

Human Head Modelling For Facial Animation

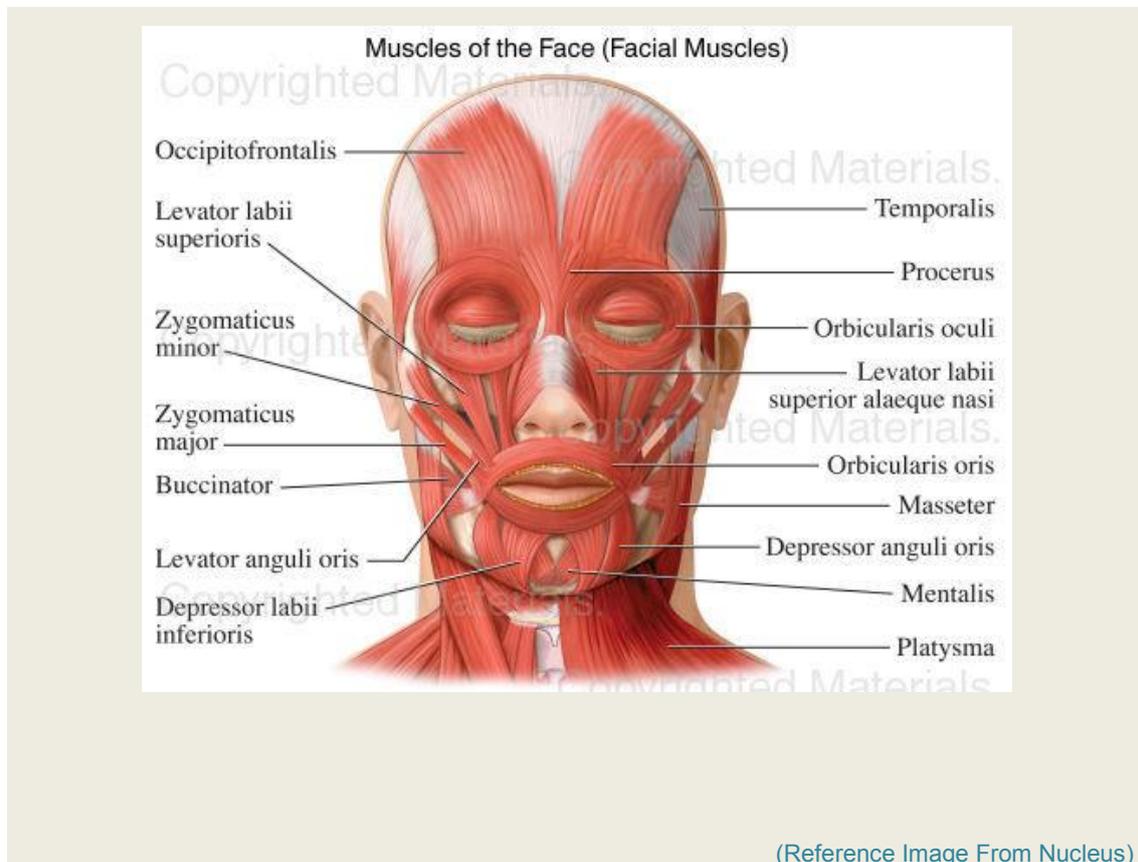
There are a lot of differences to do head modelling for different industry purpose, for example, in animation film, no matter what kind of style this film might be, it is always essential to apply enough surfaces and arrange every single line properly, or else characters cannot perform vividly to show all kinds of expressions. On the other hand, when doing modelling for games, sometimes due to the game engine's limitation, the modeller only needs to give one's model the shape of a head; this kind of head model will not be animated by animation tools at all. In this poster, I will talk about head modelling for facial animation purpose, which excluded the second situation.

Observation and Understanding of Facial Muscle

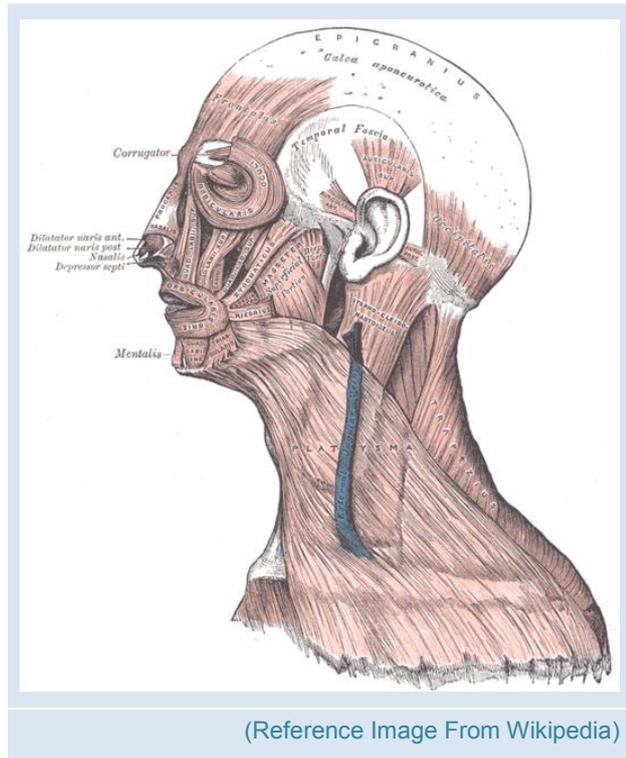
"How facial muscles work:

Imagine a thick sheet of foam rubber lying on a table, with strings attached to its underside. When one or another string is pulled, part of the sheet slides and wrinkles. The strings are invisible to us - all we see is the wrinkle on the surface. To get it exactly right we must study the outside shape of the sheet, possible also the table, but not the strings themselves"

(Steven ,2005)



Facial expressions are created by facial muscles, which usually grow from skull and insert into the skin of face. However, some of the facial muscles are not attached to bones but simply placed under soft tissue, and they permit large variety of expressions.

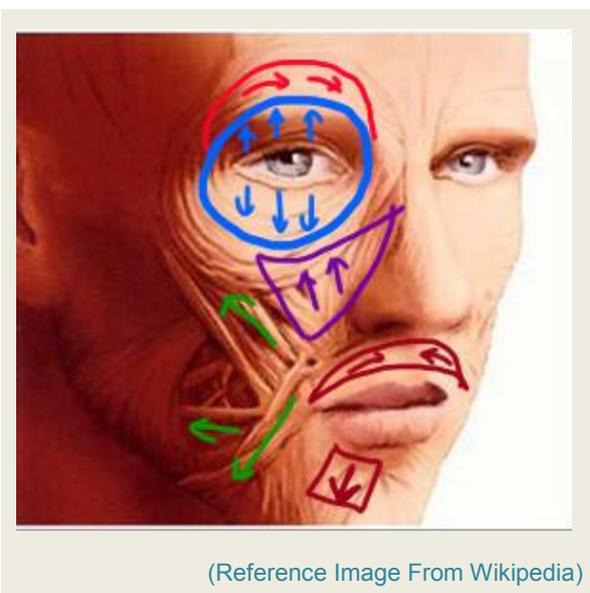


(Reference Image From Wikipedia)

From the picture on the right we can see facial muscles are groups of slim fibres beneath our skin working under innervations of facial nerve. Even though masticatory muscles are in charge of controlling jawbone to open and close our mouth, they are driven by different nerves

called mandibular nerve. When facial muscles are innervated, they pull facial skin to the point they grow on skull, and then create different facial expressions to show one's emotion. Due to different habits from person to person, sometimes it is quite easy for one to control part of one's facial muscle, however, it might be difficult or even impossible for another person to do the same thing.

The most active muscles on human skull grow around our eyes and mouth. These two parts of muscle groups work primarily to create facial expression, while other muscles are driven or influenced by them.



(Reference Image From Wikipedia)

Muscles around eyes control movements of forehead skin, eyebrow and eyelid. Not only do they create expressions like frowning or blinking, but also provide protection for our fragile eyeballs from both outside attack or inside change of air pressure basing on instinct. From this picture on the left side you can see there are three groups of muscles there, working in different directions. Around our eyes there are Orbicularis oculi muscles that grow from the eye's inner corner that's near the nose and it ends near the ear. The upper parts work closely with corrugators to control eyebrow, while the lower parts are attached to the cheek.

Muscles around our mouth usually help in the process of moving lips, talking or chewing. This part contains fibres from different muscles, some come from muscle on the cheek, and some start at the jaw. That's why their movements are in different directions and can show various combinations of skin movements.

How to simulate facial muscle with 3D geometry

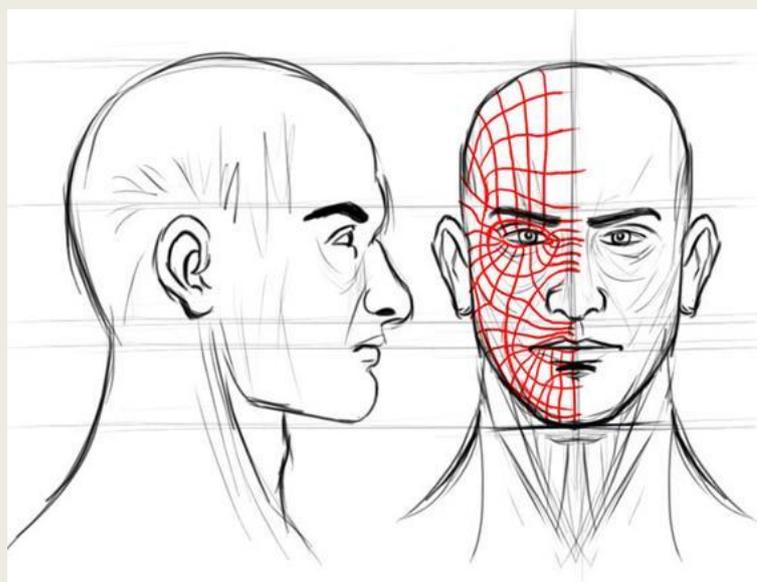
Human skeleton and muscle system are quite complicated, if modellers do things like building the skeletons first, then adding muscles and skin, it will take a long time for someone to make a model. In order to work with efficiency, nowadays people use 3D geometry to simulate the relationship between muscle and skin, by using lines and points to define the direction of muscle movement, modellers can work better and faster than before.

Before start modelling, it is important to know what kind of character is going to be modelled. With sketches or photos from both front view and side view, it is possible to find out the size and proportion of this character. Modelling a character that can be animated is quite different from one for sculpture purpose, it is important to understand connection between skeleton, muscle and skin, although it is not necessary to build them all. In this picture we can see different pieces of geometry are linked together by circles around them, and when the points that define the direction of those circles are pulled in certain way, geometry move too. This is also the reason why after having sketches or photos, it is better to draw the topology first.

How To Draw Topology

Correct topology (the way a surface is structured) is the single most important aspect of head modelling. We'll be creating special topological structures, known as 'edge loops', which outline areas of the face and mimic the rings of muscle under the skin. Without proper loops, a head will be difficult to animate. We'll also be making sure all the polygons have four vertices (called quads). A mesh of all quads is less likely to pinch when smoothed and animated.

---Model The Perfect 3D Face

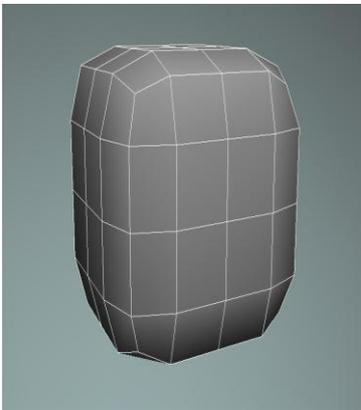


(Reference Image From 3D2Dizayn)

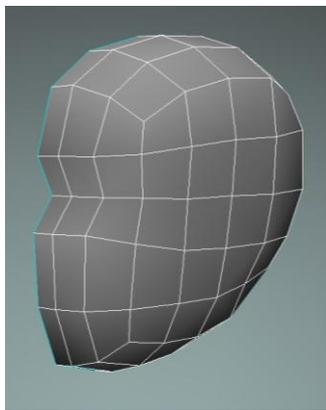
After the preparation step, we load in the reference and start modelling. There are many ways to do modelling, but only two are generally accepted. One is to draw curves on topology and then create surfaces between them; another is by adding details to one cube or sphere to give it the shape of a human head. There are advantages and disadvantages of both methods. For the first one, it is hard to control the whole shape from beginning because it starts from details, while the second one defines outlines first, leaving correct topology to be created.

Here are the steps I did with Softimage to do head modelling

1. Create the basic shape of human head from one cube by adding edges.



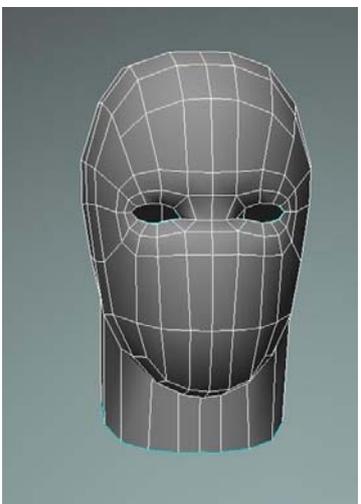
2. Cut this cube into two and block out the overall shape of human head.



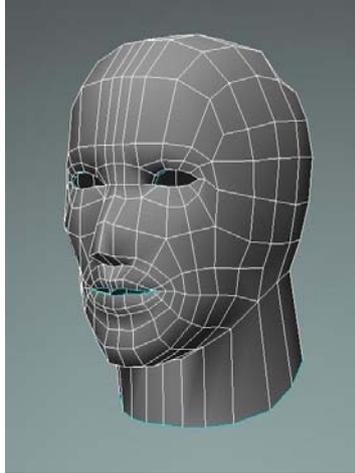
3. Use duplicate symmetry command to create another half, then create eyes.



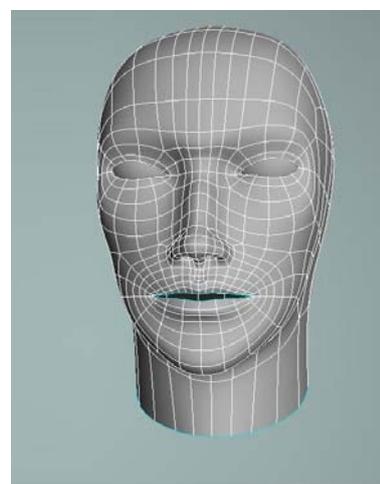
4. Add more edges but always try not to have triangle surface.



5. Focus on edge loops around eyes and mouth for right topology.



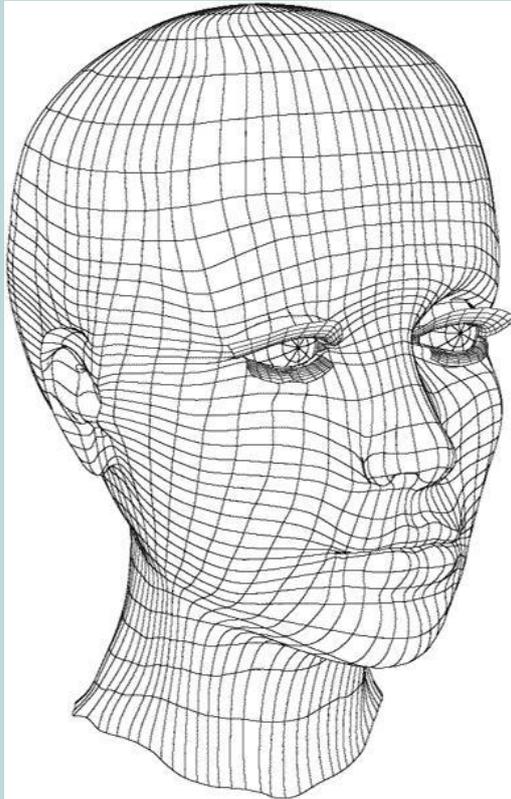
6. Double check the topology first, details can be added later.



How topology works in facial animation

It is easy to find out what kind of model is good for animation and what is not from details. Now that we know the most active parts of human facial muscle are around eyes and mouth, it is easy to understand why there must be enough curves to define how muscles move. It is always the structure of muscles that affect the movement of skin, and the principle lies under topology.

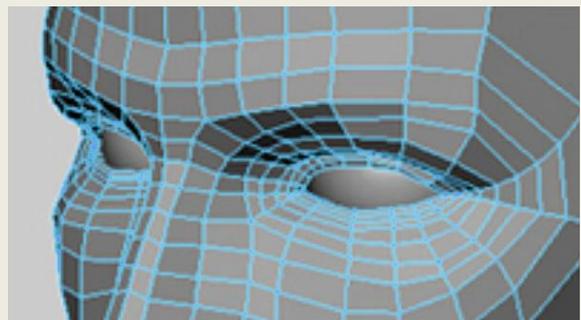
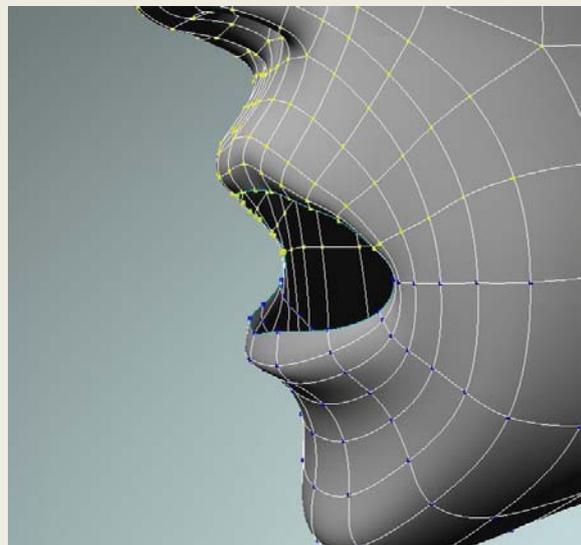
Bad Example



(Reference Image from 3dRender)

In this model, curves are not circling the mouth, which means polygons at mouth corner will be extremely stretched when it is open. For the eye part, it will be difficult for her to frown because the eyebrows will look quite weird.

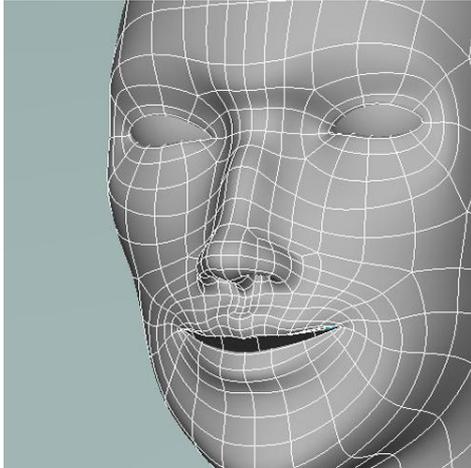
Good Example



(Reference Image from 3dTotal)

For animation purpose, there must be at least 3 lines in the corner of mouth and eyes, what's more, without enough circles around, facial expressions may look quite rigid.

Here are pictures to show how topology works on my model

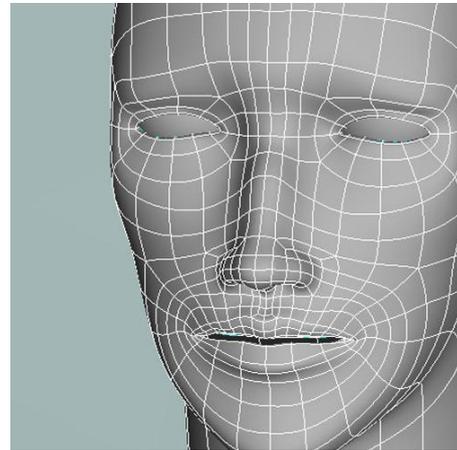


Happy :

Eyes become bigger and eyebrows raise, mouth corners are lifted and muscles on cheeks become short than without expression.

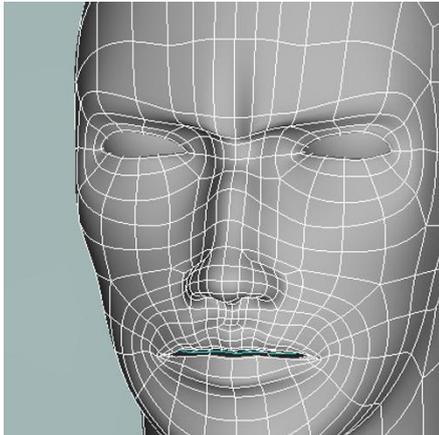
Sad :

Narrowed eyes and the eyebrows are pulled together with raised lower eyelids and stretched lips.



Annoyed :

Lowered eye brows that are pulled together to form wrinkles in forehead skin, tensed lower eyelids and lips show the angry expression.



Some of the references I quote in this post were right 10 years ago, today they are still useful for beginners, but just not good enough for animation. With development of technology, there are always better tools to try. As long as modellers know how to do observation and researching, by practicing it is not difficult to use any kind of software.

Reference

This tutorial shows how to model female head, but the topology is really good for male too.

Antti, L., 2007. *3D Modelling a Human Head*. Second Picture. Available from: http://www.secondpicture.com/tutorials/3d/3d_modelling_an_eye_socket_in_3ds_max.html [Accessed 5 May 2010].

From this PDF I learnt how to do modelling from drawing the profile.

Future Publishing, 2008. *Model The Perfect 3D Face*. England: Future Publishing. Available from: http://www.computerarts.co.uk/__data/arts_pdfs/cap56_3dface.pdf [Accessed 5 May 2010].

This character was done by MAYA by extruding polygons piece by piece, and I learnt another way to do modelling from it.

Hatice, B., 2009. *Head Modelling in 3ds max*. 3d2dizayn Team. Available from: <http://www.cgarena.com/freestuff/tutorials/max/headmodelling/index.html> [Accessed 20 Apr 2010].

This tutorial has a lot of details and is quite helpful for modelling.

James, M., 2005. *Modelling a Female Head tutorial*. Free 3D Tutorials. Available from: <http://www.free3dtutorials.com/modelling/maya/modelling-a-female-head-tutorial.php> [Accessed 5 May 2010].

This is one very old tutorial. It used curves to do modelling. From this one I found how modelling method has changed during the past years.

Jeremy, B., 1996. *Nurbs Head Modelling*. 3D Render. Available from: <http://www.3drender.com/jbirn/ea/HeadModel.html> [Accessed 1 May 2010].

From this page I found some information about how emotion affects facial expressions.

Joseph, C., 2003. *Theories of Emotion And Emotional Expression*. Corel Corp. Available from: <http://www.face-and-emotion.com/dataface/emotion/theories.jsp> [Accessed 12 May 2010].

This is one medical site from where I found some useful images of facial muscles.

Nucleus Medical Media, 1999. *Adult Skull 3D*. Georgia: Nucleus Medical Media. Available from: <http://catalog.nucleusinc.com/generateexhibit.php?ID=2436&ExhibitKeywordsRaw=&TL=&A=2> [Accessed 20 Apr 2010].

In this article, the writer told us how to do modelling by comparing good and bad examples.

Phung Dinh, D., 2008. *Realistic Human Face Modelling*. Available from: http://www.phungdinhdung.org/Studies_paper/Realistic_face_modelling.shtm [Accessed 10 May 2010].

This is another site for facial muscle reference.

Smart Imagebase, 1999. *Muscles of the Face*. Ipswich: EBSCO Publishing. Available from: <http://ebSCO.smartimagebase.com/muscles-of-the-face-facial-muscles/view-item?ItemID=9300> [Accessed 20 Apr 2010].

From this PDF I found how muscle connects to bones and skin.

Steven, S., 2005. *Character Modelling*. Australia: Balistic Publishing.
University of Colorado, 2005. *Muscles of Facial Expression*. Colorado: University of Colorado. Available from: <http://www.colorado.edu/intphys/iphy3415/oia3e.pdf> [Accessed 10 May 2010].

From this page I found some basic information of facial muscle.

Volker, b., 2008. *Facial Animation and Modelling*. Germany: Mzx-Planck-Institut. Available from: <http://www.mpi-inf.mpg.de/resources/FAM/> [Accessed 5 May 2010].
Wikipedia, 2009. *Facial Muscles*. England: Wikipedia. Available from: http://en.wikipedia.org/wiki/Facial_muscles [Accessed 2 May 2010].