Making a flock of animated birds

a Tutorial by Christian Bloch

If you want to let your audience know that a certain object is really huge, you should add an easy accessible size reference. This is nor only important in big budget Hollywood movies, rather it is an essential rule of filmmaking and applies first of all to architectural visualization, too. A flock of swarming birds is a welcome solution, because it adds a lot of live, causes visual attraction and its size is well known to every spectator.

This tutorial is intended to make expert knowledge accessible to ambitious beginners. A basic knowledge of LightWave’s Modeler and Layout is highly recommended, because advanced techniques are in focus, explained in step by step workshops. If you are willing to follow me into the world of ornithology, then you will not only learn about EndoMorps, ParticeFX, and the ancient art of MTSE-Morphing. Rather you will find a lot of useful hints towards a fast and economic workflow.

Of course, all the described techniques can also be used to make swarms of fishes, killer bees, robotic spy units or any other strange creatures.

1. Just enough bird-like.

The key to successfully creating such a mass scene is preplanning and preparation. The bird needs to as simple as possible, just enough to let everybody know at a distance. If you put too much detail into the model, your computer will get really slow when it we are dealing with hundreds of them.

Using MetaNURBS and Symmetry mode a raw bird is done fast and easy. First build the body by creating a longish box with 5 segments. Make sure that the head points towards the positive Z-axis, this will later enable automatic path align to work properly.

Now we change the first two segments into a stylized head. Scale down the very front polygon to make the head spiky, and bend it down to signify a beak. Make the last two segments flat and spread them out to make the tail.

Use the bevel tool to pull the wings out of the middle segment. The first bevel pass remains near by the body, to avoid undesirable body deformation. When you shape the wings, pay attention to the contour: The rear curve needs to be smooth and round, but the front curve should firstly point ahead, and suddenly flow into a straight line towards the tip. To make it as perfect as it gets you can even streamline the wings by thinning the rear polygons.

One small hint: Most ornithology books contain stylized sketches, which might be a good reference.

On most occasions you will only need a nice moving silhouette, blending in front of so you don’t need to care about texturing the bird. Just make it dark gray.
2. Preparing to take off!

If you would try to use bones to animate hundreds of birds, the processing power needed would surely stress your hardware as well as your nerves. Unless you can call a Deep Blue your own, you will have a really slow refresh rate, so don’t even think about it! We will have to cheat and use morphing to create the illusion of life. Hence, we have to model first all the poses, right out of the initial bird.

If your character is much more complex, and you feel you really have to use bones, then you should consider to bake the motion by exporting transformed objects on several key poses, and use morphing instead. The speed boost you will get on large crowds is worth the effort.

Now you need to know that in LightWave there are several ways to do a morph through multiple poses. On the one hand, you can use EndoMorphs, which are animated in a very intuitive way. This is done by using the fabulous MorphMixer, where you can independently blend all targets in, out, or even between them. At the same time, this is also the biggest drawback of this method, because you will have to control every target with an own envelope. Let’s say you need 3 envelopes to animate a single bird, you will end up with 300 envelopes on 100 birds. Plus, your scene will contain a lot of redundant information, caused by the fact that EndoMorph-Targets are stored as MorphMaps within the objects itself, and thus they will be multiplied, too.

An alternative method is an old school MTSE-Morph. This one is a little more tricky to setup and requires much more precise planning, but in the end you will save really much processing power. “Multi Target/Single Envelope” is the full pronunciation, and as the name already implies you can drive many targets (up to 40) by a single envelope. So you can animate 100 birds with exactly 100 envelopes. You will really appreciate the speed boost once you are working on the full scene or you want to make a preview then. In addition, all morph targets only need to be present once in the scene, and this saves a lot of memory.

To give you a maximum insight, I will try to cover both methods in comparison. For small swarms of quite complex moving individuals you might prefer to use EndoMorphs. But if you want to make a really huge swarm with thousands of animated individuals, then MTSE is the only way to go.

2a. MTSE-Morph: Modeling the morph targets

At first, copy the bird to 3 new layers! The first, original layer remains untouched now.

Be aware, that from now on we can only use the tools from Modify tab, because all MorphTargets must have the same point count as well as point order like the original. Modify only tools are save.

Now we build the first pose in Layer #2.

Be sure to have Symmetry mode switched ON.
Select the wings and rotate them around their roots (or shoulders if birds had any). To exaggerate the strike out, move the wings up a little. Bend the middle body down to simulate a contrary force.

The next pose is the wing-stroke down.
Because of the air resistance the wings are slightly bent, whereas die muscles take most effect on the root part. To let the flutter even look good in place, you should also tilt the wings a little bit.
In effect the body moves up. Exactly for that very reason, the bird is doing wing-strokes at all.

Now we need another pose with folded wings, working as a transition to the first pose. This in-between is especially important, because otherwise the bird would press itself down again when striking out for the next stroke.
The root points up, but the overall wing down. So the body is just very slightly bent down, about a third of the way to the first pose.
All these flight poses depend to a middle sized bird, somewhat between a sparrow and a dove. Of course, on larger birds the body movement is much less – if any – visible. Additionally, larger birds move their wings so slow and accentuated that you should better model more in-between poses.

It makes perfect sense, to make a decision for a special kind of bird from the very beginning. As reference material I recommend the book “Animal Locomotion” by Eadward Muybridge. This is the first and most comprehensive collection of motion studies at all, and has been an invaluable source of inspiration for animators since the very beginning. On the subject of birds it contains photo sequences of a hawk, American eagle, pigeon, chicken and cockatoo.

Before going ahead to use the poses as MorphTargets you should name the layers. Open the Layer Browser by pressing [^F5] or find it in the Main Menu Modeler>Windows. Double-click on the layer names to enter a new name.

By the way, working with individual layers enables you to see the former phases in background. This way you can imagine the movement just like on a light table.

Now our birdie is prepared and fledged. Save the whole object as “bird” and use the small triangle button in the top-right corner to send it to Layout.

If you are really following right now, you may jump to chapter 3.

2b. EndoMorph: building Morph-Maps

As an alternative offer, I am going to describe the preparation of the EndoMorph now. Actually, this process has much similarity, you also have to model all flight poses out of the initial bird. The difference is, that we need no additional layers, instead all targets will be incorporated as MorphMaps in the first layer.

What exactly is a MorphMap? Well, as you know every point of our bird has 3 coordinates. Distinctly, it has XYZ variables assigned. Now, since LW[6] every point can hold any desired number of variables. This feature is called VertexMaps, and enables WeightMaps, UV-Maps, and MorphMaps. Hence, we can assign an arbitrary number of alternative coordinate sets to every point. Exactly that is it what we call a MorphMap – an alternative set of point positions and therefore a different object shape. Fully integrated in the model itself. Quite clever, eh?

Alright, let’s go on and create some MorphMaps for the birdie!

Click on the little M button in the down-right corner and choose (new) from the pull-down menu beside. A requester will pop up, asking for a name. Enter “wings.up”!

Now it’s on you to transform the initial bird into that pose. All Modify-tools are allowed, the Symmetry mode is a great help, and the actual work is the same like in 2a) described.

So select the wings, rotate ‘em up and maybe press the body down a little. Done..

Do the same for the other poses, too (“wings.down”, “wings.folded”), and follow the hints in 2a). Always use the pull-down menu beside the M to create a new MorphMap or to switch between the already existent!

When you have finished all motion poses, it’s again time to save and send the object to Layout. The EndoMorph method continues in chapter 3b.
3a. MTSE: First flight training

Now we have all motion poses in Layout as individual objects. We are going to create a morphing sequence, that goes through all of the poses. Therefore, we need to link all targets together into a target chain. In addition, the animation needs to be seamless looped, hence we also have to close the chain. It is not required to close it in the initial “base”-state, rather we are free to join the end with any in-between step. For example, our bird’s wings are supposed to go “up, down, fold, up, down, fold...”. The rigid, stiff “base”-bird we never ever want to see.

How does one build a target chain in detail?

Firstly, there is the hard way, which has to be taken in LightWave 5 to 6.5. Attention please!

- At first we need a Copy of the “wings_up” pose, because this will become our seam, turning the target chain into a loop. So select “Bird: wings_up” and clone it once by pressing [STRG-c]!

- Now change to the “base” object and open ist Property Panel by pressing [p]. Switch over to Deformations Tab, and pick “wings_up (1)” as Morph Target.

- Enter any value as Morph Amount, and then enable the “Multi Target/Single Envelope” (MTSE) check box.

- Stay in the Property Panel, and change the current object to “wings_up (1)”. Set its morph target to “wings_down”.

- Change to „wings_down”, set target to „wings_fold”.

- Finally change to „wings_fold”, and set its target to „wings_up (2)“.

- Phuu – you’re done!

It has shown, that singing a little mantra is a good way to avoid confusion. Come on, nobody’s listening, sing with me: “base to up / up to down / down to fold / fold to up / it’s gonna pop”.

Here is a sketch of all the settings, and how they translate to the base-objects morph amount:

BASE ⇒ WINGS_UP (1) ⇒ WINGS_DOWN ⇒ WINGS_FOLD ⇒ WINGS_UP (2)

LightWave[7] users can happily shorten this setup process by using the fabulous new Spreadsheet. Simply open Spreadsheet panel, and change the property bank to „Object Properties: Morphing“.

Within Spreadsheet you can link all morph targets in an comfortable and easy accessible listing style. You can even activate the MTSE feature for the “base”-object.
From now on we don’t need the target objects themselves any more, we only need their geometry as reference for the morph. Hence we can hide them by setting them to 100% Dissolved. Since we’re lazy, we do this right here in Spreadsheet. Simply change bank again, shift-select all target objects, and set the Dissolve value to 100%.

LW 5 - 6.5 users need to go through the properties panel for every object as they used to.

OK, the setup is finished and now we are finally going to animate the birdie.

This is turning into a very easy part now, because we can morph the “base” into every target with an envelope in the Morph Amount channel. So enter GraphEditor by clicking the E beside Morph Amount.

Set 2 Keyframes first (Frame 0 = 100% und Frame 10 = 400%). Then, change „Post Behavior“ to Repeat and press the Play button. Now you see the birdie flutter forever. During Play mode you can tweak the animation and instantly see the effect. For example, you can set another Keyframe (Frame 6 = 300%) or play with the TCB values. To me, the settings you see in the screenshot above looked best, but you might like some other settings more.

OK, for security reasons you should save the scene now as “1bird_short_loop”.

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Spreadsheet
Well, the actual flutter motion looks just right now, but in real live you will rarely see a bird flutter all the time. Rather, a bird does 3-4 wing strokes to gain speed or height, then glides for a while before he strikes his wings again. So let’s animate this!

- Select all 3 keyframes by drawing a rectangle around them with RMB.
- Hold CTRL and grab the first keyframe with RMB. Drag it to the right, to frame 11. The automatic repeated curve is your reference. Take care, that your mouse cursor points on the curve (a little pop-up appears, showing the frame number).

- Copy all 3 keyframes again with CTRL+RMB, now to frame 22. By the way, you don’t need to memorize this shortcut, you can always find them in the quick help line.

- Now switch to “AddKeys” tool by using the down-left button, and insert a long gliding sequence. Look for a nice in-between pose with outspread wings, and hold it for about 15 frames. Watch the bird in viewport while doing this.

- Finally you can press Play again, and tweak the animation until it looks perfect to you. For example, I used the Stretch-tool to make the wing strokes faster and the gliding slower.

I hope, this page could show you how easy and fast an MTSE-morph is edited using GraphEditor. With lightning speed and minimum effort you can change timing and posing.

Alright, save scene as “1bird_long_loop”, and everybody who’s following can jump to chapter 4.
3b. EndoMorphs: Take off with MorphMixer

If you decided for the EndoMorph method, you don’t need to care about target linking at all. That’s caused by their nature, because instead of going through a target chain, we are free to control all targets separately and even mix or jumble them wildly.

So, let’s go:

- Open the birds properties panel. [p]
- Set subdivision order to Last, to ensure we get a clean shape.

![Image of object properties panel]

- Change to Deformations Tab.
- Now open the list of available plug-ins by clicking on “Add Displacement” and pick Morph Mixer from the list.
- Setup finished. Double-click on the just added plug-in to open the Morph Mixer slider panel. You are free now to leave it open as long as you need it.

![Image of MorphMixer slider panel]

That was just too easy, wasn’t it?!

Well – but when we proceed to animation we have to be very careful. Having the possibility to blend unlimited combinations of targets together might be great on many occasions, but in this special case we don’t really need this.

All we want is the bird’s wings to morph from up to down, down to fold, and from fold back to up again. Because every single move is to be executed at a 100% exclusive level, we have to fix all other targets at 0% at a time, to suppress all unwanted mixing.
Hence, we always have to set 3 keyframes at a time. Let’s go:

- Activate AutoKey! (Make sure this feature is enabled for modified channels in options panel.)
- Set the timeline range to 0 – 10 by typing into the number fields beside.
- In frame 0 drag the morph slider labeled “Up” to 100%.
- Go to frame 4, and drag the “Down” slider to 100%. For compensation drag the “Up” back to 0%, and – most important! – touch the “Folded” slider to make a keyframe at 0%.
- Before you proceed to the next frame, make sure a tiny key icon appears behind every morph slider, signifying that a keyframe is set.
- Go on to frame 7. Drag “Down” to 0%, “Folded” to 100%, and again, touch “Up” on 0%!
- Frame 10 equals frame 0: Down = 0%, Folded = 0%, Up = 100%.
- Press Play and watch the birdie flutter.

Calling the GraphEditor right from MorphMixer, you see all 3 animation curves now.

Please note, how the additional 0% keyframes cause nice even 50/50 blends.

Now you have to take care that all channels remain synchronized, hence you always have to edit all of then simultaneously. So shift-select all channels in the left bin, and set Post Behavior to repeat. Be careful, and always use RMB-rectangle selection to select all keys at a specific time. This way you can, for example, move all keys from frame 4 to frame 3. Or set Tension to 1 (like I did here).

In direct comparison with the MTSE-method, the EndoMorphs are winning the setup contest as well as an extra price for interactive animation. Thus, they are the preferred method for complex morphs, where you cannot make out a definite target chain. On the dark side, we needed 3 instead of 1 envelope, with a total of 12 keyframes instead of 3.

Things get really complicated (but also much more controlled), if you decided to insert a gliding sequence, just like we did on MTSE-Morphs.

OK, again, it's time to save the scene and move on...
4. Gimme more birdies!

Sure, not an issue, that’s what we’ve got Particle_FX for, Lightwave’s integrated particle system. Let’s say, we wanted to create a loose flock of 100 birds, passing by lazy, and roaming around a bit. Total shot length should be 10 seconds, equals to 300 frames.

Alright then, new scene, ParentInPlace OFF, AutoKey ON, set LastFrame to 300, and follow me:

- Firstly, create a new Null object and name it “main_mover” (Add → Objects → AddNull)
- Call FX_Browser from the Scene tab.

- Here, add a new HVEmitter.
- Open its Property panel right from FX Browser, and set birth rate to 50 and particle limit to 100. Simply leave the panel open for later adjustments.
- Add a Wind from FX Browser. Again, open its property panel and set the wind mode to “path”.
- Now parent both FX objects, emitter and wind, to the “main_mover” Null.
- Set your viewport to camera view and move the “main_mover” way back, and slightly off screen, just to the place where you want the birds to appear.
- By moving the wind object you can now drag the flock over the screen. To do this, go to Frame 100 and move the Wind to the right. Quite cool, how this spreads the flock in real time, eh?
- Set some more keyframes for the Wind, and the particles will follow. You should animate its rotation, too – this will twist the flock.
- Actually, it’s all done. But to me the flock still looks far too uniform. We are heading natural movements, and thus we have to fight uniformity.
  All the following points are suggestions to do this, none of them is obligatory, and surely there are many more ways.
- For example, you could animate the size of the emitter object. Easy done with AutoKey. Putting an envelope on the emitters birth rate causes a similar effect, indeed.
- Another good advise is to add a second Wind object, which is supposed to deflect every particle individually. I found wind mode “vortex” with falloff turned off quite nice. Press Play and watch the motions change while play around with the wind settings.
- Of course, you are free to add as many local winds as you want. You only have to be aware that strong winds can push some particles out of the path wind’s range. So watch out, and if you catch a runaway, enlarge the path winds radius.

- By the way, the winds affect each particle depending on their weight. Therefore, you can easily add additional chaos by randomizing the particle weight.
• To avoid nasty bird crashes, you should include some collision detection. But before you can enable this cool feature, you must give the particles a size first, of course variations are allowed again.

• "Show Size" is a great help on picking the proper size value immediately.

• In the Interaction tab you can tell the particles what you expect them to do when they collide. "Push" is topnotch qualified for birdie behavior.

• Lastly, hit the FX_Start button in FX Browser (or in Layout-Scene-tab). Surprised?

Of course, there are many more cool swarming effects you can do with ParticleFX. By animating local winds you can literally terrify the swarm, or you can let them swirl around objects, you can even join together several swarms from different directions, mix them up, and separate again.

Please allow me another tiny example:

• If you insist on a special flock shape, for example the typical delta formation, you can even prepare this in Modeler. This is achieved by creating points first [+], and connect always 2 of them to a 2-point-polygon by pressing [p]. This way you get a so called Polyline.

• Then, in Layout, go to the Polylines Properties panel and add FX_Emitter manually into the Custom Object slot.

• Now this special emitter is linked to the object, and therefore it knows its shape. Simply open the emitter properties by double-clicking the plugin.

• There, you just set the nozzle to object line, to tell the particles to appear on the line, please.

• That’s it. Use the methods above to animate the flock.

Alright, these are my tips on ParticleFX. For sure, there is a lot more to discover, and you might have some cool ideas now for more particle fun stuff. But for now we have a nice flocking motion, and should go on. Of course, you are always free to revise the ParticleFX later.

Save the scene, and leave it open.
5. Fine, but what about the birdies??

Don’t panic, in this chapter we will finish the scene. We are going to attach a copy of the animated bird from chapter 3 to every particle. Actually, this is a matter of two clicks, but this short way would result in fully synced motions. This would look quite artificial, more like a ballet than a flock of nutty birds. Therefore, we will use a special technique to add a maximum variation.

- At first, use the “Load Items From Scene” command to – well, load the bird from scene “1bird_long_loop”.
- Go to Scene tab and open FX_Linker.

Here we need only a fraction of the available options. (red marked ones) Please note, that we modestly ask for 10 copies for now. By enabling the “size effect” we ensure that the cloned birds will adopt the particle sizes we made in the last chapter.

- Create a new Null object and parent all Clones (Bird: base(2)-(10)) to it in SceneEditor.
- Stay in SceneEditor and shift all the animations by dragging the bars to the left.

Press Play and see the resulting offset in the birds motions. If you want them to differ even more, you should enter GraphEditor now, and manually edit some birds morph channels. However, I was satisfied, thus I resisted on that.

- Finally, select the parent Null, and then run “Clone Hierarchy” from Generics pull-down list (in Utilities section of the Scene tab). Repeat this step until the number of clones equals the number of particles.

Well, that’s it.
I hope you found some useful information in this tutorial. Of course, I’m all ears to your feedback. Please send questions, criticism, comments, greetings, or future tutorial wishes to Blochi@Blochi.com.