Studio 11: Principles of Animation

Today’s studio will cover some principles of animation as well as Flash basics.

A little bit of animation, done well, is superior to none at all, or a large amount of low quality animation. With 3 or 5 frames you can capture the essence of a motion. How and where you use it as a web designer is another matter.

Principles of animation

Ease-in, ease-out

Linear motion is easy to create with computer software, but it’s not very realistic. Instead of the position of an object (or its shape) changing by a constant amount on each frame, try changing it by changing amounts. This occurs when you ease-in and ease-out. Think of a bouncing ball for an example- at the top of the bounce, the ball eases-out to its highest position, then eases-in on the way down. No ease-in or out occurs when the ball hits the ground- it bounces up at the same speed with which it hit the ground. (Minus friction, of course)

Squash and stretch

Unless you’re animating a marble, when you animate (for example) a bouncing ball, it will squash and stretch- try to convey the properties of the object with your animation. Change the shape of the object in accordance with the resistance it encounters.

Show weight

Conveying the weight of objects in your animated universe is vital to selling the realism of you animation. Showing a character straining to move something shows a) the character’s strength and b) the weight of the object.

Capture the essence

No, I’m not talking about harvesting souls here, but rather using your powers of observation to really get to the bottom of what makes a motion look the way it does. If you have footage of the motion, all the better- try to remove as many frames of the source video as you can while still retaining the essence. For example, a 10 frame animation:

1 2 3 4 5 6 7 8 9 10

may only require 3 frames to capture the essence. BUT, we don’t want to speed it up per se, so you would duplicate for missing frames:

1 1 1 5 5 5 9 9 9

The best animators in the world are very interested in observing the thing they’re trying to capture.
The Basics of Flash Animation

Flash Basics

Flash is a Vector Shape application. It has been designed to cope with Vector shapes very well. In animation this can be useful because we can scale vector shapes to any size, and we can deform and distort them without unwanted mosaicing, fringes, or other pixelly artefacts. It’s possible to import Illustrator EPS files, thus taking advantage of Illustrator’s power. For any serious work you should consider this.

How Flash Organises Things

Flash movies are composed of Scenes. By default the first Scene will play, followed by the second Scene and so on. Scenes are composed of Layers and Frames. The intersection of a Layer and a Frame is called a Cell. A Cell may contain a Graphic, a Button or a MovieClip. A Graphic may contain shapes, which are composed of Strokes and Fills. Bitmaps may also be used. A Graphic can be grouped or broken apart. A Movieclip may contain other Movieclips, Graphics or Buttons.

Starting in Animation

The first thing an animator is asked to do when applying for a job is to make an animated bouncing ball. This is exactly what we’ll start with today. Firstly, let’s create the media we need, and organise our project appropriately.

I’m using Flash MX 2004 Educational (the one in the Labs) and I’m setting my document size to 640x240. If there are any Flash terms that you don’t understand, then ask your tutor, or, infinitely better, consult the Flash help file.

Animation Terms

FPS (Frames Per Second) n. – the number of frames per second that Flash attempts to display. Complexity of the frame and lack of computer grunt may mean this figure is not achieved. Common FPS settings are 15, 24.9 (not in Flash), 25, and 30.

Key Frame n.
A frame of animation that defines an extreme of action; a major defining frame.

Tween n., v.
Noun: A frame of animation designed to fall between two Key Frames. Generally there are many Tweens in between two Key Frames. Verb: To create a tween.

Scrub v.
To move the playback head across the timeline of a movie.

Media

An option at this point would be to import some bitmaps, but instead we’re going to create some media within Flash itself. I say “we” because everything you see me do here is what you’ll need to do for today’s hand-in exercise. We need at least two elements—the ball, and something for it to bounce on. This is also tutorial exercise one. Name it “ex1.fla”.

1. Open Flash.

2. Set the document (Stage) size to 640x240.

3. Arrange your windows to look like this:
4. Notice one thing that needs to change- save the file. Save often, and save versions. Bear in mind that Flash won’t close your last file.

5. Draw a ball on the Stage- any colour will do. Hold the shift key to keep to circular. Drag a selection marquee around a part of the ball and see what happens. Only part of it is selected. This is annoying when you first use Flash, as you might expect it to select the entire ball, but with this feature you can cut out parts of simple shapes to make more complex shapes. For now, select the entire ball and hit control-G to make a group of the entire ball. (Modify:Group)

6. Make a symbol out of the ball (now a group) by right-clicking it and selecting “Convert to Symbol..”. You’ll find that unless you convert your artwork to a Symbol that strange, unexpected, and annoying things will happen.
Name it “sym_Ball” (just a coincidence it sounds like “Symbol”) and notice how it’s now part of the Library now. [What just happened? It seems like not much, but actually something relatively profound occurred- some geometry out on the Stage has been made into a Symbol, and an Instance of that Symbol has been placed on the Stage in the exact location that the original geometry was at. (I’m going to capitalise Flash words.) We could delete the ball now if we wanted to, and drag it out again from the Library. In fact we could drag many Instances of the ball out onto the Stage, and give each Instance separate properties, the most obvious being position, but others could be changed. In the next two (of my) lectures I’ll talk more about Object Orientation.] For now, leave the ball where it is.

7. Now we’ll make a ground plane for the ball to bounce on. I’m going to make a simple box, but you could make something more organic and mountainous if you wished. Surprise me. Firstly though, we need to get our Layers in order. Flash has made a default layer, “Layer 1”- let’s rename that to “Ball” and then create another Layer called “Ground”. In this case the order is irrelevant. Select the “Ground” Layer and create your ground shape. Lock the “Ball” Layer just for good measure. My recommendation is to lock and unlock layers as you work- it’s highly frustrating to find out later that some artwork has been placed in an unexpected Layer. I’ve used a gradient filled rectangle for my ground. I had to use the “Fill Transform” tool to rotate the gradient to be vertical. Now let’s get to the animation part.

Animating Media in Flash

8. Zoom out the Stage so that it’s at 50%. Lock the “Ground” Layer and unlock the “Ball” Layer. Move the ball off-screen. I’ve chosen the left hand side. If you’d prefer, you can just make the ball bounce up and down on the spot.
9. It’s time to Keyframe the animation. There will be two types of Keyframes- when the ball is at the top of its journey, and when it’s touching the ground. (The previous sentence is all you need when it comes to remembering the usage of apostrophes with “its” and “it’s) The first one is set already; now we need to make some more. We need to extend the duration of our shapes across the length of our animation. Let’s do the ground first, so that when we animate the ball we can see where it needs to bounce. Even though the ground is locked, we can still do this. This animation will run for 60 frames, so click in the 60th frame, in the “Ground” Layer. Then press F5, which inserts a frame (this is not a Keyframe, as we won’t be moving the ground). Pressing F5 is the same as selecting “Insert:Timeline:Frame”.

10. Now we’ll Keyframe the ball. There are two major ways of doing this- depth first and breadth first. Depth-first would involve moving the ball to its next Keyframe and repeating that activity, breadth-first involves moving the ball to its last key frame, then its middle Keyframe, then the two Keyframes in-between those three key frames, and so on. The Keyframes were 1, 15, 30, 45, and 60. Click in each of these frames in the “Ball” Layer, then choose “Insert: Timeline: Keyframe”. Then drag the ball to where it should be. You should end up with something like this.
Interpolation

11. There’s not much animation going on though- just a bunch of positions that the ball is in over time. There’s no interpolation between these frames. Let’s add some. Select all the frames in the “Ball” layer and look at the Properties panel. See the “tween” option? Change it to “Motion”. Play the movie (Control-Return). Now we’ve got animation, but it’s linear and not very convincing. We’ll have to tweak our tweens in two ways. Firstly, we’ll need to make the path that the ball follows into a parabola (a spatial change), and secondly we’ll need to alter the ease-in and ease-out of the tween (a temporal change). Note that there’s a much better way to make a path of this kind- a Guide Layer with a parabolic arc drawn in it, but let’s learn this way first because it offers an alternative technique that can be useful.

12. Add some Ease-In and Ease-Out to each of the interpolations. Select the first span of frames and change the Ease to “In” I used - 50. Then select the next span and change the Ease to “Out”- 50 this time. Understand why you’re doing this. The ball is falling from its highest position. If you’ve never bounced a ball, then I fear for your future. Therefore you would have noticed that at its apex, a ball is stationary, then it accelerates towards the ground.. it hits the ground and leaves at a very similar speed to that at which it hit. Then, it decelerates until it completes the cycle and is once again stationary. Easing in is acceleration, and easing out is deceleration.

13. Play the animation. The temporal aspect has improved, but the motion is still very linear. We can soften this somewhat by adding some more keyframes. In between each existing Keyframe, add another key frame, and move the ball up. I did this by 8 pixels.

You’ll notice that the animation is.. well.. naff. The ball appears to hover near its apex, and the motion isn’t smooth or convincing. That’s where Guide Layers (Motion Paths) come in.

Better Animation

Shape Animation

Our ball animation lacks pizazz.. a good way to add this is to add some properties to the ball itself- faked, of course. I’m talking about squash and stretch.

As well as tweening the position of objects, it’s possible to tween (in-between) their shapes. Let’s create a simple example.

Shape Tweening

This is tutorial exercise 2. Name it “ex2.fla” (Save-as your file or start again)
1. Create a new layer called “Scratch” and select it.

2. Drag the ball from the Library onto the Stage (Or make another one). In order to make shape tweens, you have to work with ungrouped shapes.

3. Ungroup the ball by selecting Modify:Break apart. (Control-B)

4. Select frame 5. Insert a Keyframe (Insert:Timeline:Keyframe)

5. Ensure that all the frames with the ball in them (in the “Scratch” layer) are broken apart. Control-B them just to be sure.

6. Select frame 5, and use the Free Transform tool to squash the ball down.

7. Now select all the frames in the “Scratch” layer and choose a “Shape Tween” in the Properties panel. If you see a yellow triangle with an exclamation mark in it, click it to find out what went wrong.

8. Move the playback head through the frames. You should see the ball squash. Now we want to reverse the animation. Right-click the first frame, and select “Copy Frames” (You can’t do a regular Edit:Copy here). Now choose frame 9, and right-click and choose “Paste Frames”. Inst-Mucho-Chango -Presto!! The ball will now spring back into its regular shape.

9. Make a movieclip (symbol) of these frames of animation, and call it “sym_bounce”. Now you can use this symbol into the larger animation at those points in time when the ball hits the ground. Aligning it with the other Symbol so that it doesn’t appear to jump is important here.

The Dangers of Tweening

Tweening was once the job of poorly-paid workers who would be given key frames, and have to draw the intermediate frames. Automatic tweening is a compeuter concept, that I first saw in an Apple II program called “Fantavision”. In this program you would create a series of very simple vector shapes, with the same number of points, and the program would tween them for you. You’ve seen this effect before and it’s not very convincing. For an example, look up “Shape Tween” in the Flash help. Even motion tweens can look naff- a better idea, an idea that shows off your talent as an artist and a designer, is to animate on every frame.

Practically, this involves keyframing every frame, and adjusting the position, and other attributes of the shape (or even swapping the shape for another.) Changing the shape itself is also a good technique.

Motion along a Path

If you can’t achieve the motion you want with a simple Tween, try a complex one. Guide Layers can be used to define a complex path for an object to follow. You can even get the object to rotate in accordance with the path, along the direction of travel. It is a little tricky to get working though. If your Flash isn’t too flash yet, then make sure you check out the references below. Here’s my quick run-through of how to do it. (ex3.fla)

1. Create a new Flash movie and make a Symbol (not a circle) and create two Keyframes for it- one in frame 1, and one in frame 50.

2. Create a new Guide Layer- it’s the icon to the right of the “New Layer” icon. As there’s already a Layer there, it will become automatically grouped with the Guide Layer. You can group as many layers with a Guide Layer as you like, and they will all obey the Guide Layer.

3. Create a path in the Guide Layer- try an open path first, such as one created with the Pen tool.

4. Select the first frame of the animation and drag the Symbol over the first part of the path. The registration point of the symbol (a circle) should be over the path end. This (for me) was tricky. Did I mention that I.. tolerate.. Flash?

5. Select the last frame of the animation and drag the Symbol over the last part of the path.

6. Right-click in the middle part of the block of frames in layer 1 and choose “Create Motion Tween”.

7. Preview the movie. Turn on “Align to path” if that floats your boat.
Cycles

When you’ve made a repeating animation in Flash, for example a ball bouncing up and down, or a cute 3D looking animated smiley, you have the choice now of making it cycle through that animation some number of times - once, many, or unlimited. This setting can control the cycles of Movieclips. On annoying feature of Flash is that when you scrub through a movie, it won’t show you the animation of the embedded Movieclips. You Flash experts out there, prove me wrong, PLEASE!! One needs to preview the movie to see the action, which isn’t always convenient, especially if you don’t want to preview the animation from the start of the movie. Have a look at this simple movie I made that demonstrates Embedded Movieclips, Layers, and Scenes.

Making Friends with Flash

Planning Ahead

Flash can be a frustrating application if you jump straight in and start animating. If you do this, you will quickly discover that unless you have a plan of organisation, it will become a mess very quickly. It helps to have a written description / diagram prepared in advanced. It helps to be able to see at a glance the site map for your project, as well as the hierarchy of it. Yes, these are two different things. Let’s look at them both very quickly:

Site Map

A Site Map has a topology. A site map describes the nodes of a project, and how they interconnect. It can be a matter of definition what makes up a node- in a traditional web site design it’s quite easy to define- a node is a page. However in some sites, for example http://maps.google.com, it’s harder to say where one node ends and another begins.

Hierarchy

This applies to each node of the site map, as well as the entire site. It describes the containment relationships within the site. For example, page 2 contains button “Next”, Button “Prev” and Textbox “Name”. The site contains Pages “1”, “2” and “3”. When you design the functionality of your pages/nodes, you need to have a clear idea of which parts contain which other parts, and what are the responsibilities of those parts. For example, if your site allowed you to change the colours of all the pages in it, one method to achieve this would be for the site to “tell” all of the pages it contained to change their colour.

MovieClips can contain other MovieClips

Understanding the hierarchy of your project is vital. Yes, we’re talking trees here. The root of the tree is the Flash movie, and any movieclips within it are branches; possibly containing other branches.

Navigating through your MovieClips

When you doubleclick a MovieClip, it will open that MovieClip. If it contains other MovieClips, you can click these too. Where you are in the hierarchy is displayed up the top of the window. Keep an eye on it as you edit to remind yourself where you are- it can avoid confusion.

Bundling up Animations

When you’ve made an animation that you’re happy with, if it’s modular, that is it can be used as is in other animations, then save it as a .swf file, and import it into your other animations. Build up a library of commonly used animations that you can reuse.

Layering your Compositions

I can think of two ways in which this is possible:
1. By using Layers within a Scene to differentiate content- allowing you to selectively work on individual layers by locking and/or hiding and unlocking and/or showing them.

2. By using symbols to encapsulate (bundle) complex animations so that they can be placed in a single layer.

**Animating a Simple Walk Cycle**

**Setting up**

Now let’s have some fun. Forget the bouncing ball; this is the real deal when it comes to animation. We’re going to set up a simple character, and animate a double bounce walk cycle.

We’ll do this with static shapes, and then if you’re really keen, you use it as a template to paint over, to really add some character, via flexible joints, wobbling fat, whatever you like.

First we’ll create a guide that will help us work out where to put the feet and head, then place body components, and finally Keyframe these components to achieve the walk.

Needless to say, once you’ve set this up, you’ll spend a great deal of time ironing out kinks, and generally improving the quality of the walk cycle.

Use ‘Graphics’, not ‘Movieclips’ for this stuff- you can preview the results more easily just by scrubbing.

**The Process**

1. **How many frames?** If you’re new to animation this isn’t so easy to answer. The more frames the more work, but the smoother the result. I like smooth animation, so I’m choosing 23 frames in the cycle. It’s a double bounce walk, so our character’s head will go up and down twice over 23 frames. The aim is have the animated cycle repeat ever 23 frames, which means that frame 25 should be identical to frame 1. (But we don’t draw frame 25, otherwise the animation would jump.) One trick I’ve used is to copy the frames from frame 1 into frame 25, then when I’ve finished the animation, get rid of frames 24 and 25.

2. **Get the geeky stuff out of the way first:**
   a. Create a horizontal line with 25 regularly spaced tick marks across it. Place numbers under these marks, from 1-25. Above this line create a curve that has two peaks and two troughs. My advice it to turn on guides and use these to snap to, using the path tool to make the curve. It’s up to you how tall to make the curve, but as you can see in my example, keeping it subtle is good- you can certainly still see the bounce. Make a Symbol from this when you’re done. The idea is to place the curve so that the top of your character’s head touches it, whilst the character’s feet touch the numbered guides. Adjust the curve later if you need to. (Using ‘Edit in Place’ can really help here). Use a vertical guide to represent the center of the character.

3. **Create a graphic and place your guide in there.** Make the graphic run over 23 frames, and key the guide so that it moves 23 of the 25 ticks in that time. In frame 1, the character’s feet will be over tick 1, and in frame 23 the character’s feet will be over frame 23. Play the animation and fix your eyes in one place- notice how the curve seems to bob up and down- this is what our character’s head will do.

4. **Now we need media for the character-** make a simple head, torso, upper legs, lower legs, arms (or optionally upper and lower arms) and optionally hips. Register these shapes so that they rotate around their natural points, eg a lower leg rotates around the knee.

5. **Place all these shapes (in a layer of their own each) into the graphic and move them so that your character is in the first position.** “First position?” you ask- well again, that’s up to you. Bear in mind that if you place them in a standing position with the intention of animating them into a walk, then you’re not animating a walk cycle, you’re animating a walk transition. Let’s stick with a walk cycle- the first position might be with both sets of arms and legs in positions opposite to each other.

6. **Key the head every two frames to match the curve.** Do the same for the feet- one at a time. Each foot needs to complete a single walk cycle within that time. I made life easy for myself creating a separate leg animation, and I just used that for both legs. Make sure the feet stick to the appropriate number, until it’s time for them to lift again. Key the body to follow the head; if you like you can introduce some delay so that the body doesn’t seem to be linked so stiffly to the head. I’ve done this with the hair on the head, as well as producing a simple hair bounce animation.

7. **This technique is quick because you’re simple keying rotation and position of the limbs- you’re not drawing every frame.** However unless you’re making a robot it’s very difficult to avoid a ‘tearing’ effect at the joins between each limb segment. What I’ve done is make a layer over the top of the leg segments and painted-in a fix for each frame- this took far less time.
than drawing every frame of the leg from scratch. I avoided the problem entirely by making the arms out of a single segment.

8. Test your creation by placing it in a scene- I’ve used a scrolling background and kept the character still, alternatively you could move the character and keep the background still, or both. In any case, making sure the feet don’t slip is a vital quality that you must strive for. Using the guide I mentioned in step 1 is vital.

References:

Flash Cartoon Animation, Kevin Peat and Glenn Kirkpatrick

Richard Williams- The Animator’s survival kit
http://www.theanimatorsurvivalkit.com/