3D Face Morphing Tutorial

by Fred Lewis at MOVING MEDIA
(www.movingmedia.com)

Note:This tutorial assumes a basic working knowledge of ElectricImage™, including how the Project window works, what Groups are and how to animate Group parameters, such as position, orientation, scale, etc. using keyframe animation. If you are not familiar and comfortable with these things, please try more basic tutorials before doing this one.

Overview

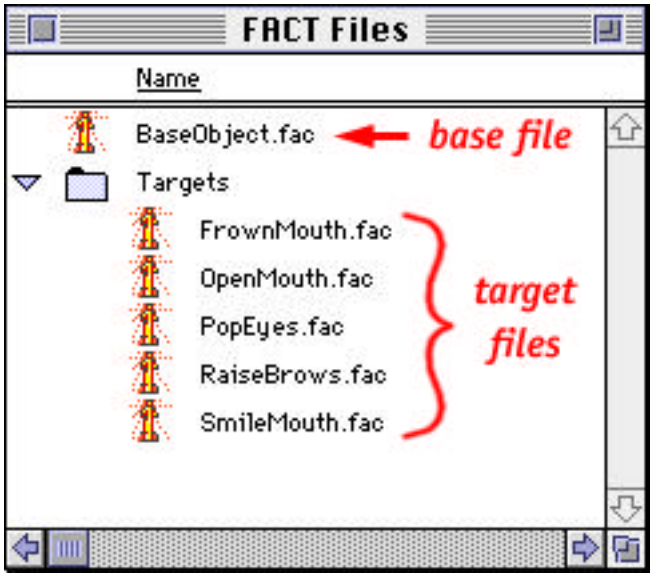
From version 2.8 on, ElectricImage™ has a new "3D Morphing" feature. This type of morphing has a variety of uses besides what most people traditionally think of as "morphing". In fact, I prefer to call it "vertex interpolation" rather than "morphing" but to minimize confusion I will call it "3D Morphing" in this tutorial. 3D Morphing is like ElectricImage's other feature for changing shapes over time, Deformation, in that it changes the shape of the Groups that it has been applied to over time. But unlike Deformation, 3D Morphing changes the shape of the Groups it is applied to, based on the shapes of other "Target" Groups that you have created in advance specifically for this purpose, in your modeler. 3D morphing is very useful in a wide variety of situations, ranging from animating a characters' facial expressions, to changing one object into another object (actual morphing), or just making some small but very specific change to an object's geometry over time in ways that might be difficult with Deformation... Often, 3D Morphing is used in ways that are so subtle that the audience will never even be aware that an effect was used. For example, in an animation of a machine, a few vertices in part of the machine might need to move slightly to allow it to fit into other parts of the machine during the animation. Such precise adjustments might be difficult using Deformation because the objects must fit together so precisely. In cases like this it is often much easier to make the changes in your modeler and then use 3D Morphing instead of Deformation.

Not just anything can be morphed into anything using 3D Morphing. For one shape to be morphed into another shape, there must be certain similarities in the way the geometry of each shape is stored, internally in the FACT file. This limitation and how to deal with it are explained later in this tutorial, under “How to Create 3D Models That Work With 3D Morphing”. For now, we will concentrate on the fun part: creating an animation using 3D Morphing.

One of 3D Morphing’s most useful applications is animating 3D facial expressions in character animation. The 3D Morphing in ElectricImage 2.8 has been optimized specifically for this kind of animation. Various facial expressions are modeled (or “sculpted”) in 3D in advance and then 3D Morphing is used to interpolate between the facial expressions over time. In this tutorial, you will learn how to create a character animation of lip-sync facial expressions, using some pre-built facial expressions and animating them using ElectricImage’s 3D Morphing. The pre-built facial expression FACT files were created specifically for this tutorial and have important characteristics which allow them to work with 3D Morphing. These characteristics, and how the facial expression Groups were created, are explained later, under “How to Create 3D Models That Work With 3D Morphing”. But first, let’s create an animation in ElectricImage, using these pre-built facial expression files.

Part 1: Setup

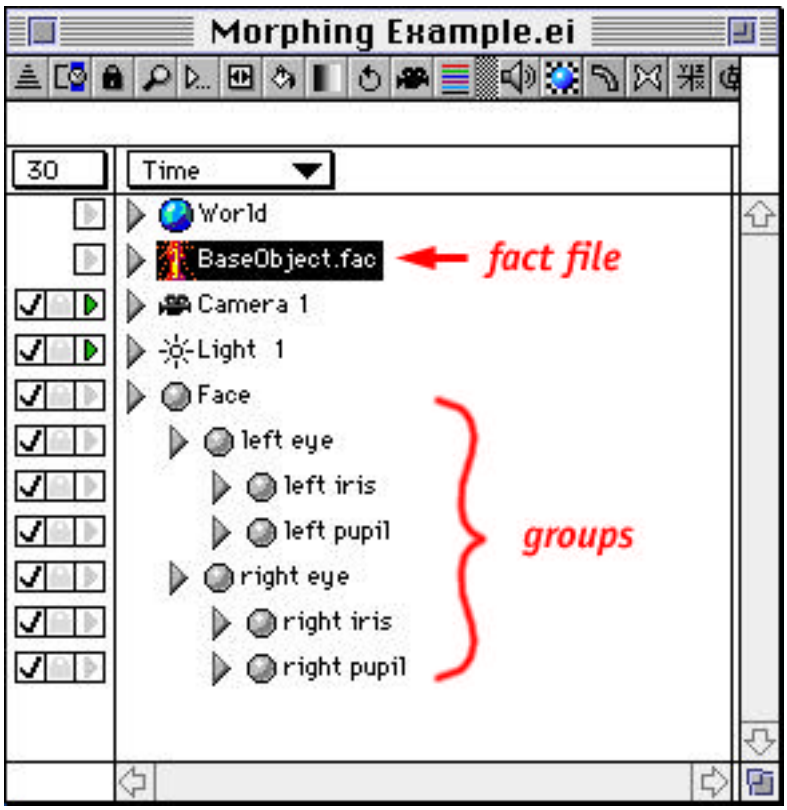
In the 3D Morphing Tutorial folder, there is a sub-folder called “FACT Files”, containing several FACT files that are each a model of a 3D face. The FACT file, “BaseObject.fac”, is a model of the face at rest, with its mouth closed. The other files, in a sub-folder called “Targets”, are each a model of the same face with specific changes made to its expression.



The Base file is the file you will import into ElectricImage and apply 3D Morphing to, to change its shape. Our Base file in this tutorial is a hierarchy of Groups, consisting of the skin of the face as the parent group and the eyeballs as child Groups. All of these Groups in the hierarchy can be morphed at the same time by a single morph operation. The advantages to morphing a hierarchy include the ability to set separate materials and textures for each Group, animate Group parameters such as position, scale and orientation, and apply Deformations separately to each Group in the hierarchy.

Start by creating a new project in ElectricImage and add the “BaseObject.fac” FACT file to the project. This will be the only FACT file you will add to the Project window so, once the file is added, click the “Done” button in the Add dialog and you will see a Group called “Face” which has child Groups for its eyeballs, in the Project window. Near the top of the Project window, you will also see an icon

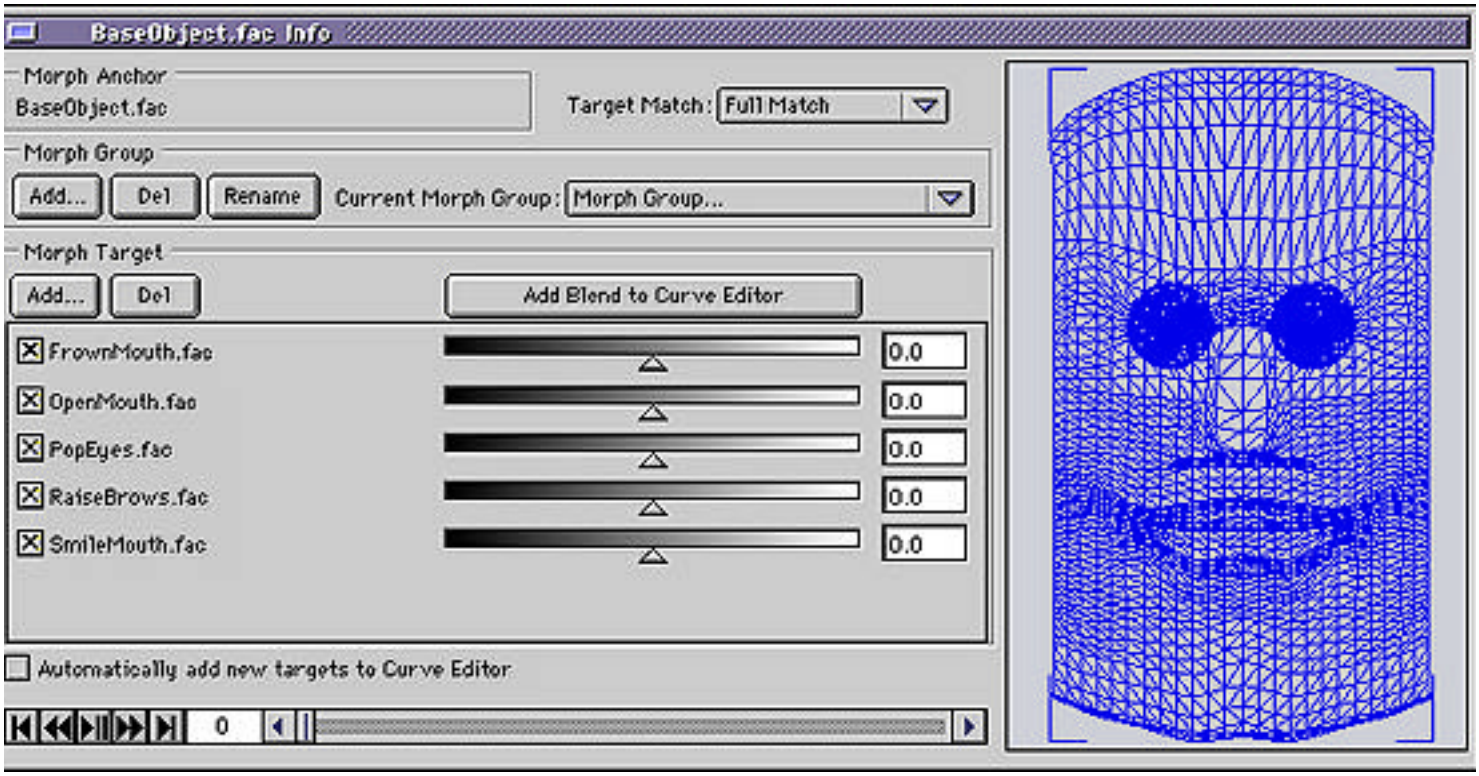
for the “BaseObject.fac” FACT file itself. Starting with ElectricImage version 2.8, this new feature allows you to animate some characteristics for the entire FACT file, rather than just for specific Groups within it. In version 2.8, 3D Morphing is the only characteristic that can be animated for the entire file.



Select the “BaseObject.fac” FACT file in the Project window and open the Morph window by clicking on the Morph icon in the tool palette.

In the Morph window, you should see a wireframe showing all of the Groups that are in the FACT file, including the face and the eyeballs. (If necessary, option-click on the wireframe to zoom in or shift-option-click to zoom out.) Click the Add button under “Morph Group” to create a new Morph Group. Morph Groups are simply categories for you to arrange your Targets into, similar to Folders in the Finder. In this tutorial you will only be using one Morph Group so it doesn’t matter what you call it. After you have created a Morph Group, click the other Add button under “Morph Target” to add Morph Target files to the

Morph Group you've just created. You will be presented with a standard Add FACT file dialog box. Add each of the five FACT files from the "Targets" sub-folder within the "FACT Files" folder. (Be sure to use the Add button, not the Import button when you add each one.) When you have finished adding them, click the "Done" button in the Add dialog and you will see them listed as Targets in the Morph Target area of the Morph window.



For fun, try dragging the sliders for each Target to see what happens to the head in the morph window when you do. Dragging the slider for any Target all the way to the right sets it's influence value to 1.0 (or 100%). If the influence of all other Targets is zero, the shape will match the FACT file of the Target that is set to 1.0. Otherwise the shape will be a blend of Targets, based on their influence values. The sliders can also be dragged in the negative direction to make the face move in the opposite direction of what is happening in the Target file. For example, dragging the Frown Target slider in the negative direction will result in a smile. Notice however that the results are better if you drag the Smile slider in the positive direction instead because the exact opposite of a frown is not necessarily a good smile. Influence values can also be entered by typing into the number fields,

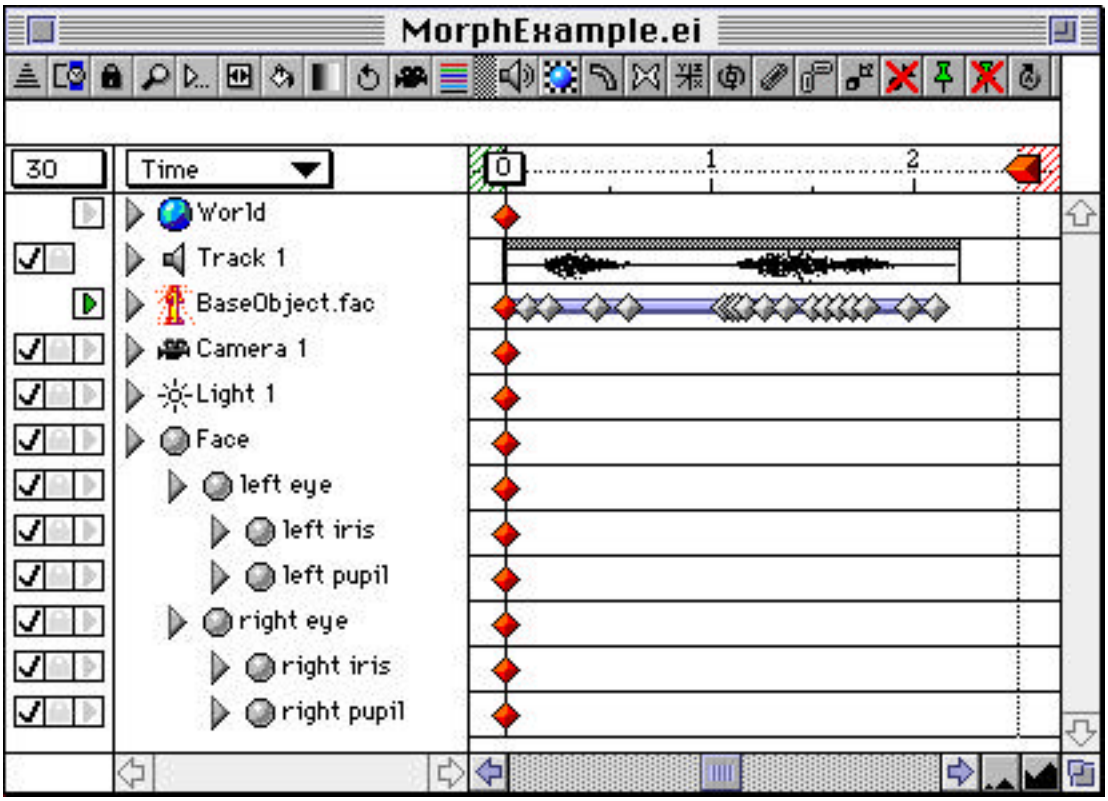
and values greater than 1 (or less than -1) can be typed, to make the face distort beyond what is happening in the Target file. Before you go on to the next section, set all Target values back to zero.

Part 2: Animating the Lip Sync

Each facial feature can now be animated independently of each other by setting the appropriate slider value and, when you are finished, they will all play back at the same time. You will first create keyframes for the "OpenMouth.fac" Target, to animate the mouth so that the head talks with its lips moving in sync. Then, in the next section, you will add keyframes for the other Targets to make the head change it's expression while it is talking.

Leave the Morph window open while you access other windows. In the Project window, set the project duration to 2.5 seconds (i.e. set the animation stop time to 2.5 seconds). Click on the time base icon at the top of the Project window and, in its pop-up menu, set the time base to Frames. Use the Add Sound command under the File menu to add the sound file "LemeOut.aiff" from the 3D Morphing Tutorial folder, into the project. The sound will show in the Project window as "Track 1". Double-click on Track 1 to open the Sound window and click the Play button to hear the sound track.

A cue-sheet indicating the timing of each syllable in the sound track is included in Appendix A of this tutorial. This cue-sheet also lists the values for the keyframes you will need to set for the "OpenMouth.fac" Target. You will use this cue-sheet as a guide as you create those keyframes. Activate animation for the "BaseObject.fac" FACT file (by clicking on its ghosted triangle , making the triangle turn green) and move the playback head to frame 3, two frames before the "H" sound starts at the beginning of the word "Hey", and set the "OpenMouth.fac" Target value to 0.25, as indicated in the cue sheet. (Make sure the "BaseObject.fac" is still selected in the Project window, and the "Current Morph Group" is set to whatever you called your Morph Group in the Morph window.) A new keyframe should be created in the Project window for the "BaseObject.fac" fact file. Continue to set the rest of the keyframes for the "OpenMouth.fac" Target, as indicated in the cue-sheet. (Frames that have a "-" in the keyframe column of the cue-sheet do not get a keyframe.) When you have created all of the keyframes for the "OpenMouth.fac" Target, as indicated in the cue-sheet, save your project.



Move the Camera so that the head fills the frame in the Camera View window. Under the Edit menu, in the Preview/Render preferences, set the Output to “QuickTime” and set the Detail to “Polygon Shaded”. Then click on the Camera icon in the Camera Viewport window to do a Quicktime Preview. Be careful to name the preview file something other than the name of your project file!!! As soon as ElectricImage finishes writing the Preview Quicktime file, it will play the file for you. You should see and hear the head talking with its lips moving in sync with the sound, while its expression remains constant.

Part 3: Animating the Facial Expression

Now comes the most creative part: animating the facial expression of the head! You can make the head have almost any expression you want while it is talking by animating the values for the other Targets. As long as you do not disturb the keyframes for the "OpenMouth.fac" Target, the head will keep on talking in sync as its expression changes. The keyframes for each of the other Targets in the example animation are listed in Appendix B of this tutorial. You can start by entering these keyframes and creating a Quicktime Preview to see the finished example. Open the "BaseObject.fac" Morph channels in the Project window, so you can see the channel for each Target while you add keyframes. Your preview file should match the "MorphExample.qt" Quicktime file. If you get stuck, you can also open the "MorphExample.ei" project file to see what the finished project file should look like.

For fun, try creating your own keyframes for the facial expressions. You can also add some Deformation to the head to bend, bulge or twist it, and use standard Group rotation to rotate the eyes in their sockets. You can also add your own materials and textures to the skin and eyes. Have fun!

More Info: How Target Files Influence the Morph

Now for some more details about ElectricImage 2.8's 3D Morphing. For each Target file, only the vertices of the Target file that are different from the Base file have any influence over the morph. For example, since the mouth in the Target file "RaiseBrows.fac" matches the mouth in the Base file "BaseGroup.fac", this Target file has no influence over the shape of the mouth during the morph. Similarly, since the eyebrows and eyes in the Target file "OpenMouth.fac" match the eyebrows and eyes in the Base file "BaseGroup.fac", this Target file has no influence over the shape of the eyebrows or the eyes during the morph. Without this special feature, you'd have to create separate files for the eyebrows being raised and lowered, for every position of the mouth, and separate files for every combination of the eyebrows and the mouth for every position of the eyeballs... etc. But the way the Target files work in ElectricImage 2.8 eliminates the need for all of that, making ElectricImage's 3D Morphing extremely convenient when doing 3D facial expression animation.

In some cases, however, this feature will be inconvenient. For example, when you want to morph between several unique objects (a teacup morphs into an orange which then morphs into a fountain pen), you will not be able to smoothly execute the morph from one target to another. The original base group continues to influence the morph. If you need to smoothly morph between three or more unique Target files, the shareware plug-in, Keymorph, may be more appropriate for you to use. Keymorph can be found on the ElectricImage home page, www.electricimage.com.

Mathematically (i.e. don't read this sentence unless you are a nerd) ElectricImage 2.8's 3D Morphing takes the difference between the position of each vertex in the Target file and the position of the corresponding vertex in the Base file and multiplies this difference by the Target file's influence value and then adds the result of that to the position of the corresponding vertex in the Base file to get the new position for each vertex in the morph.

How to Create 3D Models that Work With 3D Morphing

In order to understand how to create 3D models that work with 3D Morphing, you must first understand the basics of how 3D models are stored in the computer. Each 3D model is made up of polygons (or facets) and each polygon made up of vertices (or points) in space. Within any 3D model file, the vertices and polygons are listed end to end, from the beginning of the file to the end of the file, just as they would be if you wrote them all down on a piece of paper in a list. And, just as they would be in a list on paper, the vertices and polygons listed in a 3D model must be listed in some order, from beginning to end. It doesn't matter what the order is. What matters is that they are listed in some order. What order the vertices and polygons are listed in the model file has nothing to do with where they are in 3D space. The order they are listed in is completely arbitrary with respect to position in 3D space. It is normally just the order they happen to have been created in, in the modeler.

When ElectricImage's 3D Morphing morphs an object from the shape of one Target file to the shape of another Target file, what ElectricImage really does is change the positions of each vertex in the object from its position in the first Target file to its position in the second Target file. In other words, the first vertex listed in the object moves from its position in Target file A to its position in Target file B. At the same time, the second vertex listed moves from its position in Target file A to its position in Target file B. And so on, for all of the vertices listed in the object, all at once. Since the polygons are made out of the vertices, when the vertices move, the polygons move right along with them, and change shape.

In order for this to work, all Target files must have the same number of vertices and the corresponding vertices in all Target files must be listed in the same order. The same goes for polygons. All Target files must have the same number of polygons and the corresponding polygons must be listed in the same order. If any of these things is not true, then vertices that do not correspond with each other in different Target files will be morphed together. This will result in unexpected shapes during the morph and parts of the object will appear to move through each other as the morph progresses. The results of this can be frustrating. In order to avoid this, some careful

steps need to be taken to avoid changing the number and order of polygons and vertices from one Target file to the next.

In your modeling software, the basic procedure for creating several morph Target files that all have the same number and order of vertices and polygons is to start with one Target file and modify that object to create the other Target files. "Modify", in this case, means moving vertices and polygons around but not adding or deleting any vertices or polygons. When modifying one Target file to create other Target files, you must never do anything that adds or removes any vertices or polygons. You have to work with the vertices and polygons that already exist. You can rearrange them in space however you want, as long as you do not add or delete anything. You cannot do any trimming or stitching operations or welding operations, or any complex modeling operations such as extruding, revolving, etc. These kinds of operations all add or delete vertices and/or polygons or change the order that they are listed in the file.

Once you have created several Target files, you can get away with doing things that create and/or delete geometry, as long as you are very careful to do the exact same thing, in the exact same order, to each of the files. For example, if you already have 5 Target files, you can get away with carefully extruding the same exact polygon in all 5 files. You can make the extrusion height different in each one, as long as the same basic operation is performed, creating the same number of new vertices and polygons in the same order.

The Base file and Target files may have as many Groups as you want, as long as you are careful to make sure they correspond. Corresponding Groups in each file will be morphed. Extra Groups in either Target or Base files will be ignored.

Once you have your finished Target files, the trick is to get them into ElectricImage without changing the order or number of vertices or polygons. This may require some experimentation. The main thing is to avoid doing any unnecessary processing to the object during export to FACT or adding to ElectricImage. It is best not to use the Import function to bring the file into ElectricImage because most of the options in the Import dialog will change the number of vertices. Not all modelers are necessarily able to export geometry to a FACT file without changing the number and/or order of vertices. The modelers I have been able to verify so far include: formZ and Amapi. I am sure there are others that will work.

Appendix A: Cue Sheet

Cue sheet for “Hey, let me outa here!”:

(“-” indicates no sound or no keyframe.)

Frame	Sound	“OpenMouth.fac” Target Keyframe Values
00	-	0.00
03	-	0.25
04	-	-
05	H	-
06	E	2.50
07	E	-
08	E	-
09	E	-
10	E	-
11	E	-
12	E	-
13	Y	0.35
14	Y	-
15	Y	-
16	Y	-
17	Y	-
18	Y	0.30
19	-	-
20	-	-
21	-	-
22	-	-
23	-	-
24	-	-
25	-	-
26	-	-
27	-	-
28	-	-
29	-	-
30	-	-
31	-	-
32	-	0.25
33	-	0.50
34	L	-0.25
35	E	-0.25

36	M	-
37	EE	-
38	EE	0.80
39	EE	-
40	EE	-
41	OU	1.60
42	OU	-
43	OU	-
44	OU	-
45	OU	0.20
46	TA	-
47	A	0.80
48	A	-
49	A	0.50
50	H	-
51	EE	1.50
52	EE	-
53	R	0.50
54	R	-
55	R	-
56	R	-
57	R	-
58	R	-
59	R	0.40
60	-	-
61	-	-
62	-	-
63	-	0.00
64	-	-
65	-	-
66	-	-
67	-	-
68	-	-
69	-	-
70	-	-
71	-	-
72	-	-
73	-	-
74	-	-
75	-	-

Appendix B: Expression Target Keyframes

FrownMouth Target

Frame	Key Value
0	1.00
12	0.00
30	0.00
42	1.00

SmileMouth Target

Frame	Key Value
0	0.00
12	1.00
30	1.00
42	0.00

RaiseBrows Target

Frame	Key Value
0	0.00
12	1.50
19	1.40
25	1.50
40	0.00
43	0.00
51	0.75
55	0.75
68	0.00

PopEyes Target

Frame	Key Value
0	0.00
6	0.90
15	-0.10
20	0.30
55	0.20
75	0.00