Principles of Animation for Visualization, Architecture, and Design

Handout

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This course will show designers, architects, and engineers how to make better and more-appealing animations for visualization, architecture, and design. Taught by an animation-industry veteran, this fast-moving presentation will take the basic principles of animation and use them to demonstrate ways to make your animations more visually appealing and easier to understand. The course will cover such topics as the importance of design and layout and the importance of storytelling, and we'll discuss maintaining proper timing. We will also cover technical topics such as animation curves, motion paths, and rigging, but in a non-software-specific way to make the topics and processes accessible to all.

0) Introduction

1) Animation starts with images

Animation starts with a collection of images that tell a story.   Getting these images right is the first step to making engaging animation.

Good Composition & Design

Start with a good composition that highlights the key story point for that scene.   Check your camera angles, understand the before/after shots as well. Always ask yourself "What story point do we need to communicate here?"

Layout

This is the organization of your "set". Make sure you have enough room for the intended action to happen.

Staging

This is how the action proceeds within the layout. Make the key elements of the scene stand out so that the audience's eye is drawn to them.   Subtly telling the audience where to 'look' is an important part of staging.

Silhouetting

Key elements should look good in silhouette. Remember, people see outlines first, and then fill in the details. If the silhouette is confusing, it will take longer for the shot to "read"

Sequencing

Multiple shots require continuity between shots. Understand basic film language (long shot, medium, close up, etc.) Understand the concept of screen direction. Be sure to do hook ups across cuts, etc. Storyboards help!

2) Basic Principles of Motion

Animation is what brings the scene to life. In character animation, we bring characters to life, but the same principles apply to anything that is animated. We'll focus on the laws of motion as they apply to non-character related scenes.

It's really just Physics

The Principles of Motion for animation are simply derivations of Newton's laws of motion (i.e. F=ma). These have been boiled down into some rules of thumb that animators use to simulate reality. Remember, animation is the animator's interpretation of reality, not reality itself.

Slow-in/Slow-out

As things move, they typically "slow in" to the start of the motion and "slow out" at the end of the motion. This is really just the result of forces acting on the object. In some cases, things stop suddenly, but these are exceptions.

Arcs

In nature, most things move along arcs. For things moving freely, this is an extension of the slow in/slow out concept. Forces slow an object along one axis, giving the appearance of an arc. In connected assemblies, such as joints, the end points of these assemblies tend to follow arcs.

Overlap and Follow-Through

Not everything in a scene moves at the same time, and this principle applies mostly to assemblies of objects. Motions can overlap when an object is in motion, so parts of the assembly may overlaps the main motion of the object. When an object or assembly comes to rest, some parts of the assembly may "follow-through", where they continue the motion for a few frames, then settle into a stop. This is sometimes called "secondary motion"

Drag

This is basically the concept of friction as applied to animation, and is similar to overlap and follow-through. A force does not affect an entire assembly at once. The motion of some parts may "drag" behind the others due to this.

Anticipation

In some ways, this is more of a character animation principle, but it can be used to good effect in other types of animation. Anticipation is moving something in the opposite way for a few frames before it moves in the intended direction (i.e. raising the hand before hitting the table). This little trick can draw the audience's eye to an object before it starts moving.

Timing

Timing makes the scene flow smoothly and keeps the audience engaged. This is probably the most subjective of the principles. Good timing is felt more than seen, and it can have strong roots in other time-based art forms, such as music. There are many ways to develop a good sense of timing. Music helps a lot, as does watching other animation to see what works.

Keyframing Motion

Animation in a CGI application happens mostly through keyframing. The keyframe records the position (or other important attributes) of an object at a specific point in time. Multiple keyframes change the attribute though time.

Block it out, then refine.

The best way to animate with keys is to do repeated passes over the animation. The first pass is typically called a blocking pass, which keys just the major points of the motion. After that, the timing of the blocking pass is refined, new keys are added (if needed) and the process repeats.

Make your curves matter to reduce number of keys

> During the animation process, the animator may need to adjust timing. This can be done by either adding keys or by refining the curves. The rule of thumb is to adjust curves first, since it keeps the timeline free of extra keys. Too many keys can create headaches when revisions happen. A cleaner timeline makes adjusting the overall animation an easier process.

Use your tangents

> There are several types of tangents, and these will vary depending on the software used. These can include, Bezier, linear, and stepped, among others. Understand your options and use them well.

Motion Paths

Another way to create motion is to use a motion path. Typically, this is a spline or a curve that is placed in the scene. A motion path can be a good alternative to pure keyframing in that the motion curve defines the motion of the object through space.

Creating Motion Paths

> The motion path is typically followed by the object's pivot point, so take that into account when drawing paths. Alternatively, you can link the object to a helper object which, in turn, is controlled by the motion path.

Maintaining Velocity

> One common problem with motion paths is maintaining velocity. Sometimes adjustment of a motion path can lead to your object speeding up or slowing down, so be sure to understand your software.

Using keys on Motion Paths

> Another way to control motion is to add keyframes to an object controlled by a motion path. Typically, this key represents a percentage of the total curve, so as the curve is adjusted, the relative positions may change.

Rigging

One more way to control objects is to rig them. A rig can be as simple as a hierarchy, but it can also extend to other tools such as constraints, joint chains, and deformations, all the way up to script and expression-based automation.   A good rig makes logical connections between objects in a system and speeds the animation process.

Hierarchies

Hierarchies are the simplest way to connect the motion of objects together. You can use them to connect objects directly, or you can use helper objects/nodes to create additional points of control for a single object.

Constraints

Constraints typically tie two similar attributes together so that object motion can be controlled more easily. An object can have its attributes tied to the attributes of one or more other objects. These attributes can be anything from position, rotation, and scale, to other attributes such as hierarchical links.

Joints and Inverse Kinematics

Joints are basically just another type of hierarchy. Typically, these simulate the bones of a character, but they can be used in a variety of non-character animation related tasks. Forward Kinematics is where a joint chain is manipulated via rotation. Inverse Kinematics introduces the concept of a "goal", where the joint chain rotates automatically to touch the goal. Moving the IK goal via translation automatically rotates the joints.

Deformations

Not every object is rigid. Deformations allow for an object's shape to change and animate. Deformations can be controlled by joint chains, but can also be controlled parametrically using such tools as bends, lattices, and waveforms.

Scripting and expressions

In more complex rigs, scripts and expressions can be used to algorithmically create motion, or animate an object in relation to another.

Conclusion

As you can see, the animation process can be simple or complex, depending on the needs of the project. Regardless of the complexity of the process, the basic goal is to simply create high quality images that

tell a story.   Above all, animation is a communication medium, so be sure to keep this in mind as you create your own projects.