FRAME AND TIMELINE ANIMATION

Film
The origins of frame based animation go back to the earliest history of film making. This dates from the late 1870s, when Eadweard Muybridge, a San Francisco photographer, was hired by Leland Stanford – the founder of Stanford University – to settle a bet. Stanford, one of the founders of the transcontinental railroad, was immensely rich and had taken up horse racing. He became involved in a controversy with other racehorse owners as to whether all four of a horse’s hooves left the ground at the same time during a trot or a gallop.

Muybridge took on the commission and used a series of cameras placed in a line, each being triggered by a thread as the horse passed. The resulting images were viewed as a sequence in a circular viewer called a zoopraxiscope and resulted in Stanford’s winning the bet as one or more frames in each sequence clearly showed all four hooves off the ground. However when the images were viewed rapidly, over twelve per second, the image of the horse appeared to show it trotting. This phenomenon,
known as persistence of vision, was unknown before. It amazed viewers.

Muybridge abandoned his landscape photography and devoted his career to developing the analysis of human and animal action using sequences of photographs; indeed, many of his photographic sequences continue to be of use to artists and sculptors today.

The image on the first page shows not photographs of Sallie Gardner (Stanford’s racehorse that was used in the first set of images) but paintings of its outline. Muybridge soon realized that drawings as well as photographs could be animated and the idea was taken up widely in the United States and Europe. A pioneer in the US was Thomas Edison, who created short movies on film loops to be shown in arcades, but the looping technology was limited in its scope. A more open format – the film reel – was developed in Europe, and particularly France, where the Lumiere Brothers and later Georges Melies created many technically advanced short movies in the 1890s and 1900s. There is a good article about Melies’ A Trip to the Moon at [http://en.wikipedia.org/wiki/A_Trip_to_the_Moon](http://en.wikipedia.org/wiki/A_Trip_to_the_Moon) and it can be seen in a complete version on YouTube at [http://youtu.be/BNLZntSdyKE](http://youtu.be/BNLZntSdyKE). One of the iconic images from A Trip to the Moon is shown above.

**Frame animation**

Animation in Europe began with stop motion, but that was treated as a special effect only in the United States until the 1980s. However drawn animation began in the 1910s as a narrative medium in its own right. One early classic is Windsor McCay’s Gertie the Dinosaur, made in 1914. You can see it at [https://vimeo.com/23059359](https://vimeo.com/23059359). The animation is surprisingly advanced considering it was made over a century ago. During performances McCay would walk out on stage in front of the animation and “interact” with it, having conversations with the dinosaur and asking it to do tricks. At this point the dinosaur could not answer back; sound for movies did not appear until 1927.

The market for movies and animations exploded after the First World War. The US center for both became Hollywood, initially because of its predictably sunny climate, suitable for outdoor filming most of the year. Later it grew simply because it was the place to be if you were a movie maker or animator, very much as Silicon Valley has developed locally for software.

The technique of mass market drawn animation was simple: a master animator would draw “key frames” that showed the characters at important points of the action. These sketches would generally be made in pencil on white paper. The sketches would then be handed to a team of “in-betweener” who traced each keyframe with ink on transparent plastic sheets called cels, from the material of which they were made – celluloid. Working from the back of the sheet, a second team of painters would fill in the inked outlines with block color – shades of gray until color film appeared in the 1930s. Backgrounds, however, which did not move were generally painted on white paper. This allowed gradients of color and gave rise to the typical look of hand drawn animation of the time: flat cartoon color for the characters and traditional shaded painting for the backgrounds. Finally the cels and backgrounds were assembled in order under a camera and made into a movie, frame by frame.

This kind of animation was (and remains) immensely time consuming. It also requires a great deal of material, as each second of film may require 24 complete cels: 14,400 for a ten minute short, and over a hundred thousand for a movie. For this reason studios often took to animating by “twos” (shooting each frame twice to halve the amount of work) and even threes.
**Timeline animation**

Timeline animation only became possible with the appearance of relatively powerful, affordable computers in the 1960s and 70s. Once useful meshes could be created in 2D or 3D in a computer the key frames could be defined mathematically and the work of in-betweeners replaced by computer calculation. The process of estimating the inbetween positions is known as interpolation, and there are several ways for the computer to do it. The most common, in keeping with the principle of animation called easy-in, easy-out, is Bezier interpolation. The action starts off slow from the beginning keyframe, accelerates to a maximum in the middle of the movement, then slows into the second key position. This looks most like the action of a character. Mechanical action is better simulated by linear interpolation, in which the speed of the movement is a constant value between the keyframes. Other types of action, such a fast start and an ease into the second keyframe, can also be defined by the animator.

**Software**

Photoshop can produce both frame and timeline animation, with frame animation being saved in the GIF format and timeline animation as any one of a number of standard video formats. Blender only produces timeline animation, with the keyframes being defined and adjusted in the Dope Sheet and the interpolating curves being controlled in the Graph Editor.

Chris Yonge 20160130