

# Chapter 1

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## Introduction to Character Animation

### Learning Objectives

**After completing this chapter, you will be able to:**

- *Learn different types of animation.*
- *Know history of animation.*
- *Understand the concept of resolution and aspect ratio.*



## INTRODUCTION

The character animation is one of the specialized areas of animation. It involves creating different types of postures of a character and making it move according to the background. In this chapter, you will learn about history of animation and its different types. Also, you will learn about the production pipeline of the character animation, aspect ratio, and some concepts of physics in applying motion.

## ANIMATION

Animation means 'to give life'. The word 'animation' is derived from the latin word 'anim', which means soul or spirit. Animation is a presentation of various displays and movements in such a way that they create illusion of life. There are different types of animation and they are discussed next.

## DIFFERENT TYPES OF ANIMATION

There are many types of animation. The three basic types of animation are: cel, stop, and computer. These animation types are discussed next.

### Cel animation

The cel animation is also known as the traditional animation, classical animation, or hand-drawn animation. It is the oldest and the most popular method of animation. The cel animation was first introduced in cartoon animated movies where the scene would require hand-drawn frames. This works fine in small clips. However, in case of full-length films produced using the cel animation, the scene may require millions of hand-drawn drawings, which is a tedious and time-consuming task to complete.

The process of creating animation by using cel animation is discussed next.

### Storyboarding

In cel animation, first a storyboard, which is a very big comic strip, is created. In other words, a storyboard means adding various drawings in a sequence such that they together depict a story. The storyboard helps the animation team plan the flow and sequence of the animation.

### Animatics

Animatics involves the process of synchronizing the pictures of the storyboard with the soundtrack. This process is started after the voice has been created, so that timing of the pictures could match the storyboard.

### Designing and Timing

Once the animation has been finalized, the process of designing the important characters and props starts. The designer creates the desired character from various angles with number of poses and expressions so that he can have a better idea about the looks and appearance of the character. Sometimes, they create clay models to have an idea of how the character will look in 3D structure. In this phase, the background and color schemes are also finalized.

Next, the time director fixes the timing by using animatics and analyzes which poses, drawings, and lip movements should be there in a particular frame. Next, the X-sheet or the Bar sheet is created. The X-sheet and the Bar sheet are the printed tables that break down the action, dialogue, and sound frame by frame. They show the relation between actions, dialogues, and music, which helps animate a scene efficiently.

## Layout

Layout begins after a design has been approved by the time director. The layout artists determine the camera angles, camera paths, lighting, and shading of the scene. The character layout artists determine the major poses for characters in the scene, and make a drawing to indicate each pose.

The layout drawings are created using the X-sheet as a guide. After all the layout drawings are complete, it is called a Leica reel. The term has its origin from the Disney Studio in the 1930s, from the frame format used by Leica cameras.

## Animation

The animation process starts after creating the Leica reel. The animators begin by drawing the sequences of animation one frame at a time. They create these animations on sheet of papers using colored pencil. The key animator draws the key drawings in the scene by using the character layouts as a guide.

While working on a scene, a pencil test is done by the key animator. The pencil test is a preliminary test of the final action. The drawings made with pencil are quickly scanned, photographed, and synced with the voice. This helps in reviewing and improving the animation before passing it to the final stage.

Once the key animation has been approved, the lead animator forwards the scene to the clean-up department, consisting of clean-up animators and inbetweeners. The clean-up animators take all data and trace them on a new sheet of paper, such that details become available on the original model sheets, and it appears as if somebody is animating the entire film. The inbetweeners draw those frames that are found missing in between the other animator's drawings.

While creating an animation, the animators always take care of timing, because it is the most important factor in animation. The animators need to synchronize the voice and the action properly to avoid discrepancy while matching them. Else, it will distract the audience.

## Background

After the animation is complete, the background artists paint the sets over which the action of each animated sequence takes place. The background artists have to make sure that the background colors are harmonious with the character designs.

### **Traditional Ink & Paint and Camera**

Once the clean-ups, tweening, and background layout have been done, the next step is to prepare for the photography. This process is known as ink & paint. In this process, each drawing is transferred from paper to a thin, clear sheet of plastic known as cel.

The drawing outline is inked or photocopied onto as well as on the reverse sides of the cels, and then colors are added in appropriate shades by using paint. In several cases, characters may have more than one color palette assigned to them. The usage of each color depends upon the mood and lighting of each scene.

Once you have transferred an entire sequence to cels, the photography process begins. Each cel used in the frame of a sequence is laid one over the other, with the background at the bottom of the stack. Then, the composite image is photographed by a special animation camera.

### **Stop Animation**

The stop animation or the stop motion animation is one of the latest animation techniques. In this technique, some drawings are drawn and then they are captured separately using a camera. Next, these captured images are transferred to the computer and then combined using an editing software. Some of the famous movies that were created using stop animation technique are: King Kong, The Dinosaur, The Missing Link.

The process of creating stop motion animation is divided into three different phases that are discussed next.

### **Pre-production**

This phase includes the following steps:

#### **Scripting**

To create a stop animation, first you need to have a script to get a clear idea about the animation. The script should be clear and precise, not complex. It should contain all minute details while scripting information about the animation such as the long, medium, and close-up shots, columns for action, dialog, camera position, and lighting. For example, you can specify whether lighting should be projected from below or from above the animation.

#### **Deciding the Characters**

After scripting, the character to be cast for the animation should be decided. Even if a character is a toy car or a table, it should be decided earlier.

#### **Choosing Background and Camera**

Next, you need to choose the background and digital camera which best suits your animation. You should look for a place where you can place the camera for a long time as the stop motion animation takes time. The digital camera suits best for creating such animations as you can send pictures or videos side-by-side to the computer using this camera.

**Selecting the Software**

You need a software to animate and edit any animation. Install the required software before capturing any picture from the camera.

**Production**

During the production stage, the camera man starts taking shots of the scene from the best angle. While shooting the animation, you can decide the frame rate for your animation as per your need. The motion pictures are shot at 24 frames per second (fps) and full-motion video is shot at approximately 30 fps.

While shooting from different angles and distances, it is recommended to use more than one camera. With multiple cameras fixed at required angle and distance, you will be able to maintain exact position and distance throughout the shooting. But incase you have only one camera, you can carefully mark the position of the tripod, both the position of its legs and its height, so that you can have a better chance of putting the camera angle back in its original position.

**Post-production**

Post-production is the last phase in Stop Animation. There are two steps involved in this phase, which are discussed next.

**Exporting and Editing the Movie**

After creating the required animation, you need to export the movie to the computer and edit it using an editing software. You can also add special affects to the animation at this stage.

**Viewing the Final Result**

The last and the most important step is to view your final animation. This helps you in finding if there are any shortcomings or mistakes in your animation. If you find any shortcoming at this stage, you can revert back and fix it.

**3D Animation**

3D animation is an art of creating moving images using computers. The process of creating 3D animations involves modeling or shaping objects in a scene, applying material, lights, camera, and finally rendering the scene to view the final output by using 3D software. All 3D software are vector-based. A vector-based software creates a series of mathematical instructions from one point to another.

There are different stages of 3D production pipeline. These stages are discussed next.

**Stages of 3D Production Pipeline**

The creation of a 3D animation undergoes a workflow process to organizes things. The workflow process is divided into three broad stages: preproduction, production, and postproduction. These stages are discussed next.

**Pre-production**

Pre-production is the first and the foremost phase of the production pipeline for computer graphics. It involves organizing all reference materials, layout drawings, and all model sketches. In this phase, the estimated budget for the project is set. Also, the plan for next stage, the production phase, is created in this phase. The pre-production phase involves the following three steps:

**Creating a Script**

The first step is to create a script. A script acts as an initial blue-print for animation. It contains the content of the animation.

**Creating a Storyboard**

A storyboard is a further elaboration of script. A script is divided into scenes, and the scenes are further divided into shots. Each shot is sketched on the panel of the storyboard. The storyboarding is a process of creating drawings in order to know how the animation would look like. The storyboard visually appears like a comic book. For the production process, it is an invaluable tool to generate all models required for the animation.

Some of the important things that the storyboard helps in finalizing are as follows:

- (a) What and how many characters are in the frame, and how are they moving?
- (b) What do the characters say to each other?
- (c) What is the duration between the last and current frames of the storyboard?
- (d) Where is the camera located in the scene?

The creation of a storyboard helps you plan an animation shot by shot, and all this information helps in making an effective and systematic animation.

**Creating Conceptual Art and Design**

After storyboarding, the conceptual art and design is done for all characters. In this process, different poses of the characters are drawn into a character sheet. Generally, the poses are taken from the front, side, and an angle called 3/4 view. Sometimes, clay sculptures of the characters are created for better idea. The props and sets are identified from the script and storyboards, and then they are sketched on model sheets. The better the conceptual art is visualized, the easier it will be to model and texture a character.

**Production**

After the script, storyboard, conceptual art and design is approved, the project enters the production phase. In the production phase, models are created from the storyboard, model sheets, and conceptual art. The production phase is divided into different steps: modeling, texturing, rigging, animation, and rendering. These steps are discussed next.

**Modeling**

The production of a 3D animation begins with the modeling process. It is the process in which 3D objects are created with reference to the conceptual arts and design in the scene by using different tools available in the software. To create 3D designs from 2D designs,

first the 2D designs, posing in two or three different directions, are imported into the software. Next, based on these designs, 3D models are created.

Modeling is done according to the position and requirement of the model in the scene. For example, if a table is required to be modeled for a scene and it has to be shot from a distant place, then it does not need much detailing. However, in case of close-up, the model needs to have as much details as possible.

The modeling phase is further divided into three different steps: character modeling, background modeling, and props modeling.

**Character Modeling.** The character modeling involves characters that have organic forms such as humans, animals, cartoons, and so on. Most models need to be deformed during animation. Therefore, you need to create them in a way so that they can be deformed easily and naturally.

**Background Modeling.** The background modeling involves modeling buildings or interiors, mountains, rivers, or anything required for a scene. You may also need objects such as chairs, benches, lampposts, glasses, and so on for the background. Note that greater the amount of detailing required for backgrounds, slower will be the speed of rendering. Therefore, you need to take it into consideration while creating the background. To avoid delay due to rendering, you can create simple models, and apply textures such that they look realistic without applying greater details.

**Props Modeling.** The props modeling involves modeling of props in a scene. Props are the things that the character uses in a scene. Anything can be used as a prop. It may be a sword, a purse that the character holds, or a car being driven by a character. If the character is not driving the car, and it is shown in the background, then the car comes into the background modeling. However, if the character is driving it or sitting in it, then it is a part of props modeling.

### Texturing

After 3D models have been created, you can apply textures and maps to them to define their surface appearances. Texturing determines the properties such as color, transparency, sheen, bump, and so on. Materials such as glass, metal, concrete, water, plastic, or fabric help in giving an object an object realistic look. High quality texture maps add details to a surface, thereby providing a high level of realism on rendering.

### Lighting and Effects

After the texturing is done, the next step is to apply lights and camera to the 3D scene. Lighting helps in controlling the appearance of shadows and highlights. You can also add camera in the scene to capture a specific point from the view.

**Animation**

Animation is a time-consuming yet an important process of production pipeline. As per the requirement of an animation, models are setup. For example, for character animation, you need to create skeleton and then rig them (discussed in detail in later chapters) to make the character move.

**Postproduction**

Postproduction begins after setting up and animating objects in a scene. The postproduction is a process in which all elements are joined together to create the final animation. The postproduction is divided into two steps: Rendering and Editing and compositing.

**Rendering**

Rendering is the process of generating a 2-dimensional image from a 3-dimensional scene. This process helps in visualizing the lighting effects, materials applied, background, and other settings in a scene.

**Editing and Compositing**

Editing is a process of changing the sequence of shots or trimming the duration of shots of a given animation. The editing process is performed to improve the synchronization and timing of an animation clip.

Compositing is the process of combining multiple video inputs into a single video track. During this phase of postproduction, you can add special effects, including 2D particles and blur effects. Other functions that are handled by compositing tools include color correction and preparing video for output in specific formats. Compositing can significantly affect the final look of the project and is considered as an integral part of 3S animated scenes.

## HISTORY OF ANIMATION

In early days, different motions of an animation were represented through drawings by using several devices. In 1872, a device was invented to produce an illusion of movement called Phenakistoscope, as shown in Figure 1-1. Using this device, an illusion of moving objects was produced by moving sequential drawings. The flip book and the praxinoscope are some of the other devices that were used for animation in earlier days. However, it was the introduction of Motion Picture films in the late 1890s which took animation to a new height.

Stuart Blackton was the first person who made an animated movie called “Humorous phases of funny faces” in 1906. He drew comical faces on a blackboard, one after the other, and filmed them together. To draw a new drawing, each time he had to stop filming of the existing image, erase the previously drawn images, and then film the newly drawn image. He then filmed all the drawings together to create a real picture like effect.





*Figure 1-1 The Phenakistoscope*

The year 1923 was most significant in the history of animation. Walt and Roy Disney launched the Disney Brothers Cartoon Studio which led animation entirely to a new level. In 1928, they produced the first successful animated movie with sound feature called “Steamboat Willie”, which set the benchmark for the Disney Studio of today. They became the first to have added sound to the movie. Again in 1937, they produced the first full length animated movie called “Snow White and the Seven Dwarfs.”

With the introduction of computers, the concept of animation went one step ahead. Movies like “Star Wars” used computer animation for most of their special effects. In 1995, Walt Disney and Pixar Studios together produced a movie called “Toy Story”, the first full length animated feature film completely animated on computers. Since then, animated movies are being produced on computers only.

## **RESOLUTION**

The resolution is the size of an image in the form of horizontal and vertical pixels. The horizontal and vertical pixels are normally given in the form of #x#, which means 640x480. Higher the resolution of an image, better will be its display.

The final render size is adjusted according to the output medium for which you are creating the animation. Some of the standard resolutions are explained next.

### **VGA (Video Graphics Array)**

The resolution used for VGA is 640x480. It is the standard computing resolution and is still a popular television resolution for tape output.

### **NTSC D1 (National Television System Committee)**

The resolution used for NTSC D1 is 720x486. It is the standard resolution for television broadcast in North America.

## NTSC DV

The resolution used for NTSC DV is 720x480. It is very similar to NTSC D1 and is the typical resolution of digital video cameras.

## PAL (Phase Alternation Line)

The resolution used for PAL is 720x526. It is the standard broadcast resolution used in European countries.

## HDTV (High Definition TV)

The resolution used for HDTV is 1920x1080. It is the emerging television standard.

## 1K Academy (1K refers to 1000 pixels across)

The resolution used for 1K Academy is 1024x768. It is the lowest permissible resolution for film production at Academy ratio.

## 2K Academy (2K refers to 2000 pixels across)

The resolution used for 2K Academy is 2048x1556. This resolution is used for most computer graphics studio output and it gives the best size to performance ratio.

## 4K Academy (4K refers to 4000 pixels across)

The resolution used for 4K Academy is 4096x3072. It is a high resolution and therefore, it is used for highly detailed shots.

## ASPECT RATIO

The aspect ratio is the ratio of the screen's width to its height. The aspect ratios also have some standards that are discussed next.

### Academy Standard

The aspect ratio of Academy Standard is 4:3. It is the most common aspect ratio. The width is 4/3 times of the height. This Academy Standard aspect ratio is also used for NTSC (National Television Standards Committee) television aspect ratio.

### Widescreen

The aspect ratio for Widescreen is 16:9. It is the most frequently used aspect ratio for 35 mm films. When a film with this aspect ratio is displayed on television, horizontal black bars appear above and below the picture, so that the edges of the picture are not cropped off.

### Anamorphic Ratio

The aspect ratio of Anamorphic ratio is 2.35:1. In Anamorphic ratio, a lens known as anamorphic lens is used to capture images upto 35 mm. When an image is played with a projector having an anamorphic lens, the image is projected upto a width of 2.35 times its height.

## FRAME RATE

Frame rate is defined as the number of frames played per second in an animation. It is written as fps (frames per second) in short. The following are some standard frame rates for media:

1. NTSC- 30fps
2. PAL- 25fps
3. Films- 24fps

Before starting any animation project, it is important to know at what frame rate the animation has to be played. Playing a 24fps animation at 30fps results in a slow moving animation. Similarly, playing a 30fps animation at 24fps will create a faster moving animation and it also results in skipping of some frames.

## PHYSICS

To start an animation project, it is necessary to have some basic knowledge of physics. You should be aware of how objects behave in the physical world, so that you can use that knowledge to animate the objects so as to give them a realistic effect. The Newton's Law of Motion and the concept of momentum are explained in brief.

### Newton's Laws of Motion

There are three laws of motion proposed by Newton. These are discussed next.

1. An object remains in its existing state, motion or rest, unless an external force is applied on it. This is called inertia.
2. The more massive an object is, the more force is needed to accelerate or decelerate its motion.
3. Every action has an equal and opposite reaction. For example, when you strike a ball on the ground, it bounces back with the same force.

All these three laws play an important part in the final look of an animation and you should always keep these principles in mind while creating an animation.

### Momentum

The momentum is defined as the product of the mass of an object and its velocity. If the object is in motion, it means the object has momentum. If the object is heavy, or is moving faster, then it will have more momentum as compared to a less heavy or slow moving object. For example, a small bullet moving with high velocity can cause great impact on the wall. Similarly, a slow moving heavy loaded truck can cause heavy damage to the car, since it has more mass.

When a moving object hits another object, irrespective of whether it is moving or not, the momentum is transferred between them. In other words, if something hits an object, then the object will move if sufficient momentum is transferred to it.

**Note**

*In this textbook, Maya software has been used to create various animations.*

## SYSTEM REQUIREMENTS

The system requirements to install Autodesk Maya on your system as well as to ensure smooth functioning of this product are as follows:

- **System Unit:** An Intel Premium IV or Core 2 Duo workstation running on Microsoft Windows XP, Vista, Linux, and Mac OS X.
- **Memory:** 1 GB of RAM (2 GB or higher recommended).
- **Internal/External Devices:** A DVD drive or a shared DVD drive accessed through a network mapped drive for the software installation.
- **Display:** A graphic color display compatible with the selected platform-specific graphic adaptor. The minimum size recommended for monitor screen is 17 inches.
- **Graphics Card:** ATI FireGL or NVIDIA Quadro FX graphics card with minimum of 256 MB video memory (512 or higher video memory strongly recommended).
- **Mouse:** A three-button mouse or scroll wheel mouse.

**Self-Evaluation Test**

Answer the following questions and then compare them to those given at the end of this chapter:

1. Which of the following devices was used to produce movement by sequential drawing in earlier days?
  - (a) Phenakistoscope
  - (b) Telescope
  - (c) Digital video device
  - (d) None of these
2. When was the Motion Picture film introduced?
  - (a) 1880
  - (b) 1890
  - (c) 1900
  - (d) 1990
3. Which of the following was the first full-length movie?
  - (a) Humorous phases of funny faces
  - (b) Steamboat Willie
  - (c) Snow White and the Seven Dwarfs
  - (d) Alice in Wonderland
4. \_\_\_\_\_ was the first person who made the animated movie named “Humorous phases of funny faces.”
5. The completed layout drawings are known as \_\_\_\_\_.
6. \_\_\_\_\_ is an art of moving things with the help of computers.
7. When a moving object hits another object, moving or at rest, the momentum is not transferred between them. (T/F)
8. The time director schedules the timing between the poses. (T/F)
9. The aspect ratio is the ratio of the width to the height of the screen. (T/F)
10. In storyboarding, pictures are synchronized with the sound track. (T/F)

## Review Questions

Answer the following questions:

1. Which of the following stages is a part of the 3D production pipeline?
  - (a) Pre-production
  - (b) Production
  - (c) Postproduction
  - (d) All of these
2. What is the aspect ratio of a widescreen?
  - (a) 4:3
  - (b) 16:9
  - (c) 2.35:1
  - (d) 7:9
3. \_\_\_\_\_ was the first full-length animated feature film completely animated on computers.
4. \_\_\_\_\_ is also known as hand-drawn animation.
5. \_\_\_\_\_ is a process of changing the sequence of shots or trim the shot durations of a given animation.
6. \_\_\_\_\_ begins after a design is approved by the time director.
7. Compositing is the process of combining multiple video inputs into a single video track. (T/F)
8. Frame rate is defined as the number of frames played per minute in the animation. (T/F)

### Answers to Self-Evaluation Test

1. a, 2. b, 3. c, 4. Stuart Blacton, 5. Leica Reel, 6. 3D animation, 7. F, 8. T, 9. T, 10. F