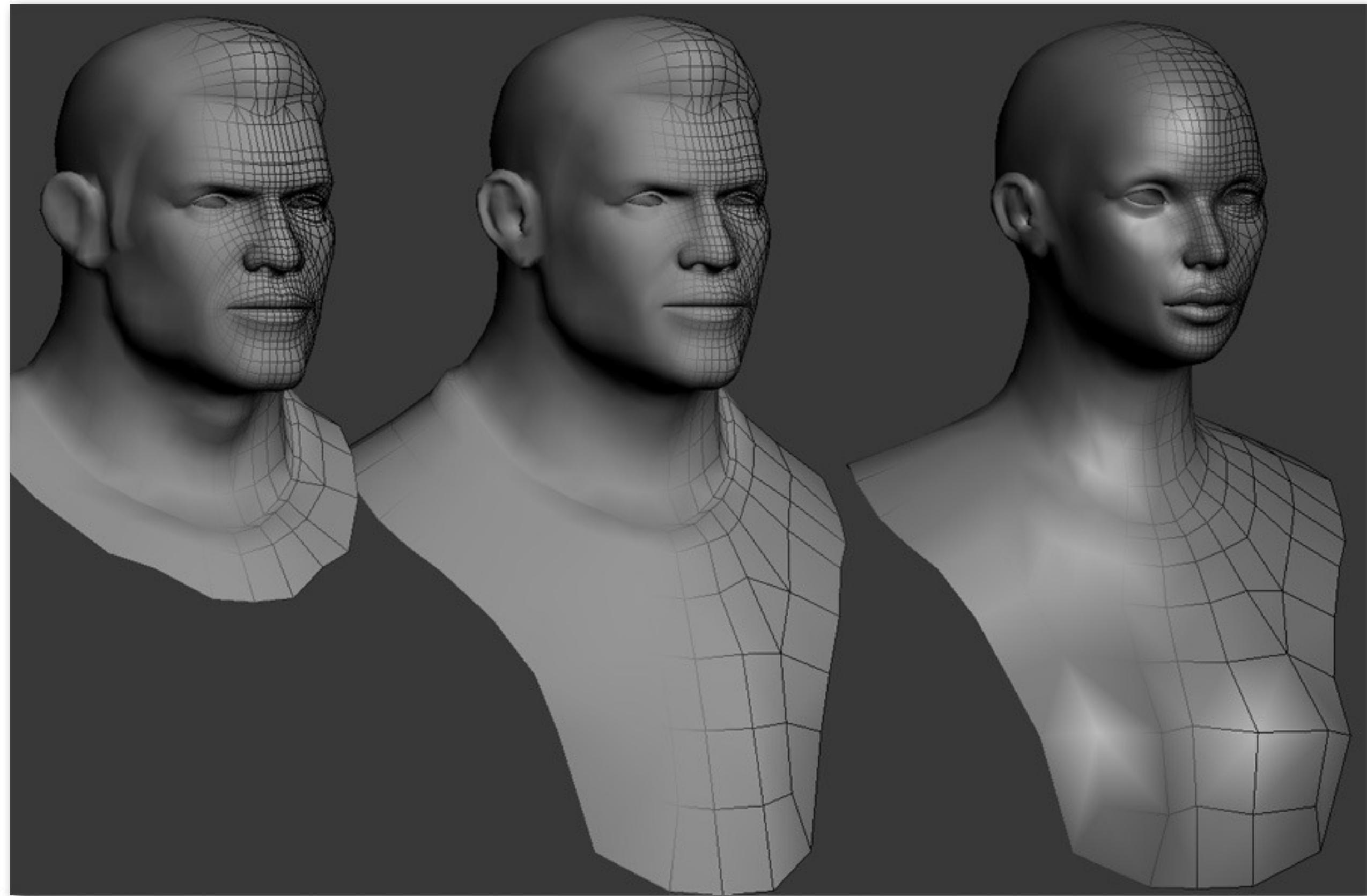
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As the bullet points say, skin weighting and making the corrective morphs proved to be the most time consuming part of the process. We absolutely had to come up with a solution for that.

Room for Improvement

SOLUTION:



Universal Head

Already skin-weighted

Already has morph targets made

Fit universal head to new sculpt

Same technique as Face Cage

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The solution was to use a universal head. This would be a mesh that all characters are generated from. As you can see in the image, it has not been a limitation for the artists. Because of this method, we can skin-weight this mesh, and make all of the corrective morphs for it. If you think about it, this is exactly like the technique used for transferring the face rig. By making a morph for a new character with the universal head, we now get all of the weighting and corrective morphs. This means within 30 minutes of getting a new model, I can have the head weighted, rigged, and corrective morphs made. Huge win.

Questions?

Contact: FaceRigTalk@gmail.com



A black and white portrait of a man with a beard and short hair, wearing a dark suit and tie. He is looking slightly to the left.

Jeremy Ernst
@Epic_Ernst Cary, NC
Character Rigger @ Epic Games.

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Wednesday, March 30, 2011

This was the abridged version of the talk, but I mostly cut on things that had lots of video examples or demonstrations. I included as many as bandwidth would allow for :)
If you have any questions, email me at the address above or send me a line on twitter.
Thanks!