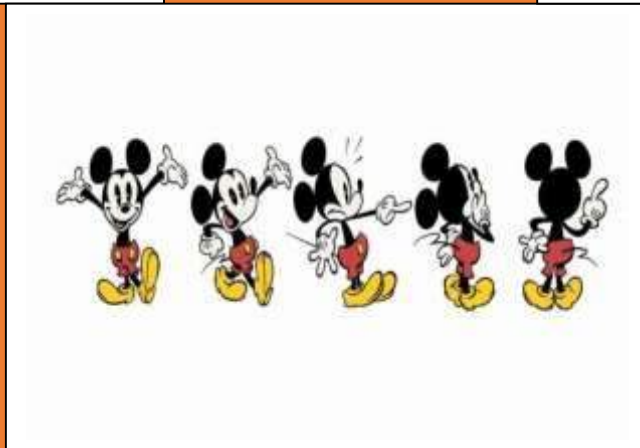


# UNIT 1: Introduction to Animation

## Student Workbook (Class 11; NSQF Level 3)

### Course: Media and Entertainment



**PSS Central Institute of Vocational Education**

(a constituent unit of NCERT, an autonomous organization under  
Ministry of Human Resource Development, Government of India)  
Shyamla Hills, Bhopal - 462 013, M.P., India

# Student Workbook

(Class 11; NSQF Level 3)

## Course: Media and Entertainment

(Job Role: Animator, QP Ref. Id.: MES/ Q 0701)

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Batch Start Date: \_\_\_\_\_

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# Preface

The National Curriculum Framework, 2005, recommends that children's life at school must be linked to their life outside the school. This principle makes a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home, community, and the workplace.

The student workbook on –**Introduction to Animation**– is a part of the qualification package developed for the implementation of National Vocational Education Qualification Framework (NVEQF). The NVEQF, an initiative of the Ministry of Human Resource Development (MHRD), Government of India, set common principles and guidelines for a nationally recognized qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities. It was subsumed in National Skills Qualifications Framework (NSQF) in 2013. It is envisaged that the NSQF will promote transparency of qualifications, cross-sectoral learning, and student-centred learning and facilitate learner's mobility between different qualifications, thus encouraging lifelong learning.

This student workbook, which forms a part of vocational qualification package for students who have passed Class VIII or equivalent examination, was created by a group of experts. The Media and Entertainment Sector Skill Council approved by the National Skill Development Corporation (NSDC) for the Media and Entertainment Industry developed the corresponding National Occupational Standards (NOS) and the Qualification Pack (QP). The National Occupational Standards are a set of competency standards and guidelines endorsed by the representatives of Media and Entertainment Industry for recognizing and assessing skills and knowledge needed to perform effectively in the workplace.

The Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), a constituent of National Council of Educational Research and Training (NCERT) has developed modular curricula and teaching-learning materials for the vocational qualification package in Media and Entertainment sector for NSQF levels 1 to 4; level 1 is equivalent to Class IX. Based on NOS, generic and occupation related core competencies (knowledge, skills, and abilities) were identified for development of curricula and learning modules.

This student workbook attempts to discourage rote learning and to bring about necessary flexibility in offering of courses, necessary for breaking the sharp boundaries between different subject areas. The workbook attempts to enhance these endeavours by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups and activities requiring hands-on-experience. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy of Education (1986).

The success of this effort depends on the steps that school Principals and Teachers will take to encourage children to reflect their own learning and to pursue imaginative and on-the-job activities and questions. Participation of learners in skill development exercises and inculcation of values and creativity is possible if we involve children as participants in learning, and not as receiver of information. These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table would be a necessity to maintain the rigour in implementing the activities and the required number of teaching days will have to be increased for teaching and training.

# About Your Workbook

This workbook is to assist you with completing the Unit of Competency **Introduction to Computers and Internet Navigation**. You should work through the workbook in the classroom, at the workplace or in your own time under the guidance and supervision of your teacher or trainer. This workbook contains sessions which will help you to acquire relevant knowledge and skills (soft and hard) on various aspects of the unit of competency. Each session is small enough to be easily tackled and digested by you before you move on to the next session. Animated pictures and photographs have been included to bring about visual appeal and to make the text lively and interactive for you. You can also try to create your own illustrations using your imagination or taking the help of your teacher. Let us now see what the sections in the sessions have for you.

## **Section 1: Introduction**

This section introduces you to the topic of the Unit. It also tells you what you will learn through the various sessions covered in the Unit.

## **Section 2: Relevant Knowledge**

This section provides you with the relevant information on the topic(s) covered in the session. The knowledge developed through this section will enable you to perform certain activities. You should read through the information to develop an understanding on the various aspects of the topic before you complete the exercise(s).

## **Section 3: Exercise**

Each session has exercises, which you should complete on time. You will perform the activities in the classroom, at home or at the workplace. The activities included in this section will help you to develop necessary knowledge, skills, and attitude that you need for becoming competent in performing the tasks at workplace. The activities should be done under the supervision of your teacher or trainer who will guide you in completing the tasks and also provide feedback to you for improving your performance. To achieve this, prepare a timetable in consultation with your teacher or trainer and strictly adhere to the stipulated norms or standards. Do not hesitate to ask your teacher or trainer to explain anything that you do not understand.

## **Section 4: Assessment**

The review questions included in this section will help you to check your progress. You must be able to answer all the questions before you proceed to the next session.

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## Introduction



Animation is the process of displaying still images in a rapid sequence to create the illusion of movement. These images can be hand drawn, computer generated, or pictures of 3D objects. There are three main types of animation: traditional, stop motion, and computer generated. Each can be used to make 2D or 3D images. There are also other less common forms, many of which focus on using an unusual medium like sand or glass to create the images, as well as combination of live action and drawings or computer created images.

Animated films and models aren't actually moving, but people see the illusion of movement because of a phenomenon called persistence of vision. In this phenomenon, the brain and eyes cooperate to store images for fractions of a second, and the brain smooths out any minor jumps or blips automatically. Since animated frames are shot at very fast rates, people generally see the movement without stoppages.

Animation has many other uses. It's commonly used in educational videos and advertisements both on TV and on the Internet, and it can also be used in the process of research and development to create simulations of how a machine or process would work.

Character design script writing storyboarding dialog recording – dialog is recorded first, so the animator can match the voice to the lips. Animation as a learning tool can help children that to solve problems in a much more flexible, creative and collaborative manner. It can also make children aware of the media and how the cartoon films are made which they see on television.

In this unit, we will take an overview of the various aspects of animation and study the history of animation. Animation can be classified in two categories: Classic animation and modern animation. Classic animations are the old traditional animations, whereas modern animation includes fully computer generated graphics called as CG.

## Session 1: Introduction to Animation

In this session, you will learn about the common terms used in animation and an overview of the historical developments in the field of animation.

### RELEVANT KNOWLEDGE

**Animation** is the process of creating a continuous motion and shape change illusion by means of a rapid display of a sequence of static images that minimally differ from each other. The illusion—as in motion pictures in general—is thought to rely on the **phi phenomenon**.

#### Phi phenomenon

The **phi phenomenon** is the optical illusion of perceiving continuous motion between separate objects viewed rapidly in succession. The basic technique of animation remains a continuous loop of two steps:

- loading a "frame"
- displaying the "frame" onscreen

A frame is defined by a **combination of the image** to be displayed and the **time the image** is to be displayed. **A sequence of frames makes an animation.** Each frame is displayed on the screen until the next frame overwrites it. Since each frame remains displayed on the screen for a tiny but finite time period, you can think of an animation as frames displayed at discrete intervals of time in a continued sequence. There are two types of frames: **key frames** and **tween frames**.



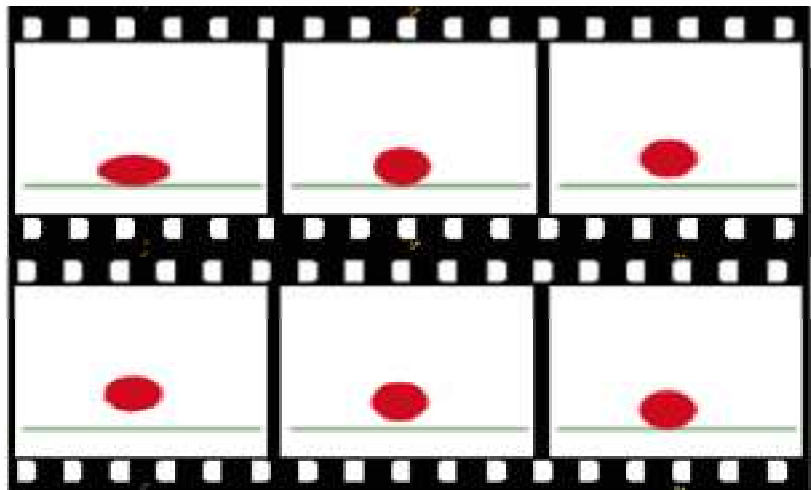
#### Key frame

A **key frame** is a single still image (frame) in an animated sequence that occurs at an important point in that sequence. Key frame is always drawn or constructed by the user. Key frames are defined throughout an animation and they define crucial points of

motion, for example start of a motion and end of a motion. In hand-drawn animation, an experienced animator would draw key frames and beginner animators would draw tween frames (also known as in-between frames). In computer animation, user of an animation program would draw key frames and computer would insert tween frames.

### Tween frame

Tween frames actually create illusion of motion. Tween frames are intermediate frames with the purpose of creating smooth transition between two key frames. For smooth appearance, animation requires at least 24 frames per second (fps). For example, you can create only two key frames, one to begin and one to end a movement. Computer program will then create remaining 22 tween frames. The final result would be one second of smooth animation with a little effort from user. For example, the bouncing ball animation consists of the following sixframes:



Animations can be recorded on either **analog media** or on **digital media**. A typical analog device is a clock on which the hands move continuously around the face. In contrast, a digital clock is capable of representing only a finite number of times (for example, every 10<sup>th</sup> of a second). VCRs, tape players, and record players, on the other hand, are analog devices. This is because they record data linearly from one point to another. All analog audio or video media must be converted to digital to work on a computer. Once the information is digital, computers can be used to edit the data and create effects that were never possible with analog media. Digital media is non-linear, which means it can be edited or played back starting at any point, which can be a huge timesaver compared to working with tape. Digital information also does not "wear out" after repeated use like tapes or records do, which results in much better longevity for digital media. Digital recordings are made with ones and zeros, while analog recordings are made with linear bumps and dips. Digital media is more

compatible and does not degrade over time therefore, it has become the common choice for today's audio and video formats.

### **Types of Animation**

Animation creation methods include the traditional animation creation method and those involving stop motion animation of two and three-dimensional objects, such as paper cutouts, puppets and clay figures. Images are displayed in a rapid succession, usually 24, 25, or 30 frames per second. The various types of animation include the following:

1. Flipbook animation
2. Traditional animation
3. Cut-out animation
4. Clay animation
5. Stop motion animation
6. Computer animation

### **Flipbook animation**

**Flipbook animation** is a very primitive way of creating animation purely with pencil, eraser and a stack of drawing pads, such as post-it pads. It is cheap and readily available at all stationery stores. It helps you to use your existing drawing skill and you can easily understand the basic concept of animation.

### **Traditional animation**

**Traditional animation**, also called **cel animation**, **classical animation** or **hand-drawn animation**, is an animation technique where each frame is drawn by hand. This was the process used for most animated films of the 20<sup>th</sup> century. To create the illusion of movement, each drawing differs slightly from the one before it. The animators' drawings are traced or photocopied onto transparent acetate sheets called **cels**, which are filled in with paints in assigned colors or tones on the side opposite the line drawings. The completed character cels are photographed one-by-one against a painted background by a rostrum camera onto motion picture film.

### **Cut-out animation**

**Cut-out animation** is a stop-motion technique for producing animations, using flat characters, props and backgrounds made out of different materials such as paper, card, stiff fabric or even photographs.

### **Clay animation**

**Clay animation**, also known as **Claymation** is any animation done using a character or characters created out of clay. Traditionally,

claymation has been associated with the time-consuming techniques of stop motion video, but with the advent of affordable computers, digital cameras, and easy-to-use software like **Frames Claymation** is accessible to almost every classroom.

Storytelling and creative —writing— are some of the more obvious ways to use claymation. It is also helpful for explanations of scientific processes, human body functions, visualizing mathematical concepts such as fractions, recreating historical time periods and events, and demonstrating physical activities such as proper exercises and stretches. Each object or character is sculpted from clay or other such similarly pliable material as **plasticine**, usually around a wire skeleton called an **armature**, and then arranged on the set, where it is photographed once before being slightly moved by hand to prepare it for the next shot, and so on until the animator has achieved the desired amount of film. Upon playback, the human mind of the viewer perceives the series of slightly changing, rapidly succeeding images as motion.



### Stop motion animation

Stop-motion animation is used to describe animation created by physically manipulating real-world objects and photographing them one frame of film at a time to create the illusion of movement. There are many different types of stop-motion animation, usually named after the medium used to create the animation.



### Computer animation

It is now also possible for animators to draw directly into a computer using a graphics tablet or a similar device, where the outline drawings are done in a similar manner as they would be on paper. **Computer animation** or **Computer Generated Imagery (CGI)** animation is the process used for generating animated images by using computer graphics. Modern computer animation usually uses 3D computer graphics, although 2D graphics are still used for stylistic, low bandwidth and faster real-time renderings.

**Computer animation** is essentially a digital successor to the stop motion techniques used in traditional animation with 3D models and frame-by-frame animation of 2D illustrations. **Classical 2D animation** is also known as **hand-drawn 2D animation** or **traditional animation**. In this technique animators need to make at least 12 drawings on paper for one second length of film. The drawings are later scanned or captured for post-production using computer. This technique was the dominant form of animation in film and TV series, until the development of CGI animation. In **digital 2D animation** technique, animation frames are drawn directly on software using mouse or pen tablet. This technique is used mostly for TV series and webanimation.



Computer-generated animations are more controllable than other more physically based processes, such as constructing miniatures for effects shots or hiring extras for crowd scenes, and because it allows the creation of images that would not be feasible using any other technology. It can also allow a single graphic artist to produce such content without the use of actors, expensive set pieces, or props.

### **History of Animation**

Animation refers to the recording of any image which goes through changes over time to portray the illusion of motion. Before the invention of film, the depiction of figures in motion through static art existed as far back as the Paleolithic. In the 19th century there were several devices which successfully displayed animated images.

Early examples of attempts to capture the phenomenon of **motion** into a still drawing can be found in **paleolithic cave paintings**, where animals are often depicted with multiple legs in superimposed positions, clearly attempting to convey the perception of motion.

In the first century BC, the Chinese craftsman **Ding Huan** invented a zoetrope-like optical device that created the impression of motion from the rapid movement of static images. A circular canopy of translucent paper painted with images of birds and animals was placed over a lamp. The rising convection currents of the lamp rotated the vanes on the top of the canopy. When the device was spun at the right speed, pictures painted on the panels would appear to move.

In the 19th century, the **phenakistoscope** (1832), modern **zoetrope** (1834) and **praxinoscope** (1877), as well as the common **flip book**, were early animation devices to produce movement from sequential drawings using technological means, but animation did not develop further until the advent of **motion picture film and cinematography** in the 19th century.

The **cinématographe** was a projector, printer, and camera in one machine that allowed moving pictures to be shown successfully on a screen which was invented by history's earliest film makers, **Auguste and Louis Lumière**, in 1894. The first animated projection (screening) was created in France, by **Charles-Émile Reynaud**, who was a French science teacher. Reynaud created the **Praxinoscope** in 1877 and the **Théâtre Optique** in December 1888. On 28 October 1892, he projected the first animation in public, **Pauvre Pierrot**, at the **Musée Grévin** in Paris. This film is also notable as the first known instance of film perforations being used. His films were not photographed, but drawn directly onto the transparent strip. In 1900, more than 500,000 people had attended these screenings.



**Praxinoscope, the first projection (1877)**

The first film that was recorded on standard picture film and included animated sequences was the 1900 **Enchanted Drawing**, which was followed by the first entirely animated film - the

1906 Humorous Phases of Funny Faces by J. Stuart Blackton, who, because of that, is considered the father of American animation.



In Europe, the French artist, Émile Cohl, created the first animated film using what came to be known as traditional animation creation methods - the 1908 Fantasmagorie. The film largely consisted of a stick figure moving about and encountering all manner of morphing objects, such as a wine bottle that transforms into a flower. There were also sections of live action in which the animator's hands would enter the scene. The film was created by drawing each frame on paper and then shooting each frame onto negative film, which gave the picture a blackboard look.

The author of the first puppet-animated film (The Beautiful Lukanida (1912) was the Russian-born (ethnically Polish) director Wladyslaw Starewicz, known as Ladislav Starevich.

The more detailed hand-drawn animations, requiring a team of animators drawing each frame manually with detailed backgrounds and characters, were those directed by Winsor McCay, a successful newspaper cartoonist, including the



1911 Little Nemo, the 1914 Gertie the Dinosaur, and the 1918 The Sinking of the Lusitania. During the 1910s, the production of animated short films, typically referred to as "cartoons", became an industry of its

own and cartoon shorts were produced for showing in movie theaters. The most successful producer at the time was John



Randolph Bray, who, along with animator Earl Hurd, patented the cel animation process which dominated the animation industry for the rest of the decade.

El Apóstol (Spanish: "The Apostle") was a 1917 Argentine animated film utilizing cutout animation, and the world's first animated feature film.<sup>[6]</sup> Unfortunately, a fire that destroyed producer Frederico Valle's film studio incinerated the only known copy of El Apóstol, and it is now considered a lost film.

## Exercise

Prepare an animal or cartoon using clay and other material. Seek the help of your teacher/trainer to perform the activity. First draw your character on a piece of paper (full size). Using your drawing as a guide you need to measure and cut the lengths of wire for the armature (skeleton). Use the polymer clay to block out the chest, pelvis, hands and feet of the skeleton, and to hold the wire together. Put the clay around to prepare your character. Visit some of the websites on claymation to learn about how to prepare a character out of clay. You will need the following materials:

### Materials Needed

1. Armature wire(1/16")
2. Plastalina clay
3. Polymerclay
4. Plier
5. Foamboard
6. Paper
7. Packingtape
8. Insta mold makingcompound
9. Petroleumjelly
10. Baby oil (mineraloil)
11. Double boiler (or cooking pot and glass mixingbowl)
12. Sculptingtools
13. Paint
14. Brushes

## Assessment

Answer the following questions

1. Describe how the animation industry evolved from its early days.

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2. Give a brief description of any two types of animation.

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3. Give examples of the uses of animation.

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### Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

#### Part A

Differentiated between the following:

1. Analog and digital medium

#### Part B

Discussed in the class the following:

1. What are the various types of animation?
2. What is the difference between key frame and tween frame?
3. How analog medium differs from digital medium?

#### Part C

##### Performance standards

The performance standard may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge of the evolution of animation		
Demonstrate the knowledge of traditional animation		
Demonstrate the knowledge of stop motion animation		
Demonstrate the knowledge of computer animation		

## Session 2: Traditional Animation

In this lesson you will learn about the traditional animation.

### Relevant Knowledge



### Flip Book

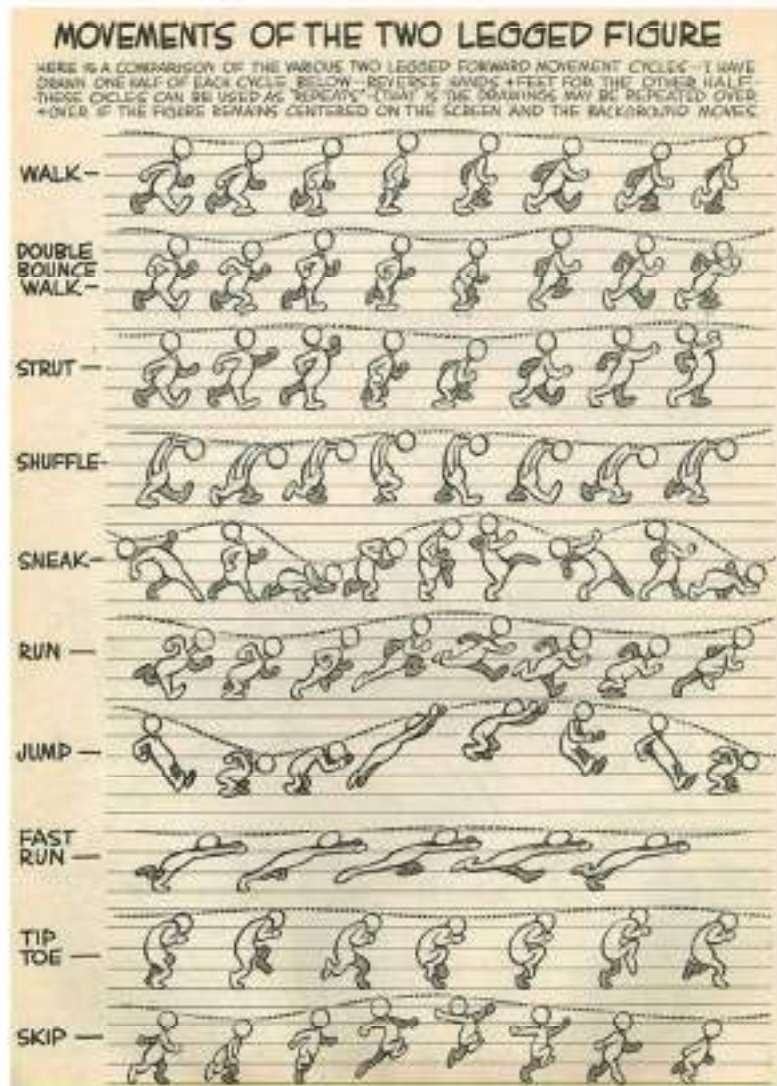
Flip books offer the most versatility and creativity in hands-on animation projects because they are not limited in length or materials, as is the case with some other techniques. They're inexpensive to create with common materials and require no viewing devices. Most important, the process used to make a flip book forms the basis for all of the more sophisticated animation techniques, including filmed animation. The basic rule is, if it will flip, it will work, so try index cards, Post-it notepads or other "flippable" media.

For a flip book you first need a story, maybe one as simple as a dot moving from one side of the page to the other, or as complicated as a truck that seems to disappear in traffic. A flip book simply takes a storyboard and inserts the intermediary steps needed to create the illusion of motion. The first time, have them use the basic compositional forms of drawing that they are already used to, like dots, lines or circles, so that they focus on placement and sequence rather than the detail within the object.

### Traditional Animation

**Traditional Animation** was the process used for most animated films of the 20th century. The individual frames of a traditionally animated film are photographs of drawings, first drawn on paper. To create the illusion of movement, each drawing differs slightly from the one before it. The animators' drawings are traced or photocopied onto transparent acetate sheets called cels, which are filled in with paints in assigned colors or tones on the side opposite the line drawings. The completed character cels are photographed one-by-one against a painted background by a rostrum camera onto motion picture film.

The traditional animation process became obsolete by the beginning of the 21st century. Today, animators' drawings and the backgrounds are either scanned into or drawn directly into a computer system. Various software programs are used to color the drawings and simulate camera movement and effects. The final animated piece is output to one of several delivery media, including traditional 35 mm film and newer media such as digital video. The "look" of traditional cel animation is still preserved, and the character animators' work has remained essentially the same over the past 70 years. Some animation producers have used the term "tradigital" to describe cel animation which makes extensive use of computer technology.



Excerpt from the 1919 Feline Follies with Felix the Cat.

Examples of traditionally animated feature films include —Pinocchio| (United States, 1940), Animal Farm (United Kingdom, 1954), and, —L'illusionniste| (British-French, 2010).



Pinocchio

Traditional animated films which were produced with the aid of computer technology include *The Lion King* (US, 1994), *Akira* (Japan, 1988), *Sen to Chihiro no Kamikakushi* (*Spirited Away*) (Japan, 2001), *Les Triplettes de Belleville* (France, 2003), and *The Secret of Kells* (Irish-French- Belgian, 2009).

**Full Animation** refers to the process of producing high-quality traditionally animated films that regularly use detailed drawings and plausible movement. Fully animated films can be made in a variety of styles, from more realistically animated works, such as those produced by the Walt Disney studio (*Beauty and the Beast*, *Aladdin*, *Lion King*) to the more 'cartoon' styles of the WarnerBrothers.

**Limited Animation** involves the use of less detailed and/or more stylized drawings and methods of movement. Pioneered by the artists at the American studio United Productions of America, limited animation can be used as a method of stylized artistic expression, as in *Gerald McBoing Boing* (US, 1951), *Yellow Submarine* (UK, 1968), and much of the anime produced in Japan. Its primary use, however, has been in producing cost-effective animated content for media such as television and later the Internet (web cartoons).



**Rotoscoping** is a technique patented by Max Fleischer in 1917 where animators trace live-action movement, frame by frame. The source film can be directly copied from actors' outlines into animated drawings, as in *The Lord of the Rings* (US, 1978), or used in a stylized and expressive manner, as in *Waking Life* (US, 2001) and *A Scanner Darkly* (US, 2006). Some other examples are: *Fire*

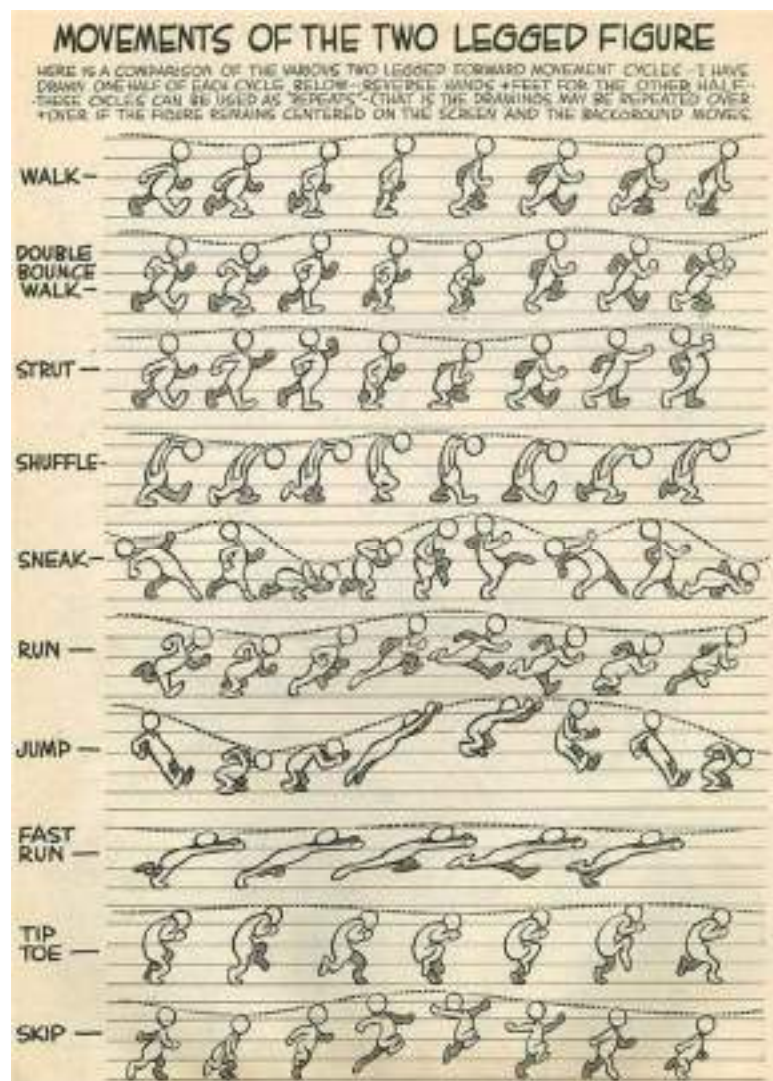


and Ice (US, 1983) and Heavy Metal (1981).

**Live-Action/Animation** is a technique combining hand-drawn characters into live action shots. One of the earlier uses was in Koko the Clown when Koko was drawn over live action footage. Other examples include Who Framed Roger Rabbit (US, 1988),—SpaceJam|| (US,1996)and—OsmosisJones|| (US,2001).

## Exercise

1. Draw the moments of the two legged figures given below and paste them on the sheets of your portfolio book.

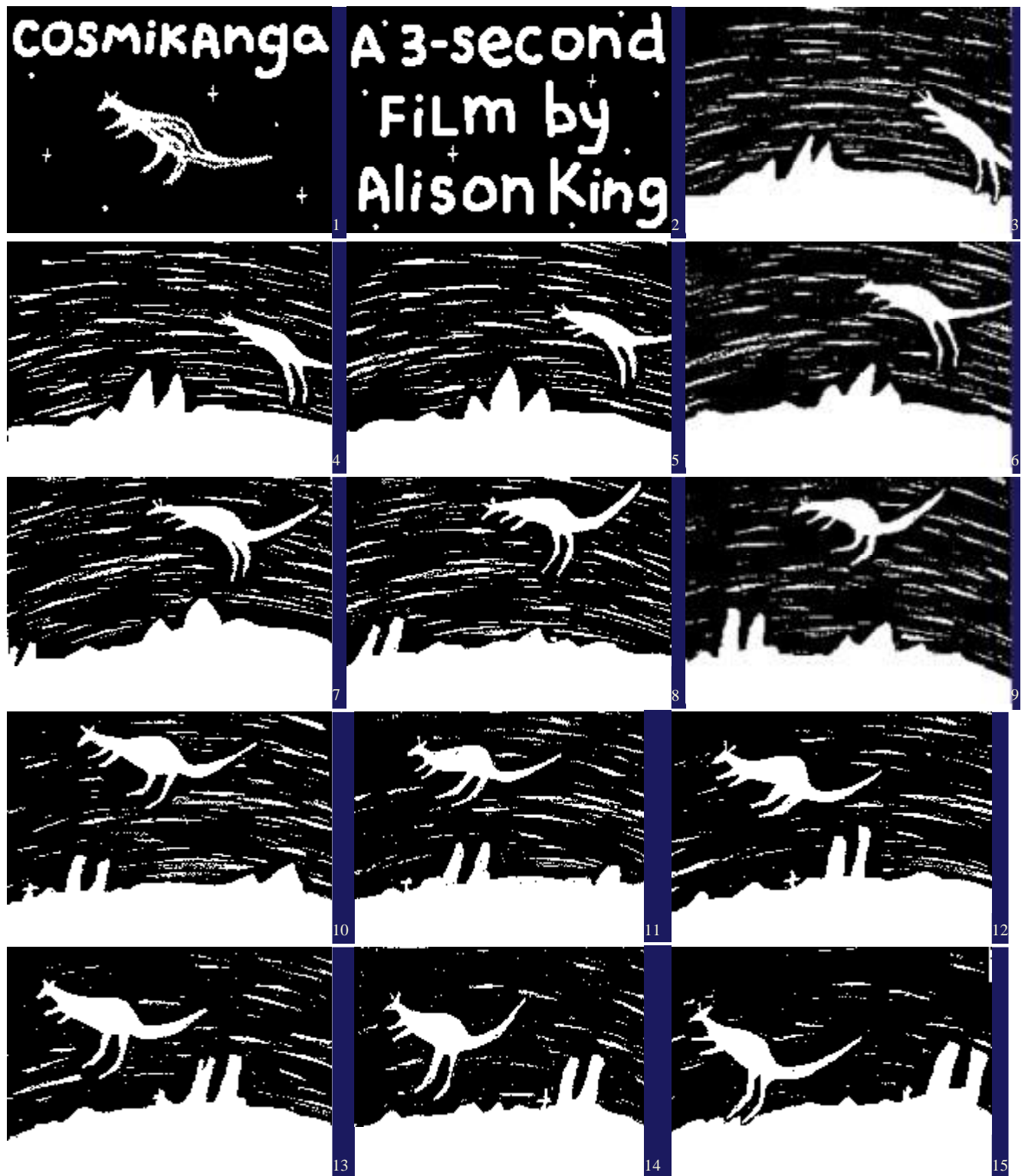


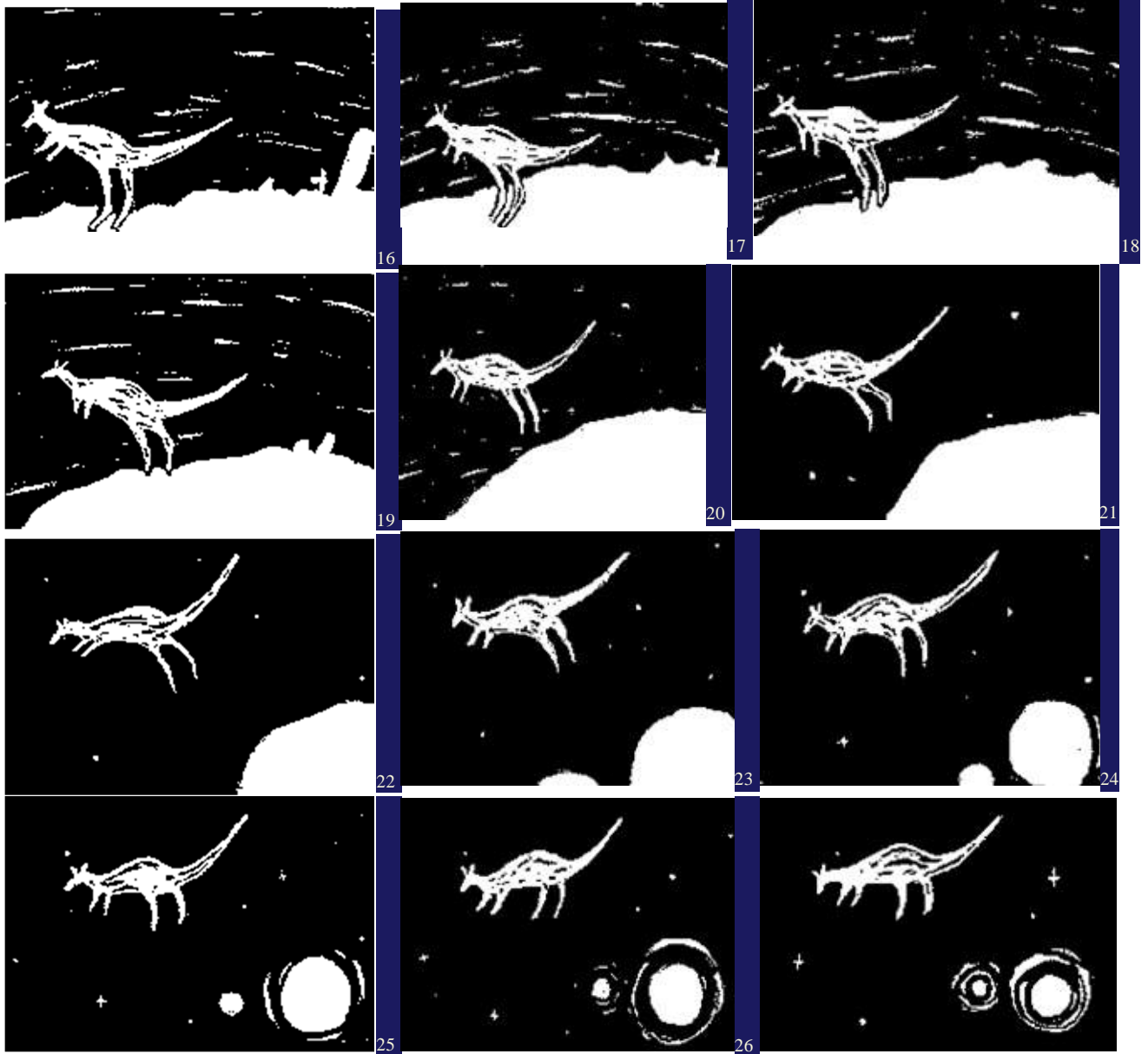
## 2. Prepare a Flipbook

Print out the frames given below and glue onto individual index cards in the same position (upper right corner is the best). Staple the left edge together, or use a rubber band to keep the cards stacked in a little book. Flip them cards with your thumb and see how the character moves. Use colour or add images to customize your flipbook (source:flipbook.<http://www.zuzu.org/printout.html>).

Try this!

You can sketch your own images and prepare a flipbook.





4. Sketch the picture of Pinocchio and paste it on your student portfolio book.





## Assessment

Answer the following questions

1. What is hand drawn animation?

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2. What do you understand by the term –full animation?

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3. What do you understand by the term Claymation?

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Traditional animation and computer animation.

### Part B

Discussed in the class the following:

What are the benefits of learning animation?

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Differentiate between full animation and limited animation		
Differentiate between traditional animation and computer animation		
Demonstrate the knowledge of claymation		
Prepare a flipbook		
Draw movements of two-legged figure		

## Session 3: Stop Motion Animation

In this lesson you will learn about stop motion animation.

### Relevant Knowledge



### Stop-motion Animation

**Stop-motion Animation** is used to describe animation created by physically manipulating real-world objects and photographing them one frame of film at a time to create the illusion of movement. There are many different types of stop-motion animation, usually named after the medium used to create the animation. Computer software is widely available to create this type of animation, however, traditional stop motion animation is usually less expensive and time-consuming than the computer animation.

Stop motion animation is animation that is captured one frame at time, with physical objects that are moved between frames. When you play back the sequence of images rapidly, it creates the illusion of movement. The basic process of animation involves taking a photograph of your objects or characters, moving them slightly, and taking another photograph. When you play back the images consecutively, the objects or characters appear to move on their own.



**Puppet Animation** typically involves stop-motion puppet figures interacting in a constructed environment, in contrast to real-world interaction in model animation. The puppets generally have an armature inside of them to keep them still and steady as well as to constrain their motion to particular joints.



**Clay Animation**, or **Plasticine** animation (often called claymation, which, however, is a trademarked name), uses figures made of clay or a similar malleable material to create stop-motion animation. The figures may have an armature or wire frame inside, similar to the related puppet animation that can be manipulated to pose the figures. Alternatively, the figures may be made entirely of clay, such as in the films of Bruce Bickford, where clay creatures morph into a variety of different shapes.

**Cutout Animation** is a type of stop-motion animation produced by moving two-dimensional pieces of material such as paper or cloth. **Silhouette Animation** is a variant of cutout animation in which the characters are backlit and only visible as silhouettes.

**Model Animation** refers to stop-motion animation created to interact with and exist as a part of a live-action world. Intercutting, matte effects, and split screens are often employed to blend stop-motion characters or objects with live actors and settings.



A clay animation scene from a Finnish television commercial

**Go Motion** is a variant of model animation that uses various techniques to create motion blur between frames of film, which is not present in traditional stop-motion. The technique was invented by Industrial Light and Magic and Phil Tippett to create special effects scenes for the film *The Empire Strikes Back* (1980).



**Object Animation** refers to the use of regular inanimate objects in stop-motion animation, as opposed to specially created dummies.

**Graphic Animation** uses non-drawn flat visual graphic material (photographs, newspaper clippings, magazines, etc.), which are sometimes manipulated frame-by-frame to create movement. At other times, the graphics remain stationary, while the stop-motion camera is moved to create on-screen action.

**Brickfilm** A sub-genre of object animation involving using [Lego](#) or other similar brick toys to make an animation. These have had a recent boost in popularity with the advent of video sharing sites like YouTube and the availability of cheap cameras and animation software.

**Pixilation** involves the use of live humans as stop motion characters. This allows for a number of surreal effects, including disappearances and reappearances, allowing people to appear to slide across the ground, and other such effects. Examples of pixilation include *The Secret Adventures of Tom Thumb* and *Angry Kid* shorts.



## Exercise

1. Visit an Animation Studio for understanding the various methods of animation.
2. Make a short stop motion animation film by following the given steps. Perform the activity under the supervision of your teacher/trainer.
  - a) Get objects and figures to use in your movie. Some good choices include clay, wire, Lego or similar building block figures. Be imaginative in the types of objects and figures that might work for your movie. You can also use a whiteboard, animating figures and editing the drawing slightly with each frame.
  - b) Set up the figures (characters) in a particular position and within the "set."
  - c) Place your camera in front of the "set" that you are going to take photos. Make sure that it can view the entire frame.
  - d) Set up a good source of lighting. It might be a lamp or a flashlight.
  - e) Take a single photo of the figure in the selected position.
  - f) Begin the movement sequence. Move the figure bit by bit, in very small movements each time. It may be the entire body if the figure is walking, or it may just be an arm, head or leg.
  - g) Repeat the movement sequence until your action step is completed.

- h) Save the pictures on to your computer
- i) Use your movie-making software.

## Assessment

Answer the following questions:

1. Describe the meaning of Stop Motion Animation

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2. Describe the terms Puppet Animation, Clay Animation, Cutout Animation and Model Animation.

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Clay Animation and object animation.

### Part B

Discussed in the class the following:

1. What are the advantages and limitations of various types of animation?

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge of stop motion animation.		
Demonstrate the knowledge of clay animation		
Demonstrate the knowledge of puppet animation		



## Session 4: 2D and 3D Animation

In this session, you will learn about 2D and 3D Animation.

### Relevant Knowledge

**Computer Animation** encompasses a variety of techniques, the unifying factor being that the animation is created digitally on a computer. 2D animation techniques tend to focus on image manipulation, while 3D techniques usually build virtual worlds in which characters and objects move and interact. 3D animation can create images that seem to be real to the viewer.



### 2D Animation

**2D Animation** figures are created and/or edited on the computer using 2D bitmap graphics or created and edited using 2D vector graphics. This includes automated computerized versions of traditional animation techniques, such as interpolated morphing, onion skinning and interpolated rotoscoping. 2D animation has many applications, including Analog Computer Animation, Flash Animation and Power Point Animation.

### 3D Animation

3D animation is digitally modelled and manipulated by an animator. The animator starts by creating an external 3D mesh to manipulate. A mesh is a geometric configuration that gives the visual appearance of form to a 3D object or 3D environment. The mesh may have many vertices which are the geometric points which make up the mesh; it is given an internal digital skeletal structure called an armature that can be used to control the mesh

with weights. This process is called **rigging** and can be programmed for movement with keyframes.



Other techniques can be applied, such as mathematical functions (e.g., gravity, particle simulations), simulated fur or hair, and effects such as fire and water simulations. These techniques fall under the category of 3D dynamics.





**Computer Imagery Animation** or **CGI Animation** is the process used for generating animated images by using computer graphics. The more general term computer-generated imagery encompasses both static scenes and dynamic images, while computer animation only refers to moving images.

Modern computer animation usually uses 3D computer graphics, although 2D computer graphics are still used for stylistic, low bandwidth, and faster real-time renderings. Sometimes the target of the animation is the computer itself, but sometimes the target is another medium, such as film.

Computer animation is essentially a digital successor to the stop motion techniques used in traditional animation with 3D models and frame-by-frame animation of 2D illustrations. Computer generated animations are more controllable than other more physically based processes, such as constructing miniatures for effects shots or hiring extras for crowd scenes, and because it allows the creation of images that would not be feasible using any other technology. It can also allow a single graphic artist to produce such content without the use of actors, expensive set pieces, or props.



To create the illusion of movement, an image is displayed on the computer monitor and repeatedly replaced by a new image that is similar to it, but advanced slightly in time (usually at a rate of 24 or 30 frames/second). This technique is identical to how the illusion of movement is achieved with television and motion pictures.

For 3D animations, objects (models) are built on the computer monitor (modelled) and 3D figures are rigged with a virtual skeleton. For 2D figure animations, separate objects (illustrations) and separate transparent layers are used, with or without a virtual skeleton. Then the limbs, eyes, mouth, clothes, etc. of the figure are moved by the animator on key frames. The differences in appearance between key frames are automatically calculated by the computer in a process known as tweening or morphing. Finally, the animation is rendered.

For 3D animations, all frames must be rendered after modeling is complete. For 2D vector animations, the rendering process is the key frame illustration process, while tweened frames are rendered as needed. For pre-recorded presentations, the rendered frames are transferred to a different format or medium such as film or digital video. The frames may also be rendered in real time as they are presented to the end-user audience. Low bandwidth animations transmitted via the internet (e.g. 2D Flash, X3D) often use software on the end-users computer to render in real time as an alternative to streaming or pre-loaded high bandwidth animations.



The process of a 3D animation pipeline is complex and can be a lot more complicated than any other forms of animation. Depending on what project and which 3D animation studio is involved, the number of steps may vary.

The 11 most common steps involved in producing a 3D animation project are given below:

1. Concept and Storyboards
2. 3D Modelling

3. Texturing
4. Rigging
5. Animation
6. Lighting
7. CameraSetting
8. Rendering
9. Compositing and SpecialVFX
10. Music andFoley
11. Editing and FinalOutput

The very first step involved in a 3D production pipeline is the conceptualization of ideas and the creation of the storyboards that translate these ideas into visualform.

### **Difference between 2D and 3D Animation**

2D animation is the traditional animation. It is one drawing followed by another in a slightly different pose, followed by another in a slightly different pose, on and on for 24 frames a second.

2D animations deals more with drawing and framing and is the base of 3D animation. 2D animators create frames to define a sequence that are then moved at varying speeds to create the illusion of motion. Traditionally these were put together in an amazing process where artists drew pencil drawings of every frame of film, then these images were painted onto clear plastic sheets called ‘\_cels’, and each of the thousands of hand drawn and painted cels were photographed one at a time over a hand painted background image and those thousands of images compiled to run as film at 24 frames asecond.

Today most 2D animation involves using computer software to one degree or another, from just digitly colouring the cels to be photographed in the traditional method, to doing every single element in the computer.

### **2D Animation Examples**

- BugsBunny
- DaffyDuck
- ElmerFudd
- SnowWhite
- The JungleBook
- The LittleMermaid
- The Simpsons
- FamilyGuy
- SouthPark

3D or three-dimensional animation has more depth and is more realistic. The texture, lighting and colour of the 3D objects are modified using software programs. Film, advertising, video and gaming are the fast growing fields for 3D animation.

3D allows you to do things that simply are not possible in 2D animation.

3D objects, once modeled, can be treated almost as a physical object. You can light it differently, you can move a camera to look at it from above, or below. 3D allows you to create realistic objects. You can use textures and lighting to create objects that appear solid, and can even be integrated seamlessly into live videoelements.

### 3D Animation Examples

- ToyStory
- Shrek
- The Incredible
- Jurassic Park (thedinosaurs)
- The Transformers (therobots)

### Exercise

1. Analyze a clip from an animated movie and animate a moment from a scene. Draw the frames for your animation, capture your drawings with a camera or scanner, and ink in and animate the drawings using 2-Dsoftware.

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2. Watch various 2d and 3d animation clip and make a chart containing the name of studios andartists.

### Assessment

Answer the following questions:

1. What is Computer Generated Imagery or ComputerAnimation?

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2. Explain the difference between 2D Animation and 3DAnimation.

### Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

#### Part A

Differentiated between the following:

1. 2D and 3D animation.

#### Part B

Discussed in the class the following:

1. What are the limitation of 2Danimation?
2. What are the uses ofanimation?

#### Part C

##### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge of 2D animation		
Demonstrate the knowledge of 3D animation		

## Session 5: Production Pipeline

In this session, you will learn about Production Pipeline and the various steps involved in animation production pipeline.

### Relevant Knowledge

Production pipeline is required in all logical organizations to produce an animated feature film. It overlaps with the company organizational structure. Every company has its own pipeline. Every movie changes its pipeline as:

- Requirements are changing
- To save money
- To increase the quality of the movie

### Steps in the Animation Production Pipeline

#### Story Boarding

When a film is in its beginning stages of production, the storyboard is one of the first aspects to be completed. The story board, a series of pictures with captions that describe the outline of the story, helps in the placement of cameras and the timing of animation later on in the production process. The story boarding process begins with an initial rough draft. Then, one of the creators acts out and describes the pictures in the story to his or her colleagues in order to receive feedback. After taking into consideration the suggestions presented, the story board is redrawn with the new ideas. This process is repeated until a final story is agreed upon.



One panel of a story board for Pixar's film "Finding Nemo."

## Voice recording

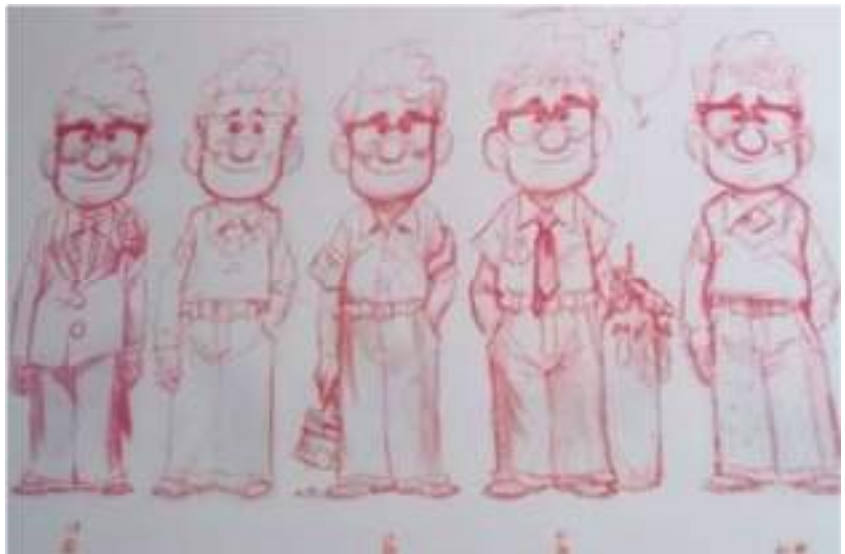
Before the animators begin working on the different scenes, the voices are recorded for the film. Before the actors are brought in to record the lines, people within the studio record scratch voices. These recordings allow the animators to gain ideas for the action based upon the movement of the actors. The recordings also influence the timing in the scenes.



One of the actors recording for Pixar's "Ratatouille."

## Concept Design

Concept design is the process where artists visualize what the director wants the film to look like. In this process, the characters and environment are created through sketches. Later on, the modelers use these sketches as guidelines when they create models in the computer.



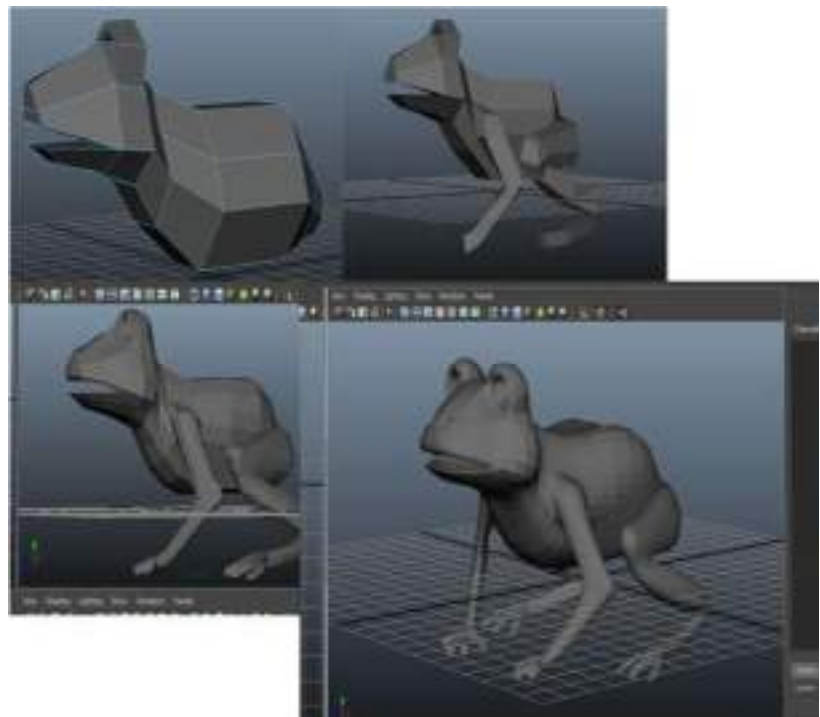
Character designs from Pixar's "Up."



Character designs for "Croak."

### Modelling

Given the sketches of the characters, modellers use programs, such as Autodesk Maya and 3D Studio Max to create the 3D computer characters. When modelling, the base object can be chosen from a cube, sphere, cylinder, cone and other options. Through the manipulation of vertices, faces, and edges, the original mesh is transformed into the final character.

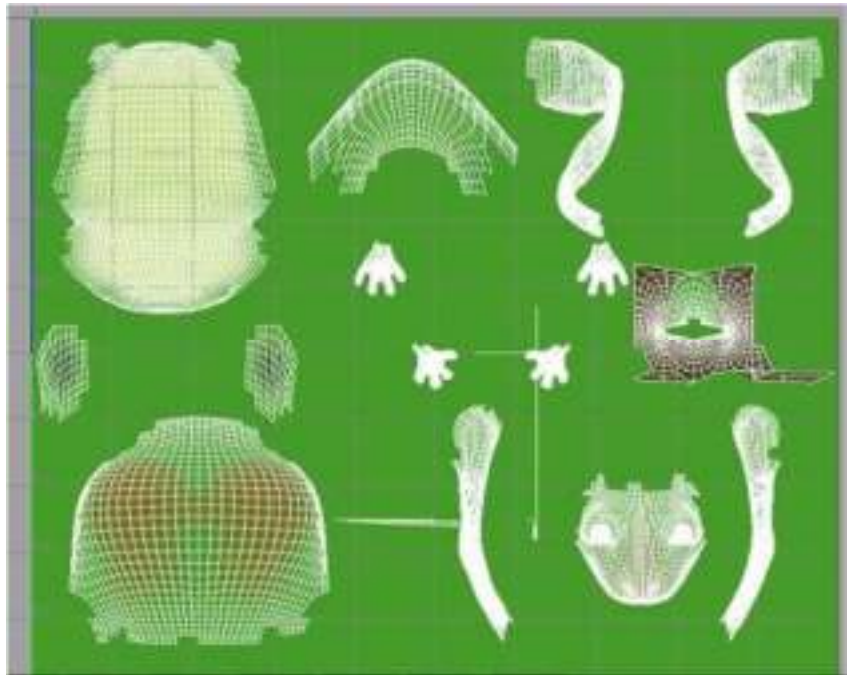




For example, in the picture given here you will see the transformation of the real frog in "Croak" from its beginning stage to the final result.

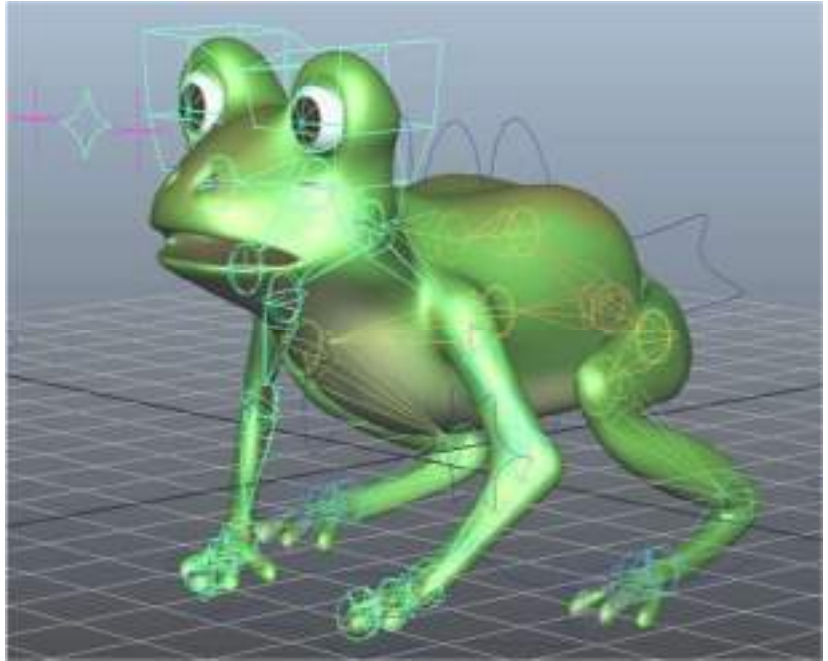
### Texturing

For texturing, one must "unwrap" the mesh into 2D and then paint in either 3D or 2D.

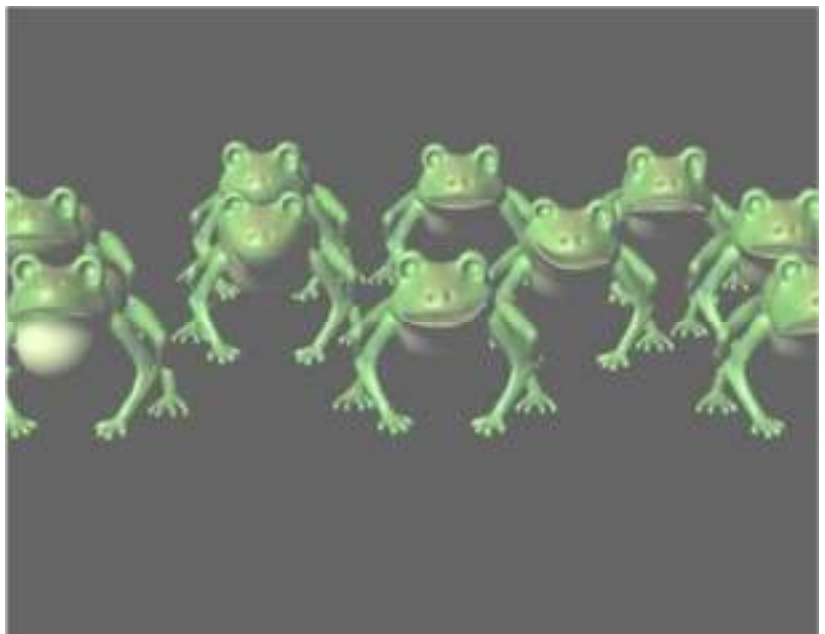


### Rigging

There are two parts to rigging a character for animation. One is constructing the skeletal rig of the model. The skeletal rig is made from joints connected together. When rigging you can choose to use a combination of inverse and forward kinematics. Inverse kinematics is usually used for legs since this allows the animators to place the foot in the correct spot and the rest of the leg will follow. Forward kinematics is usually used to rig the arms and the back. This type of rigging requires the animator to move every joint individually. Once the joints are connected properly, the rigger adds controls to them. This allows the animator to key only the controls and not to worry about the joints. Once the joints are connected to controls, this rig is connected to the mesh through "skinning" and then the rigger must paint weights to specify how the joints affect the mesh geometry.



Secondly, we need to create the extreme positions or modes of the face to give our character expressions. Autodesk Maya, a software interpolates between these extremes, called "blend shapes" to allow us to combine different shapes in different proportions and make new expressions.



Another way to affect the mesh is by using clusters or lattice deformers.

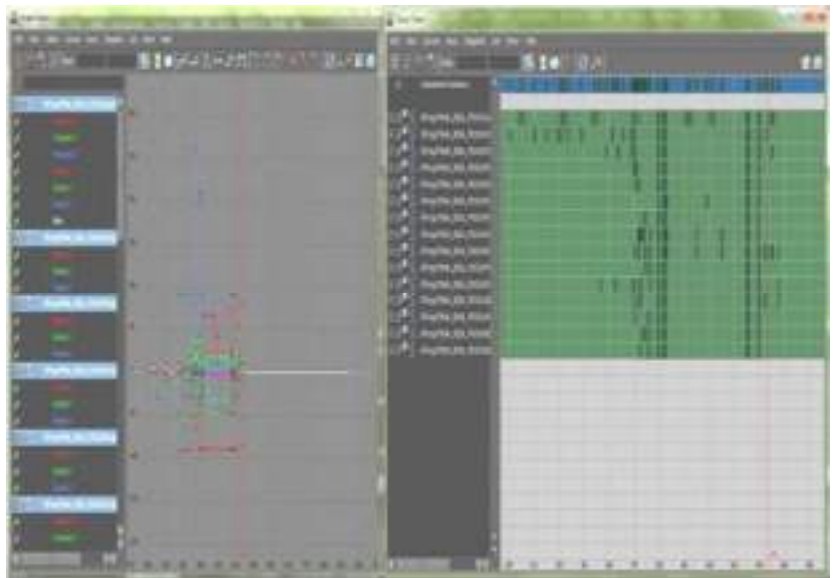
### **Animation**

Once we have our models, our scene and cameras set up, we can start animating based on our storyboard. Unlike in traditional animation,

where the animator must draw each individual frame in computer animation, the animator only sets the main key frames and the computer "tweens" between them.



Autodesk Maya gives animators the graph editor and the dope sheet to help with animation. The graph editor is used to change how the computer interpolates between the main key frames set by the animator. The dope sheet is used to change the timing of the animation.



Animation is tiring but rewarding. After many hours spent setting key frames and tweaking the timing, the character feels like they are alive.

## Exercise

1. Write a short note on production pipeline.

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## Assessment

Answer the following questions:

1. Explain the term pipeline.

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2. State the steps included under production pipeline

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Rigging and Texturing
2. Storyboarding and concept design

**Part B**

Discussed in the class the following:

1. What are the various steps involved in production pipeline.

**Part C**

**Performance standards**

The performance standard may include, but not limited to:

<b>Performance standards</b>	<b>Yes</b>	<b>No</b>
Demonstrate the knowledge of production pipeline		

## Session 6: Pre-production and Storyboarding

In this session, you will learn about pre-production and storyboarding.

### Relevant Knowledge

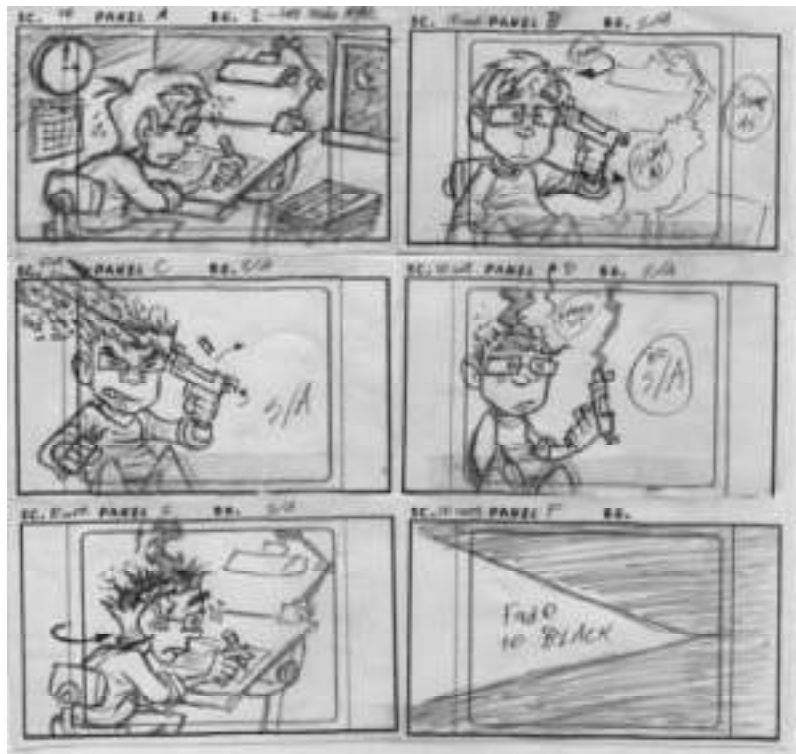
**Pre-production** is the process of preparing all the elements involved in a film, play, or other performance. There are three parts in a production: pre-production, production, and post-production. Pre-production ends when the planning ends and the content starts being produced.

**Pre Production in Films:** In filmmaking and video production, pre-production formally begins once a project has been conceptualized and approval. At this stage, preparations for production go into effect. Financing will generally be confirmed and many of the key elements such as principal cast members, director and cinematographer are set. By the end of pre-production, the screenplay is usually finalized and satisfactory to all the financiers and other stakeholders.

During pre-production, the script is broken down into individual scenes storyboards and all the locations, props, cast members, costumes, special effects and visual effects are identified. An extremely detailed *schedule* is produced and arrangements are made for the necessary elements to be available to the filmmakers at the appropriate times. Sets are constructed, the crew is hired, financial arrangements are put in place and a start date for the beginning of principal photography is set. At some point in pre-production there will be a read-through of the script which is usually attended by all cast members with speaking parts, the director, all heads of departments, financiers, producers, and publicists.

Even though the writer may still be working on it, the screenplay is generally *page-locked* and *scene-numbered* at the beginning of pre-production to avoid confusion. This means that even though additions and deletions may still be made, any particular scene will always fall on the same page and have the same scenenumber.

**Storyboarding:** Storyboards are graphic organizers which are in the form of illustrations or images displayed in sequence for the purpose of pre-visualizing a motion picture, animation, motion graphic or interactive media sequence. Storyboarding became popular in live-action film production during the early 1940s, and grew into a standard medium for previsualization of films.



## Film Storyboard

A film storyboard is essentially a large comic of the film or some section of the film produced beforehand to help film directors, cinematographers and television commercial advertising clients visualize the scenes and find potential problems before they occur. Besides this storyboards also help estimate the cost of the overall production and saves time. Often storyboards include arrows or instructions that indicate movement.

In creating a motion picture with any degree of fidelity to a script, a storyboard provides a visual layout of events as they are to be seen through the camera lens. In the case of interactive media, it is the layout and sequence in which the user or viewer sees the content or information. In the storyboarding process, most technical details involved in crafting a film or interactive media project can be efficiently described either in picture, or in additional text.

## Theatre

A common misconception is that storyboards are not used in theatre. They are frequently special tools that directors and playwrights use to understand the layout of the scene. The great Russian theatre practitioner Constantin Stanislavski developed storyboards in his detailed production plans for his Moscow Art Theatre performances (such as of Chekhov's *The Seagull* in 1898). The German director and dramatist Bertolt Brecht developed

detailed storyboards as part of his dramaturgical method of "fables."

### **Animatics**

In animation and special effects work, the storyboarding stage may be followed by simplified mock-ups called "animatics" to give a better idea of how the scene will look and feel with motion and timing. At its simplest, an animatic is a series of still images edited together and displayed in sequence with a rough dialogue and/or rough sound track added to the sequence of still images (usually taken from a storyboard) to test whether the sound and images are working effectively together.

This allows the animators and directors to work out any screenplay, camera positioning, shot list and timing issues that may exist with the current storyboard. The storyboard and soundtrack are amended if necessary, and a new animatic may be created and reviewed with the director until the storyboard is perfected. Editing the film at the animatic stage can avoid animation of scenes that would be edited out of the film. In the context of computer animation, it helps minimize the construction of unnecessary scene components and models, just as storyboarding helps filmmakers evaluate what portions of sets can be omitted because they will never come into the frame. Animation is usually an expensive, labour-intensive process, so there should be a minimum of "deleted scenes" if the film is to be completed within budget.

Often storyboards are animated with simple zooms and pans to simulate camera movement (using non-linear editing software). These animations can be combined with available animatics, sound effects and dialog to create a presentation of how a film could be shot and cut together. Some feature film DVD *special features* include production animatics.

Animatics are also used by advertising agencies to create inexpensive test commercials. A variation, the "rip-o-matic", is made from scenes of existing movies, television programs or commercials, to simulate the look and feel of the proposed commercial. Rip, in this sense, refers to ripping-off an original work to create a new one.

### **Photomatic**

A photomatic (probably derived from 'animatic' or photo-animation) is a series of still photographs edited together and presented on screen in a sequence. Usually, a voice-over, soundtrack and sound effects are added to the piece to create a presentation to show how a film could be shot and cut together. Increasingly used by advertisers and advertising agencies to research the effectiveness of their proposed



storyboard before committing to a 'full up' television advertisement.

Originally, photographs were taken using colour negative film. A selection would be made from contact sheets and prints made. The prints would be placed on a rostrum and recorded to videotape using a standard video camera. Any moves, pans or zooms would have to be made in camera. The captured scenes could then be edited.

Digital photography, web access to stock photography and non-linear editing programs have had a marked impact on this way of film making also leading to the term 'digimatic'. Images can be shot and edited very quickly to allow important creative decisions to be made 'live'. Photo composite animations can build intricate scenes that would normally be beyond many test film budgets.

### Comic books



### Novels

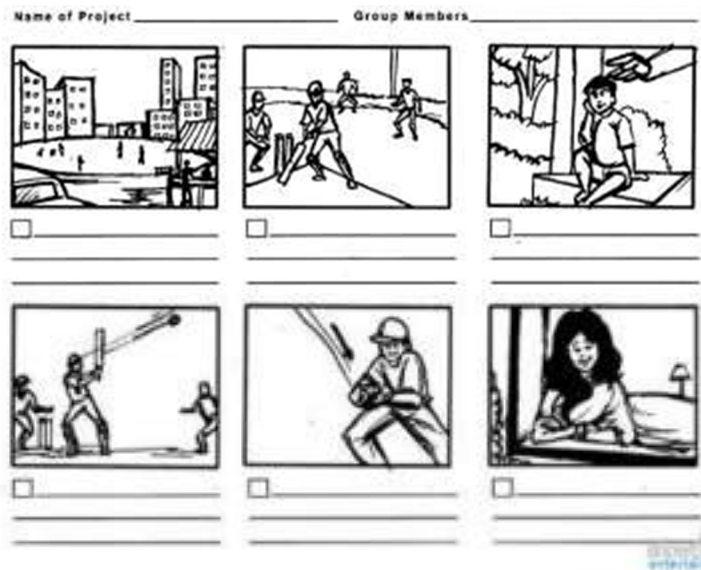
Storyboards are now becoming more popular with novelists. Because most novelists write their stories by scenes rather than chapters, storyboards are useful for plotting the story in a sequence of events and rearranging the scenes accordingly.

### Interactivemedia

More recently the term *storyboard* has been used in the fields of web development, software development and instructional design to present and describe, in written, interactive events as well as audio and motion, particularly on user interfaces and electronic pages. These are then presented to the

project's cinematographer who achieves the director's vision.

Finally, if needed, 3D storyboards are created. The advantage of 3D storyboards is they show exactly what the film camera will see using the lenses the film camera will use. The disadvantage of 3D is the amount of time it takes to build and construct the shots. 3D storyboards can be constructed using 3D animation programs or digital puppets within 3D programs. Some programs have a collection of low resolution 3D figures which can aid in the process. Some 3D applications allow cinematographers to create "technical" storyboards which are optically-correct shots and frames.



### Tips

- For a storyboard any kind of paper will do, but make sure that it's not too fragile.
- The key here is to have a rough idea of what your story is about before you start with the storyboarding.
- Storyboards can also be done as video storyboards, but these can be time-consuming.
- If you are having trouble visualizing it use models to help you draw.
- Don't make them perfect a rough sketch is perfectly fine.
- If it helps, you can fold a piece of paper into 6 squares, to frame your scenes easily or download a free storyboard template from the internet.
- Use storyboarding software as a database for script info, props needed, locations, camera directions and then generate a shotlist.

## Exercise

1. Analyzes a clip from an animated movie. Create a detailed storyboard of the moment in the story that you plan to animate.

## Assessment

Answer the following questions:

1. Explain the term –Storyboard||.

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Animatic andphotomatic
2. Storyboard and filmstoryboard

### Part B

Discussed in the class the following:

1. How to prepare a storyboard?
2. Why a storyboard isprepared?

### Part C

#### Performance standards

The performance standard may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge ofstoryboard		

## Glossary

1. **Animation** -The process of creating a progressively altering image that gives the appearance of continuous motion.
2. **Compositing** -The process of combining multiple elements shot separately (still images, movie clips) into a final image or sequence to give the impression they were all shot at the same time.
3. **Frame** - A still two-dimensional image. In computer animation, the term 'frames per second' (fps) is a measurement of the number of still frames displayed in one second to give the impression of a moving image. For film work, this value is usually 24; for the European PAL broadcast format, 25; and for the US NTSC broadcast format, 30fps.
4. **Joints** - Points of articulation between the bones in a character rig.
5. **Rigging** - The process of preparing a character model for animation, including setting up an underlying skeleton, complete with constraints, controllers and kinematic systems, and linking it to the mesh of the character model.
6. **2D** - Two-dimensional.
7. **3D** - Three-dimensional.

## Suggested Reading

### BOOKS

1. EXTRA: Animation for Beginners by MorrMeroz
2. The animator's survival kit by RichardWilliams
3. Cartoon Animation by PrestonBlair
4. The Illusions of Life by Frank Thomas and OllieJohnston
5. Simplified Drawing for Planning Animation - WayneGilbert
6. The Male and Female Figure in Motion - EdwardMuybridge
7. Character Animation Crash Course! by EricGoldberg
8. Acting for Animators by Ed Hooks
9. Timing for Animation by Harold Whitaker & JohnHalas
10. Animation from Script to Screen by ShamusCulhane
11. Inspired 3D Short Film Production by Pepe Valencia & JeremyCantor

### WEBSITES

1. [http://en.wikipedia.org/wiki/Phi\\_phenomenon](http://en.wikipedia.org/wiki/Phi_phenomenon)
2. [http://en.wikipedia.org/wiki/Key\\_frame](http://en.wikipedia.org/wiki/Key_frame)
3. [http://www.cprogramming.com/tutorial/animation/frames\\_and\\_layers.html](http://www.cprogramming.com/tutorial/animation/frames_and_layers.html)
4. <http://www.arena-multimedia.com/blog/index.php/animation-techniques/>
5. <http://www.instructables.com/id/Making-an-army-of-Gromits-Claymation-Mold-making/>
6. <http://www.animateclay.com/>
7. <http://www.stopmotionanimation.com/>
8. <http://www.stopmotionworks.com/>

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# **PSS Central Institute of Vocational Education**

(a constituent unit of NCERT, an autonomous organization under  
Ministry of Human Resource Development, Government of India)  
Shyamla Hills, Bhopal





# UNIT 2: Principles of Animation

## Student Workbook

(Class 11; NSQF Level 3)

### Course: Media and Entertainment



**PSS Central Institute of Vocational Education**

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Ministry of Human Resource Development, Government of India)



# Student Workbook

(Class 11; NSQF Level 3)

## Course: Media and Entertainment

(Job Role: Animator, QP Ref. Id.: MES/ Q 0701)

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## PSS Central Institute of Vocational Education

(a constituent unit of NCERT, an autonomous organization under  
Ministry of Human Resource Development, Government of India)

Shyamla Hills, Bhopal - 462 013, M.P., India

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## Acknowledgements

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The Institute expresses its gratitude to the subject experts, reviewers and resource persons for their contribution in the development of the course material. Their names have been mentioned in the list of contributors.

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## Preface

The National Curriculum Framework, 2005, recommends that children's life at school must be linked to their life outside the school. This principle makes a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home, community, and the workplace.

The student workbook on "**Principles of Animation**" is a part of the qualification package developed for the implementation of National Vocational Education Qualification Framework (NVEQF). The NVEQF, an initiative of the Ministry of Human Resource Development (MHRD), Government of India, set common principles and guidelines for a nationally recognized qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities. It was subsumed in National Skills Qualifications Framework (NSQF) in 2013. It is envisaged that the NSQF will promote transparency of qualifications, cross-sectoral learning, and student-centred learning and facilitate learner's mobility between different qualifications, thus encouraging lifelong learning.

This student workbook, which forms a part of vocational qualification package for students who have passed Class VIII or equivalent examination, was created by a group of experts. The Media and Entertainment Sector Skill Council approved by the National Skill Development Corporation (NSDC) for the Media and Entertainment Industry developed the corresponding National Occupational Standards (NOS) and the Qualification Pack (QP). The National Occupational Standards are a set of competency standards and guidelines endorsed by the representatives of Media and Entertainment Industry for recognizing and assessing skills and knowledge needed to perform effectively in the workplace.

The Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), a constituent of National Council of Educational Research and Training (NCERT) has developed modular curricula and teaching-learning materials for the vocational qualification package in Media and Entertainment sector for NSQF levels 1 to 4; level 1 is equivalent to Class IX. Based on NOS, generic and occupation related core competencies (knowledge, skills, and abilities) were identified for development of curricula and learning modules.

This student workbook attempts to discourage rote learning and to bring about necessary flexibility in offering of courses, necessary for breaking the sharp boundaries between different subject areas. The workbook attempts to enhance these endeavours by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups and activities requiring hands-on-experience. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy of Education (1986).

The success of this effort depends on the steps that school Principals and Teachers will take to encourage children to reflect their own learning and to pursue imaginative and on-the-job activities and questions. Participation of learners in skill development exercises and inculcation of values and creativity is possible if we involve children as participants in learning, and not as receiver of information. These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table would be a necessity to maintain the rigour in implementing the activities and the required number of teaching days will have to be increased for teaching and training.



# About Your Workbook

This workbook is to assist you with completing the Unit of Competency “Principles of Animation”. You should work through the workbook in the classroom, at the workplace or in your own time under the guidance and supervision of your teacher or trainer. This workbook contains sessions which will help you to acquire relevant knowledge and skills (soft and hard) on various aspects of the unit of competency. Each session is small enough to be easily tackled and digested by you before you move on to the next session. Animated pictures and photographs have been included to bring about visual appeal and to make the text lively and interactive for you. You can also try to create your own illustrations using your imagination or taking the help of your teacher. Let us now see what the sections in the sessions have for you.

## **Section 1: Introduction**

This section introduces you to the topic of the Unit. It also tells you what you will learn through the various sessions covered in the Unit.

## **Section 2: Relevant Knowledge**

This section provides you with the relevant information on the topic(s) covered in the session. The knowledge developed through this section will enable you to perform certain activities. You should read through the information to develop an understanding on the various aspects of the topic before you complete the exercise(s).

## **Section 3: Exercise**

Each session has exercises, which you should complete on time. You will perform the activities in the classroom, at home or at the workplace. The activities included in this section will help you to develop necessary knowledge, skills, and attitude that you need for becoming competent in performing the tasks at workplace. The activities should be done under the supervision of your teacher or trainer who will guide you in completing the tasks and also provide feedback to you for improving your performance. To achieve this, prepare a timetable in consultation with your teacher or trainer and strictly adhere to the stipulated norms or standards. Do not hesitate to ask your teacher or trainer to explain anything that you do not understand.

## **Section 4: Assessment**

The review questions included in this section will help you to check your progress. You must be able to answer all the questions before you proceed to the next session.

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## INTRODUCTION



Animation is the process of creating a continuous motion and shape change illusion by means of the rapid display of a sequence of static images that minimally differ from each other.

There are certain guidelines or principles to be followed for developing animation. It is generally said that there are 12 basic principles of animation, though there could be more. Though the 12 basic principles were originally intended for the hand-drawn animation style of the time, they still apply to the computer animation standards of today and are important for any animator to learn.

It is important that you should attain mastery over the 12 principles of animation, before you actually start making an animation movie.

The **first** and most important of the 12 principles is **Squash and Stretch** which is used to give drawn objects a feeling of flexibility and weight. Squash and Stretch are often manipulated to create a comedic effect but are utilized in all types of animation.

The **second** principle is **Anticipation** of a movement, which is just as important as the movement itself. The moment of anticipation informs the audience that an object or character is about to take action.

The **third** is the **Staging**, which is the layout of objects and characters in a scene that draw the audience's attention to the subject of the scene. Wide, medium and close up shots, camera angles, colors, and the amount of movement should all be taken into consideration when developing the staging of a scene.

The **fourth** is the **Straight Ahead and Pose-to-Pose** in which the animator draws each scene a single frame at a time. In this case, the animation is moving straight ahead from the first drawing in the scene. In Pose to pose animation, the animator plans out the key poses in the scene and then with the help of an assistant or animation software, fills in the frames between each key frame.

The **fifth** principle is the **Follow Through and Overlapping Action** which pertains to drawn objects that are in motion.

The **sixth** principle is **Slow-Out and Slow-In**, which governs the smoothness of an animation. More frames means smoother, slower animation, fewer frames will speed up the animation.

The **seventh** principle is **Arcs**, which are used for expressing

speed. Thrown objects, limbs, and even free moving characters follow what is called a “natural arc” for the scene, which is determined by the staging and perspective of the scene.

The **eight** principle is the **Secondary Action** which convey strong emotions.

The **ninth** principle is **Timing** or the number of frames in a scene or action. It governs overall speed of the animation.

The **tenth** principle is **Exaggeration**, which is used to make scene interesting in one aspect of it over another.

The **eleventh** principle is **Solid Drawing** that applies to objects drawn in three a three dimensional space. An animator use solid drawing techniques to give their drawn objects three dimensional aspects like weight, balance, anatomy, lighting and more.

The **twelfth** principle is **Appeal** which is used to make the leading characters in any project as appealing as possible to captivate the audience.

In this unit, we will discuss the 12 principles of animation and learn how to apply these principles to produce a wonderful animation movie.

## Session 1: Principles of Animation - I

In this session, you will learn about the four principles of animation i.e. Squash and Stretch, Anticipation, Staging and Straight Ahead and Pose-to-Pose Animation.

### Relevant Knowledge

Basic principles of animation were developed by the 'old men' of Walt Disney Studios, during the 1930s and amongst them Frank Thomas and Ollie Johnston, of course they were not old men at the time, but young men who were at the forefront of exciting discoveries that were contributing to the development of a new artform.

The 12 principles of animation are as follows:

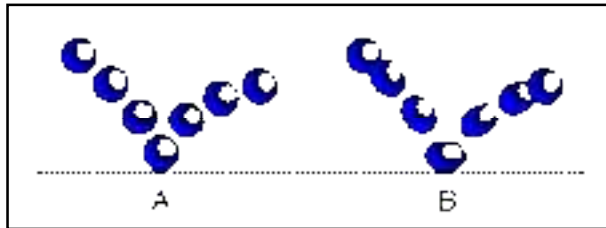
1. Squash and Stretch
2. Anticipation
3. Staging
4. Straight Ahead and Pose-to-Pose Animation
5. Follow through and Overlapping Action
6. Slow Out and Slow In
7. Arcs
8. Secondary Action
9. Timing
10. Exaggeration
11. Solid Drawing
12. Appeal

These principles came as a result of reflection about their practice and through Disney's desire to devise a way of animating that seemed more 'real' in terms of how things moved, and how that movement might be used to express character and personality.

1. Squash and Stretch
2. Anticipation
3. Staging
4. Straight Ahead and Pose-to-Pose

**Squash and Stretch:** The most important principle is "**Squash and Stretch**", the purpose of which is to give a sense of weight and flexibility to drawn objects. It can be applied to simple objects, like a bouncing ball, or more complex constructions, like the musculature of a human face. For example, a figure stretched or squashed to an exaggerated degree can have a comical effect. In realistic animation, however, the most important aspect of this principle is the fact that an object's volume does not change when squashed or stretched. If the length of a ball is stretched vertically, its width needs to contract correspondingly horizontally.

Illustration of the "squash and stretch"-principle:  
Example A shows a ball bouncing with a rigid, non-dynamic movement. In example B the ball is "squashed".



In traditional animation, characters movements had a very high degree of exaggerated and non-rigid deformation.

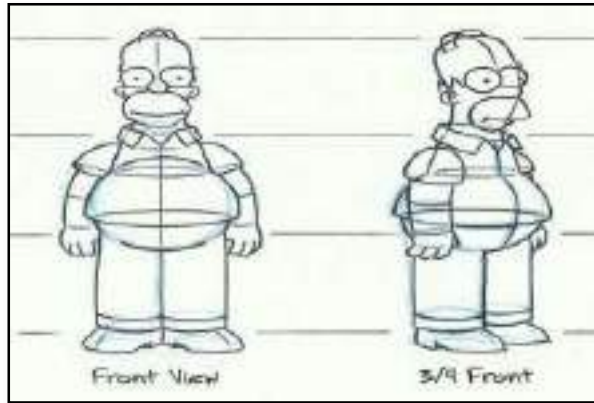
### Anticipation

In 2D animation, the anticipation of a movement is just as important as the movement itself. The moment of anticipation informs the audience that an object or character is about to take action and directs their attention appropriately. Anticipation is the technique by which the audience's eyes are drawn to where action will occur on-screen. Anticipation can be created by the skillful use of motion curves, expanding or contracting pieces of animation to create the anticipatory effect.

### Staging

Staging refers to the way in which character motion and camera movements are set up to convey the mood and intent of a scene. In 3D animation, staging can be expanded to include more detail, hide points of interest, set up for chain reactions, and so on. Staging is also useful in animistic, which establish a scene's core movements before primary animation gets underway.

Staging is how you go about setting up your scene, from the placement of the characters to the background and foreground elements and how the camera angle is set up. The purpose of staging is to make the purpose of the animation unmistakably clear to the viewer. The essence of this principle is keeping focus on what is relevant, and avoiding unnecessary detail. Staging is the presentation of an idea so that it is completely and unmistakably clear



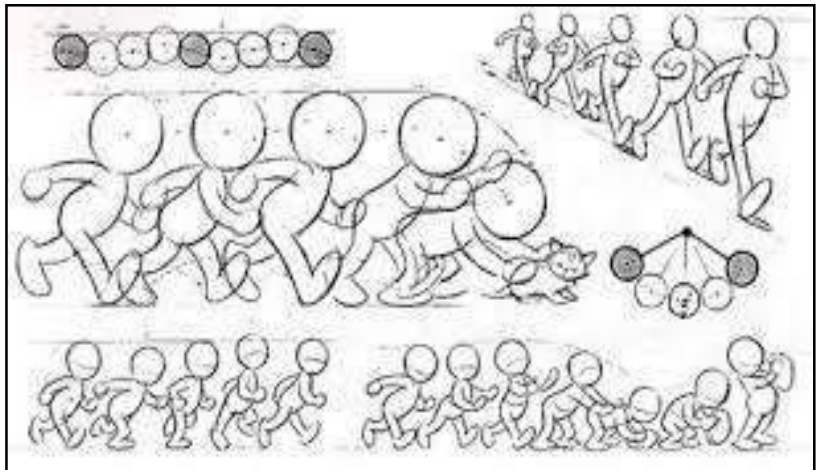
### **Straight Ahead and Pose-to-Pose Animation**

These are two different approaches to the actual drawing process. "Straight ahead action" means drawing out a scene frame by frame from beginning to end, while "pose to pose" involves starting with drawing a few key frames, and then filling in the intervals later. "Straight ahead action" creates a more fluid, dynamic illusion of movement, and is better for producing realistic action sequences. On the other hand, it is hard to maintain proportions, and to create exact, convincing poses along the way. "Pose to pose" works better for dramatic or emotional scenes, where composition and relation to the surroundings are of greater importance. A combination of the two techniques is often used.

Computer animation removes the problems of proportion related to "straight ahead action" drawing. However, "pose to pose" is still used for computer animation, because of the advantages it brings in composition. The use of computers facilitates this method, as computers can fill in the missing sequences in between poses automatically. It is, however, still important to oversee this process and apply the other principles discussed.

*Straight ahead action* is so called because an animator literally works straight ahead from the first drawing in the scene. This process usually produces drawings and action that have a fresh and slightly zany look, because the whole process is kept very creative. Straight ahead action is used for wild, scrambling actions where spontaneity is important.





In *pose-to-pose* animation, the animator plans his action, figuring out just what drawings will be needed to animate the scene. Pose-to-pose is used for animation that requires good acting, where poses and timing are important.

## Exercise

1. Go to <http://blog.digitaltutors.com/character-animation-fundamentals-squash-stretch/> and watch the videos on squash and stretch and practice the same on the software available with you or download the software from opensource.
2. Search for anticipation, Staging Straight Ahead and Pose-to-Pose on Youtube and watch the videos and practice on the software available with you or download the software from opensource.

## Assessment

Answer the following questions

1. Write 12 basic principles of animation.

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2. What is the difference between squash and stretch?

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3. Explain the term "straight aheadaction".

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Squash and stretch
2. Straight Ahead and Pose-to-Pose

### Part B

Discussed in the class the following:

1. Meaning of the following terms:
  - (a) Rigidity
  - (b) Squash
  - (c) Stretch
2. How to do squash and stretch for stronger gestures?
3. How to perform anticipation for building up an action?
4. How to introduce pose to pose animation
5. How to bridge pose to pose and straight ahead action?

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate the understanding of different character styles and types		
Demonstrate the knowledge of Squash and Stretch		
Demonstrate the knowledge of anticipation		
Demonstrate the knowledge of staging		
Demonstrate the knowledge of Straight ahead and Pose to Pose		

## Session 2: Principles of Animation -II

In this session, you will learn about the other four principles of animation i.e. Follow-through and Overlapping Action, Slow Out and Slow In, Arcs and Secondary Action.

### Relevant Knowledge

Let us now understand the other four principles of animation. These are as follows:

1. Follow-through and Overlapping Action
2. Slow Out and Slow In
3. Arcs
4. Secondary Action

#### Follow-through and Overlapping Action

These are related techniques which help to render movement more realistically. "Follow through" means that separate parts of a body will continue moving after the character has stopped. "Overlapping action" is the tendency for parts of the body to move at different rates (an arm will move on different timing of the head and so on). A third related technique is "drag", where a character starts to move and parts of him take a few frames to catch up.

#### Slow Out and Slow In

As any object or person moves or comes to a stop there needs to be a time for acceleration and deceleration. Without, ease in and ease out (or slow in slow out), movements become very unnatural and robotic. The same must be accomplished in an animation, and the easiest way to accomplish ease in and ease out is to utilize the principle of spacing. As a character stands up from a sitting position, the spacing will be closer together at the start, so they ease into the movement, and as they stand up, they will ease out of the movement. Without this acceleration and deceleration of actions everything would be very abrupt and jerky.

#### Arcs

Most natural action tends to follow an arched **trajectory**, and animation should adhere to this principle by following implied "arcs" for greater realism. This can apply to a limb moving by rotating a joint, or a thrown object moving along a **parabolic** trajectory. The exception is mechanical movement, which typically moves in straightlines.

As an object's speed or momentum increases, arcs tend to flatten out in moving ahead and broaden in turns.

## Secondary Action

Secondary action refers to creating actions that emphasize or support the main action of the animation; it can breathe more life into an animation and create a more convincing performance. A character walking down the street while whistling could be an example of secondary action or a person leaning up against a wall talking to some people at school, the main action is the character leaning against the wall and talking, and then putting in an action of them crossing their arms would be the secondary action.

### Exercise

1. Search for Follow-through and Overlapping Action on Youtube and watch the videos and practice on the software available with you or download the software from opensource
2. Search for Slow Out and Slow In Action on Youtube and watch the videos and practice on the software available with you or download the software from opensource
3. Search for Arcs on Youtube and watch the videos and practice on the software available with you or download the software from opensource
4. Search for Secondary Action on Youtube and watch the videos and practice on the software available with you or download the software from opensource

### Assessment

Answer the following questions

1. What is the difference between follow through and overlapping action?

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### Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

#### Part A

Differentiated between the following:

1. Follow-through and Overlapping Action
2. Slow Out and Slow In
3. Arcs and Secondary Action

**Part B**

Discussed in the class the following:

1. How to use arcs for correcting a path of action?
2. How to slow in and slow out?
3. How to slow in and slow out for realism?

**Part C**

**Performance standards**

The performance standards may include, but not limited to:

<b>Performance standards</b>	<b>Yes</b>	<b>No</b>
Demonstrate the knowledge of using arcs for correcting a path of action		
Demonstrate the knowledge of slow in and slow out for realism		

## Session 3: Principles of Animation -III

In this session, you will learn about the last four principles of animation i.e. Timing, Exaggeration, Solid Drawing and Appeal.

### Relevant Knowledge

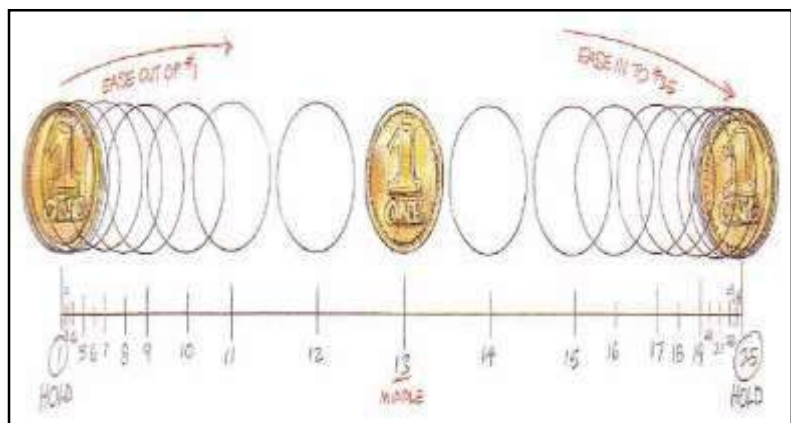
The last 4 principles of animation are as follows:

1. Timing
2. Exaggeration
3. Solid Drawing
4. Appeal

### Timing and Spacing

Timing refers to the number of drawings or frames for a given action, which translates to the speed of the action on film. On a purely physical level, correct timing makes objects appear to obey the laws of physics; for instance, an object's weight determines how it reacts to an impetus, like a push. Timing is critical for establishing a character's mood, emotion, and reaction. Timing is not exactly a rule, but it is the most important aspect of animation and is what sets it apart from other drawn **art forms**. So much of animation is about timing. Messages or feelings that cannot be portrayed by a still picture can be communicated with the addition of timing.

One classic example that you see not only in **film** but also in **real life** is the dramatic pause. Think of when somebody whispers a secret to a friend. There's a moment, just before they spill the beans, when they hesitate, looking around to make sure no one's listening. This moment makes the anticipation of the secret greater. Exaggerating a dramatic pause can make an event in your animation funnier, more poignant or more intense.



Timing, or the speed of an action, is an important principle because it gives meaning to movement. The speed of an action defines how well the idea will be read to the audience.

## Exaggeration

Exaggeration is an effect especially useful for animation, as perfect imitation of reality can look static and dull in cartoons. The level of exaggeration depends on whether one seeks realism or a particular style, like a caricature or the style of an artist. The classical definition of exaggeration, employed by Disney, was just presenting it in a wilder more extreme form.

It is important to employ a certain level of restraint when using exaggeration; if a scene contains several elements, there should be a balance in how those elements are exaggerated in relation to each other, to avoid confusing or overawing the viewer.

## Solid Drawing

Solid drawing is about creating an accurate drawing with volume and weight, and thinking about balance, and the anatomy in a pose. For example, the character may have both arms on their hips or both hands in their pockets. This creates a rather boring and unappealing pose. Making sure you implement the principle of solid drawing into your posing will ensure you avoid this issue.

## Appeal

Appeal corresponds to what would be called charisma in an actor. A character who is appealing is not necessarily sympathetic - villains or monsters can also be appealing - the important thing is that the viewer feels the character is real and interesting. There are several tricks for making a character connect better with the audience.

## Exercise

1. Search for Timing, Exaggeration, Solid Drawing and Appeal on Youtube and watch the videos and practice on the software available with you or download the software from open source

## Assessment

Answer the following questions

1. Describe the term staging.

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2. Explain the term "straight ahead action" and secondary action.

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Exaggeration and Appeal

### Part B

Discussed in the class the following:

1. How to add energy with exaggeration
2. How to introduce appeal for personality?
3. How to introduce timing and spacing for weight?
4. How to introduce timing and spacing for contrast?

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge to introduce appeal for personality		
Demonstrate the knowledge to introduce timing and spacing for weight		



1. **Animation** -The process of creating a progressively altering image that gives the appearance of continuous motion.
2. **Autodesk Maya** - It is commonly shortened to **Maya**, it is a 3D computer graphics software that runs on Windows, Mac OS and Linux.
3. **Compositing** -The process of combining multiple elements shot separately (still images, movie clips) into a final image or sequence to give the impression they were all shot at the same time.
4. **Driven keys** - Driven Keys are used to drive the attributes of one object to another object.
5. **Expression** - A mathematical formula used to define the value of a given attribute of an object during animation. The use of expressions forms a procedural alternative to hand, or key frame animation.
6. **Frame** - A still two-dimensional image. In computer animation, the term „frames per second“ (fps) is a measurement of the number of still frames displayed in one second to give the impression of a moving image. For film work, this value is usually 24; for the European PAL broadcast format, 25; and for the US NTSC broadcast format, 30fps.
7. **High Definition(HD)** - A general term for a video signal with a significantly higher resolution than standard definition.
8. **Joints** - Points of articulation between the bones in a character rig.
9. **Pivot** - To cause to rotate, revolve, or turn.
10. **Rigging** - The process of preparing a character model for animation, including setting up an underlying skeleton, complete with constraints, controllers and kinematic systems, and linking it to the mesh of the character model.
11. **3D** -Three-dimensional, Descriptive of a region of space that has width, height and depth.

## Suggested Reading

### Books

1. Digital Video for Dummies by MartinDoucette
2. The Digital Filmmaking Handbook by Ben Long, SonjaSchenk
3. Digital Non-linear Desktop Editing by SonjaSchenk
4. Cengage Advantage Books: Audio Basics by StanleyAlten
5. PC Audio Editing by RogerDerry
6. Editing with Final Cut Pro 4: An Intermediate Guide to Setup and Editing Workflow by Charles Roberts
7. The S.M.A.R.T. Guide to Recording Great Audio Tracks in a Small Studio by Bill Gibson, William A. Gibson
8. Adobe Soundbooth CS3 by Adobe CreativeTeam
9. Adobe Premiere Pro CS3 Classroom in a Book by Adobe CreativeTeam
10. AdobePremiereProCS6:TheOfficialTrainingWorkbookfromAdobeSystemsbyAdobeCreative Team

### Websites

1. <http://computer.howstuffworks.com/video-editing4.htm>
2. <http://diyvideoeditor.com/video-editing-basics/>
3. <http://www.mediacollege.com/video/editing/tutorial/>
4. <http://www.dpbestflow.org/node/637>
5. <http://www.larryjordan.biz/adobe-video-editing-workflow/>
6. [http://manual.audacityteam.org/o/man/tutorial\\_editing\\_an\\_existing\\_file.html](http://manual.audacityteam.org/o/man/tutorial_editing_an_existing_file.html)
7. <http://www.hongkiat.com/blog/25-free-digital-audio-editors/>
8. [http://en.wikipedia.org/wiki/Adobe\\_Soundbooth](http://en.wikipedia.org/wiki/Adobe_Soundbooth)
9. [http://en.wikipedia.org/wiki/Adobe\\_Premiere\\_Pro](http://en.wikipedia.org/wiki/Adobe_Premiere_Pro)

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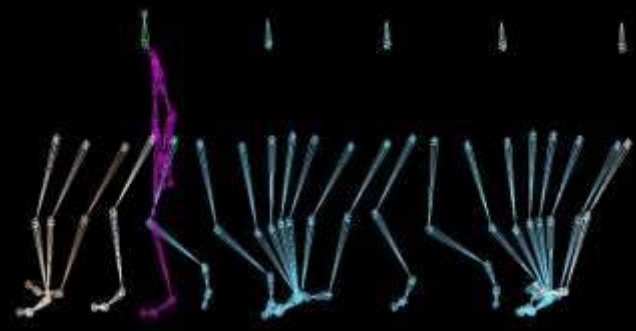
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Ministry of Human Resource Development, Government of India)  
Shyamla Hills, Bhopal

# UNIT 3: Introduction to 2D Animation

## Student Workbook

(Class 11; NSQF Level 3)

Course: Media and Entertainment



PSS Central Institute of Vocational Education

(a constituent unit of NCERT,

# Student Workbook

(Class XI; NSQF Level 3)

## Course: Media and Entertainment

(Job Role: Animator, QP Ref. Id.: MES/ Q 0701)

**Dr. Vinay Swarup Mehrotra**

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## Preface

The National Curriculum Framework, 2005, recommends that children's life at school must be linked to their life outside the school. This principle makes a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home, community, and the workplace.

The student workbook on “**Introduction to 2D Animation**” is a part of the qualification package developed for the implementation of National Vocational Education Qualification Framework (NVEQF). The NVEQF, an initiative of the Ministry of Human Resource Development (MHRD), Government of India, set common principles and guidelines for a nationally recognized qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities. It was subsumed in National Skills Qualifications Framework (NSQF) in 2013. It is envisaged that the NSQF will promote transparency of qualifications, cross-sectoral learning, and student-centred learning and facilitate learner's mobility between different qualifications, thus encouraging lifelong learning.

This student workbook, which forms a part of vocational qualification package for students who have passed Class VIII or equivalent examination, was created by a group of experts. The Media and Entertainment Sector Skill Council approved by the National Skill Development Corporation (NSDC) for the Media and Entertainment Industry developed the corresponding National Occupational Standards (NOS) and the Qualification Pack (QP). The National Occupational Standards are a set of competency standards and guidelines endorsed by the representatives of Media and Entertainment Industry for recognizing and assessing skills and knowledge needed to perform effectively in the workplace.

The Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), a constituent of National Council of Educational Research and Training (NCERT) has developed modular curricula and teaching-learning materials for the vocational qualification package in Media and Entertainment sector for NSQF levels 1 to 4; level 1 is equivalent to Class IX. Based on NOS, generic and occupation related core competencies (knowledge, skills, and abilities) were identified for development of curricula and learning modules.

This student workbook attempts to discourage rote learning and to bring about necessary flexibility in offering of courses, necessary for breaking the sharp boundaries between different subject areas. The workbook attempts to enhance these endeavours by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups and activities requiring hands-on-experience. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy of Education(1986).

The success of this effort depends on the steps that school Principals and Teachers will take to encourage children to reflect their own learning and to pursue imaginative and on-the-job activities and questions. Participation of learners in skill development exercises and inculcation of values and creativity is possible if we involve children as participants in learning, and not as receiver of information. These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table would be a necessity to maintain the rigour in implementing the activities and the required number of teaching days will have to be increased for teaching and training.



## About Your Workbook

This workbook is to assist you with completing the Unit of Competency “**Introduction to 2D Animation**”. You should work through the workbook in the classroom, at the workplace or in your own time under the guidance and supervision of your teacher or trainer. This workbook contains sessions which will help you to acquire relevant knowledge and skills (soft and hard) on various aspects of the unit of competency. Each session is small enough to be easily tackled and digested by you before you move on to the next session. Animated pictures and photographs have been included to bring about visual appeal and to make the text lively and interactive for you. You can also try to create your own illustrations using your imagination or taking the help of your teacher. Let us now see what the sections in the sessions have for you.

### **Section 1: Introduction**

This section introduces you to the topic of the Unit. It also tells you what you will learn through the various sessions covered in the Unit.

### **Section 2: Relevant Knowledge**

This section provides you with the relevant information on the topic(s) covered in the session. The knowledge developed through this section will enable you to perform certain activities. You should read through the information to develop an understanding on the various aspects of the topic before you complete the exercise(s).

### **Section 3: Exercise**

Each session has exercises, which you should complete on time. You will perform the activities in the classroom, at home or at the workplace. The activities included in this section will help you to develop necessary knowledge, skills, and attitude that you need for becoming competent in performing the tasks at workplace. The activities should be done under the supervision of your teacher or trainer who will guide you in completing the tasks and also provide feedback to you for improving your performance. To achieve this, prepare a timetable in consultation with your teacher or trainer and strictly adhere to the stipulated norms or standards. Do not hesitate to ask your teacher or trainer to explain anything that you do not understand.

### **Section 4: Assessment**

The review questions included in this section will help you to check your progress. You must be able to answer all the questions before you proceed to the next session.

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## Introduction

### Introduction to 2D Animation

What was once done with pencils, cells, and paint by a team of dozens of animators can now be accomplished by a single person with a powerful enough home computer and the right software.

The term "computer animation" broadly covers a wide variety of genres and applications, though the simplest way to break it down is into the categories of 2D and 3D animation. "2D", short for "two-dimensional", is sometimes also called "vector animation", and is typically done in programs like Macromedia Flash and Macromedia Director. The most familiar form of 2D animation are traditional cartoons, which are progressing more and more into the digital realm. You probably see simpler animations every day just while surfing the web, in the form of advertisements, E-cards, and cartoon shorts. Vector animation is also useful in designing interactive interfaces for the web.

2D animation creates movement in a two-dimensional space. Work in the field of 2D animation requires both creativity and

technological skills. It focuses on creating characters, storyboards and backgrounds in two-dimensional environment. The characters can move up and down, left and right. They do not appear to move toward or away from the viewer, as they would do in 3D animation. 2D animation uses bitmap and vector graphics to create and edit the animated images and is created using computers and software programs, such as Adobe Photoshop, Flash, After Effects and Encore. These animations may be used in advertisements, films, television shows, computer games or websites. To learn 2D animation, you will have to learn about the various aspects of character design, life drawing techniques, storyboarding, digital video, digital audio, and stop motion animation.

Unlike 3D animation, 2D animation does not employ any fancy digital models, but uses a more straightforward approach. Massive digital drawing tablets enable animators to draw their keyframes digitally and create the tweens automatically using 2D animation software. Many modern animation studios (such as DreamWorks and Pixar) use 3D animation tools to create the characters and environments for their movies, sculpting them out of thousands of tiny digital polygons and animating them with computer code like puppets on strings.

Today, visual development requires much less manual labor, but is no less an important step in the creation of an animated film. Artists use specialized tools to digitally draw and refine the characters and scenes, saving hundreds of hours of sketching, inking and painting. After the designs of each character and scene have been finalized, the production process can begin.

## Session 1: Concept of 2D Animation

In this session you will learn about the major forms of animation, production and post production.

### Relevant Knowledge

#### What is 2D Animation?

The creation of moving pictures in a two-dimensional environment, such as through "traditional" cel animation or in computerized animation software. This is done by sequencing consecutive images, or "frames", that simulate motion by each image showing the next in a gradual progression of steps. The eye can be "fooled" into perceiving motion when these consecutive images are shown at a rate of 24 frames per second or faster.

2D animation figures are created and/or edited on the computer using 2D bitmap graphics or created and edited using 2D vector graphics. This includes automated computerized versions of traditional animation techniques such as of interpolated morphing, onion skinning and interpolated rotoscoping.

2D animation has many applications, including analog computer animation, Flash animation and Power Point animation. The overall process of creating a 2D animation is divided into three parts: pre-production, production, and post-production.

- Pre-Production
- Production
- Post-Production

#### Pre-Production



#### Pre-Production

Pre-production involves establishing the plot of the completed animation. Because each **shot** in animation is so labour-intensive, that it is necessary to get shots right during the pre-production. Re-animating a shot is very expensive, especially compared to live-action filming, therefore, almost care needs to be taken while taking shots.

Most animations are *storyboarded*, in which the main action in each scene is drawn in a **comic book**-like form. Storyboards are usually pasted on large foam-core or posterboard sheets, which can be quickly read through by the staff. During pre-production, the **staff reviews** the storyboard for consistency, and parts of the storyboard may be redrawn multiple times.



**Production**

### **An Inked Drawing**

Each shot in a 2D animation involves multiple single drawings of characters (although some **computer programs**, such as 'Anime Studio', can create characters much like puppets, which can be posed at different keyframes, and the computer moves the character between those keyframes). To demonstrate the concept, think of a still camera that can take many photographs in rapid succession. Imagine aiming that camera at a person and taking many quick photographs as the person walks towards you.

Each photograph corresponds to an individual drawing in an animation.

A shot may contain only one drawing (especially in "limited animation" forms like anime), but usually contain about ten to twenty drawings. These drawings are divided into "keys" and "in-betweens." Keys are important drawings that convey the extremes of the character's movement--the first drawing is almost always a key--while in-betweens (or "tweens") are the remaining, less important drawings in the shot.

Typically, each drawing begins with a **sketch**, in pencil, of the character's pose.



**A Colored Key Cel**

This is the point at which computers often step in. Some companies hand-ink each drawing, writing over the **cleaned** pencil lines with a pen. Others--especially **studios** whose artists can draw very clean pencil lines--will scan the **pencils** directly into the computer, then ink the drawing digitally.

The drawing is now considered a "cel." Before computers, the drawing would now be photocopied onto a sheet of clear celluloid or acetate, then hand-painted. This created a "cel," which was placed on top of a background painting and filmed with the click of a **film camera**. Cels are still highly prized by collectors, though few true cels remain. Many of those on the market are reproductions.

Today, the digital cels are coloured on a computer. Meanwhile, a background is drawn (on the computer, or hand-drawn and scanned). The background is imported into an animation program, and each cel is layered onto the background in **succession**. This is then saved on the computer as a single video file.



**A Colored Tween**

In practice, the keys are usually drawn by a top animator, and these are then scanned and assembled into a "rough cut" of the shot while the keys are given to a junior animator, who will draw

the tweens. The film can then be assembled during production, and junior animators can be directed in small adjustments to improve the flow of each shot and scene.

### Post-Production

Even after all the tweens have been colored and added to the animation, the film is far from complete. There's still music and sound effects to be added, as well as visual effects. The animation also may need to be edited in the more traditional film sense; shots cut slightly short or held longer, even scenes cut entirely.

### Exercise

1. Watch some 2D animated clips to understand about 2D animation.

### Assessment

Answer the following questions

1. What is 2Dcel?

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2. What are the hardware requirements for 2Danimation?

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3. Which type of animation uses still frames with a graphic that slightly changesposition?

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4. Which animation techniques uses a seamless transition to change one image intoanother?

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiate between the following:

1. 2D animation and 3D animation
2. Object oriented animation and frame by frame animation

### Part B

Discussed in the class the following:

1. What are different types of 2D animation?
2. Basics of 2D animation
3. What is object oriented animation?
4. What is frame by frame animation?
5. What is another name for vector animation?

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge of general features of 2D animation		
Identify at least 4 features of 2D animation		
Name at least 2 software used for 2D animation		



## Session 2: Types of 2D Animation

In this session you will gain knowledge on how animation is created on a computer using bitmap images.

### Relevant Knowledge



2D animation is created on a computer using bitmap images, or it can be created and edited using 2D vector graphics. 2D animation can be used for many different things, like video games, advertisements or creating an animated film.

**Cel Animation** - (traditional animation) is based on a series of frames or cels in which the object is redrawn in each consecutive cel to depict motion. Cel comes from the word celluloid (a transparent sheet material) which was first used to draw the images and place them on a stationary background.



**Digital Animation** - It is a paperless version of traditional animation, where drawings are drawn straight out the computer.

**Path Animation** - Path Based animation is the simplest form of animation and the easiest to learn. It moves an object along a predetermined path on the screen. The path could be a straight line or it could include any number of curves. Often the object does not change, although it might be resized or reshaped.

**Stop Motion Animation** - although this can be classified also as 3D animation, Stop Motion Animation can work with 2d objects, such as illustration and **photos**.

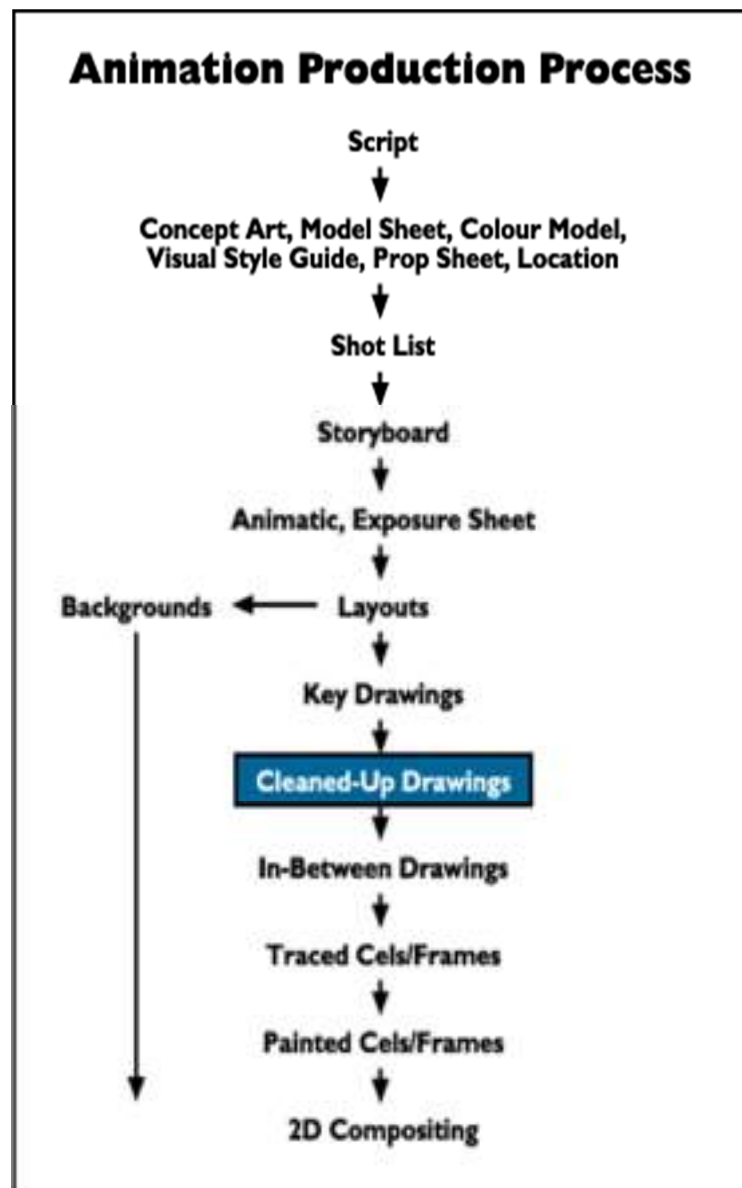
**Sand Animation** - sand is moved around on a back- or front-lighted piece of glass to create each frame for an animated film. This creates an interesting effect when animated because of the light contrast.

**Cut-out Animation**, is made by cut pieces of paper card fabric etc. They are placed under glass and then a frame is taken and cut out is moved slightly and again a new frame is taken.

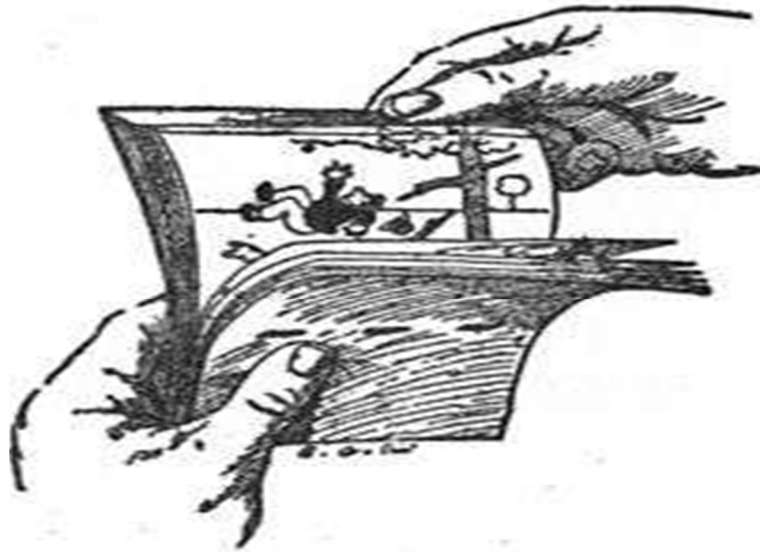
**Rotoscoping** is made by tracing over live video to create realistic movement. Each frame is traced over individually then the reel footage is removed leaving you with just the traced drawing.

### Cinemagraphs

**Cinemagraphs** are still photographs in the form of animated GIF where the animator chooses the part where to animate.



## Flip Book



THE KINEOGRAPH.

### Flip Book

A **Flip Book** or **Flick Book** is a book with a series of pictures that vary gradually from one page to the next, so that when the pages are turned rapidly, the pictures appear to animate by simulating motion or some other change. Flip books are often illustrated books for children, but may also be geared towards adults and employ a series of photographs rather than drawings.

Flip books are essentially a primitive form of animation. Like motion pictures, they rely on persistence of vision to create the illusion that continuous motion is being seen rather than a series of discontinuous images being exchanged in succession. Rather than "reading" left to right, a viewer simply stares at the same location of the pictures in the flip book as the pages turn. The book must also be flipped with enough speed for the illusion to work, so the standard way to "read" a flip book is to hold the book with one hand and flip through its pages with the thumb of the otherhand.

## Exercise

1. Make a chart containing various 2D animation processes, with some examples
2. Make drawings of characters with background

## Assessment

Answer the following question

1. What is cell animation?

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Stop motion animation and cut-out animation

### Part B

Discussed in the class the following:

1. What is cell animation?

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate an understanding of cell animation		
Demonstrate the knowledge of cut out animation		
Make drawings of character and background		

## Session 3: Basics Process of 2D Animation

In this session you will learn about the basic principles of animation.

### Relevant Knowledge

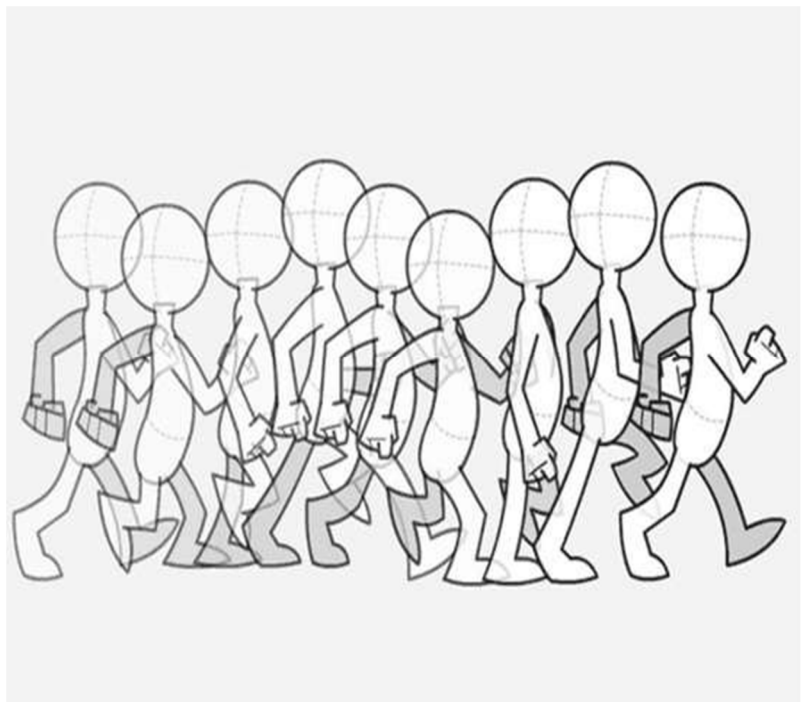
The difference between 2D and 3D animation is the appearance of depth. 2D animation is a flat animation and all the actions happen in the x-y axes. 3D animation includes an extra dimension and that is the z axis. 2D animation uses onion tool kits while 3D animation requires digital modeling.

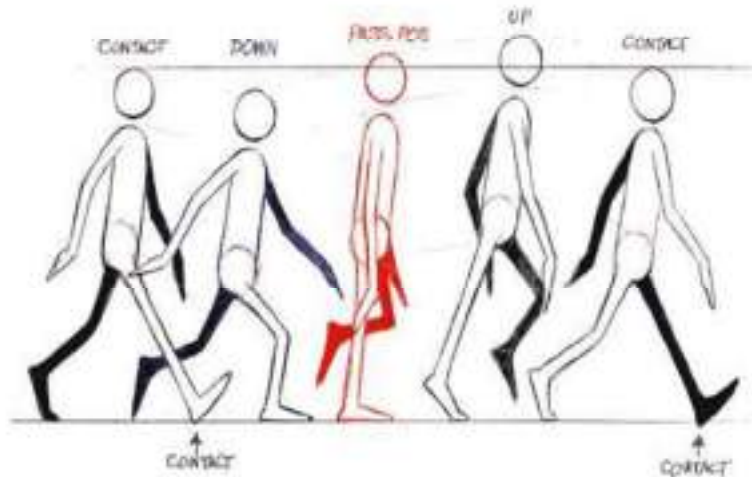
### Walk Cycle 2D

In animation, a walk cycle is a series of frames or illustrations drawn in sequence that loop to create an animation of a walking character. The walk cycle is looped over and over, thus having to avoid animating each step again.

### Creating a Walk Cycle

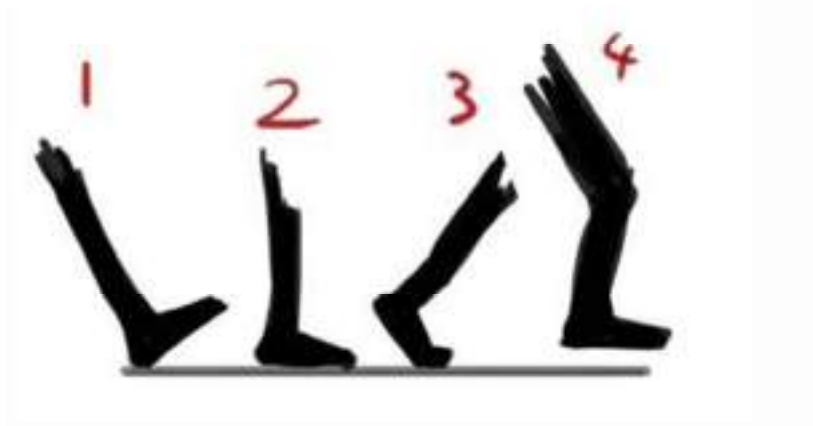
Walk cycles can be broken up into 4 key frames, namely Forward Contact Point, Passing Pose1, Back Contact Point and Passing Pose 2. Frames that are drawn between these key poses (traditionally known as in-betweens/In betweening) are either hand-drawn or using computer software to interpolate them.





Besides the apparent move of the legs, many more details are necessary for a convincing walk cycle, like animation timing, movement of the arms, head and torsion of the whole body.

There exist many techniques to create walk cycles. Traditionally walk-cycles are hand drawn but over time with the introduction of new technologies for new mediums, walk cycles can be made in pixel art, 2D computer graphics, 3D computer graphics, stop motion method, cut-out animation or using techniques like rotoscoping.



#### Software for 2D Animation

The **Pencil software** is a studio application designed to resemble the traditional flipbook style animation. It is simple to use as its user interface offers only the tools a beginning animator needs to start creating basic animations on their own.

**Adobe Flash** is the most widely used software for animations and motion graphics on the web.

**Synfig** is a free, open source program for 2D animators that offers a powerful suite of tools that can be used to make anything from quick motion graphics to cinema quality animation.

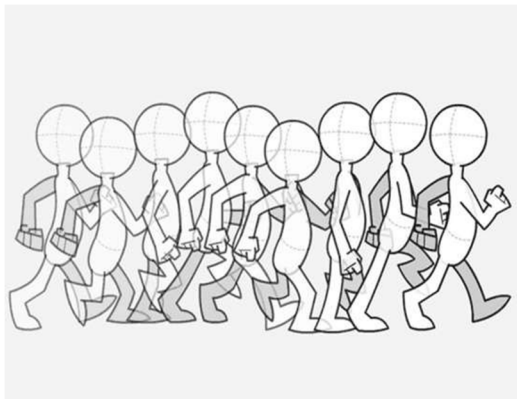
**Toon Boom Studio** is an all in one animation application for beginners that is actually designed to teach you the fundamentals of 2D animation as you work.

**Creatoon** is a free and powerful piece of animation software

**Animate** encourages artists to draw in an environment that feels natural with most digital drawing tablets, and simulates an entire animation studio within a small, easy to use application. This animation suite provides advanced features like interactive camera tools that drastically cut down on the time and effort needed to achieve that perfect studio quality aesthetic.

## Exercise

1. Draw the poses of a walk cycle, as shown in the figure below.



1. Create contact position
2. Create down position
3. Create passing position
4. Create up position
5. Refine up and down weight
6. Refine the side to side weight
7. Refine chest movement
8. Add drag
9. Fix any kneepopping
10. Flap the feet
11. Polish the walk

## Assessment

Answer the following questions

1. What is the difference between 2D and 3D Animation?

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2. List the 12 "basic principles of animation.

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## Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

### Part A

Differentiated between the following:

1. Adobe flash and Toon Boom

### Part B

Discussed in the class the following:

1. What is the difference between 2D and 3D Animation?
2. Describe 4 key frame names for creating a walk cycle.
3. Give two example of industry oriented software that can be used to create 2D digital animated sequences.

### Part C

#### Performance standards

The performance standards may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge of poses of a walk cycle		
Identify the software used for 2D animation		



## Session 4: Flash Animation

In this session you will learn about the flash animation technique.

### Relevant Knowledge



Cut out animation is considered the oldest animation technique around - probably the first in animation history.

The arrival of the computer took cut-outs to a whole new level of madness and creativity. Computer cut-outs have the immense advantage of being able to go back and forth on the timeline and work with key frames, in the “pose to pose” method.

Cut out animation got a whole new life when Flash showed up. This software, mainly a web authoring tool, made cut out animation so easy to make that EVERYONE became an animator. For one dangerous moment it looked like someone has found the legendary “Make Animation” button.



Flash today is used for everything between banner web animations to full feature films shown in the cinema.

A Flash Animation or Flash Cartoon is an animated film which is created by Adobe Flash or similar animation software and often distributed in the .swf file format. The term Flash animation not only refers to the file format but to a certain kind of movement and visual style.

Flash is able to integrate **bitmaps** and other raster-based art, as well as video, though most Flash films are created using only vector-based drawings which often result in a somewhat clean graphic appearance. Some hallmarks of poorly produced Flash animation are jerky natural movements (seen in walk-cycles and gestures), auto-tweened character movements, lip-sync without interpolation, and abrupt changes from front to profile view.

Flash animations are typically distributed by way of the **World Wide Web**, in which case they are often referred to as Internet cartoons, online **cartoons**, and webtoons. Web Flash animations may be interactive and are often created in a series. A Flash animation is distinguished from a Webcomic, which is a comic strip distributed via the Web, rather than an animated cartoon.

When building animations in Flash you have two directions you can go: create each individual frame (**frame-by-frame**) or ask Flash for help (**tweening**). You can also have an animation that has **both** frame by frame and tweening.

“**Tween**” is actually short for “in-between”, and refers to **auto-rendering** of graphics, by Flash, of the frames between **two** author defined keyframes.

Flash's has three forms of tweening - **motion (new)**, **Classic** (used to be called Motion) and **Shape**. For all types of tweening, you ask Flash to help you with the frames **in between**.



### Motion Tweening

A motion tween animates symbols moving in space; when you create a motion tween, then you can click on any frame in the tween, move the symbol on that frame, and a motion path animating the frames between that frame and the next keyframe. Any frame where you've manually moved the tweened symbol becomes a keyframe.



Motions tweening requires that the same base graphic (bitmap or vector) be used at **both** ends of the tween. Because the same base graphic is used at both ends of the tween, we convert that graphic into a **symbol**. Symbol use decreases file size, allows for much faster editing and is a prerequisite for Motion Tweens.

### Classic Tweening

A classic tween works the way old motion tweens used to, in versions CS3 and earlier. In this kind of motion tween, you'd have to manually create all your keyframes and connect all of them with motion tweens that followed point A to point B. So basically, a shape tween is a transformation tween, while a motion tween/classic tween affects position and rotation.

### Shape Tweening

Shape tweens, on the other hand, perform distortions on non-symbol shapes/vector graphics. If you create one shape on one keyframe and another shape on another keyframe, you can connect those two shapes with a shape tween. The tween will perform whatever calculations and morphs needed to transform the first shape into the second.

## Exercise

1. Draw and shapetween
2. Drawsymbols
3. Draw motiontween
4. Drag and droptween

## Assessment

Answer the following questions

1. What is limited animation or cutoutanimation?

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2. Describe flashanimation

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3. What is the difference between .jpg, .gif, .png, .swf and animated .giffiles?

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4. What is the meaning oftween?

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5. What are the three forms oftweening?

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6. What is motiiontweening?

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7. What is shapetweening?

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8. How to change colour and size?

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### Checklist for Assessment Activity

Use the following checklist to see if you have met all the requirements for assessment activity.

#### Part A

Differentiate between the following:

1. Limited animation or cutout animation
2. .fla and .swffile
3. Bitmap graphics and vector graphics

#### Part B

Discussed in the class the following:

1. What are the advantage and limitations of flash animation?
2. What is a .fla file?
3. What is a .swffile?
4. What is bitmap graphics?
5. What is vector graphics?
6. How to use flash drawing tools?

#### Part C

##### Performance standard

The performance Standard may include, but not limited to:

Performance standards	Yes	No
Demonstrate the knowledge of flash animation		
Demonstrate the knowledge of shape tweening, motion tweening and classic tweening		
Demonstrate the knowledge of .jpg, .gif, .png, .swf and animated .gif files		

## Glossary

1. **Animation** -The process of creating a progressively altering image that gives the appearance of continuous motion.
2. **Autodesk Maya** - It is commonly shortened to **Maya**, it is 3D computer graphics software that runs on Windows, Mac OS and Linux.
3. **Compositing** -The process of combining multiple elements shot separately (still images, movie clips) into a final image or sequence to give the impression they were all shot at the same time.
4. **Driven keys** - Driven Keys are used to drive the attributes of one object to another object.
5. **Expression** - A mathematical formula used to define the value of a given attribute of an object during animation. The use of expressions forms a procedural alternative to hand, or key frame, animation.
6. **Frame** - A still two-dimensional image. In computer animation, the term „frames per second“ (fps) is a measurement of the number of still frames displayed in one second to give the impression of a moving image. For film work, this value is usually 24; for the European PAL broadcast format, 25; and for the US NTSC broadcast format, 30fps.
7. **High Definition (HD)** - A general term for a video signal with a significantly higher resolution than standard definition.
8. **Joints** - Points of articulation between the bones in a character rig.
9. **Pivot** - To cause to rotate, revolve, or turn.
10. **Rigging** - The process of preparing a character model for animation, including setting up an underlying skeleton, complete with constraints, controllers and kinematic systems, and linking it to the mesh of the character model.
11. **3D** -Three-dimensional, Descriptive of a region of space that has width, height and depth.

## Suggested Reading

### Books

1. Character Animation: 2D Skills for Better 3D by Steve Roberts
2. Character Animation Fundamentals: Developing Skills for 2D and 3D Character by Steve Roberts
3. Producing Independent 2D Character Animation: Making & Selling A Short Film by Mark A. Simon
4. Creating 2D Animation with the Adobe Creative Suite by Debra Keller
5. The animator's guide to 2d computer animation by Hedley Griffin
6. All About Techniques in Drawing for Animation Production (All About Techniques Series) by Sergi Camara
7. Cinematography: Theory and Practice: Image Making for Cinematographers and Directors, by Blain Brown
8. Painting With Light, by John Alton
9. Cinematography by Peter Ettedgui
10. Digital Cinematography by Paul Wheeler
11. First Steps Drawing in Pen & Ink by Claudia Nice
12. Pen and Ink Drawing by Frank Hoar
13. Ink drawing techniques by Henry Clarence Pitz
14. Cel Aesthetics: A Method for the Analysis of Animated Cartoons by Jeffrey Neal-Lunsford

15. Cel Animation: Small Production Unit Concept by John RogerBolton
16. Digital Character Animation by GeorgeMaestri
17. Basics Animation 02: Digital Animation by Andrew Chong, AndrewMcNamara
18. Animation from Pencils to Pixels: Classical Techniques for the Digital Animator by TonyWhite
19. Secrets of Digital Animation by StevenWithrow
20. The Art of Stop-Motion Animation byPriebe
21. Stop Motion: Passion, Process and Performance by BarryPurves
22. Basics Animation 04: Stop-motion by BarryPurves
23. Stop Motion: Craft Skills for Model Animation by SusannahShaw
24. The Animation Book: A Complete Guide to Animated Filmmaking--from Flip-books to Sound  
Cartoons to 3-D Animation by KitLaybourne
25. Cutout Animation by Frederic P. Miller, Agnes F. Vandome, McBrewsterJohn
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