Draft Study Material

ANIMATOR

Qualification Pack Code: MES/Q0701
Sector: Media and Entertainment
Class XI

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NCERT

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION

(A constituent unit of NCERT, under Ministry of Education, Government of India)

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PREFACE

Skill Education is a dynamic and evolving field, and ensuring that every learner has access to quality learning resources is of paramount importance. The absence of finalized study material should not hinder the educational progress of students in the schools. To address this need, the PSS Central Institute of Vocational Education (PSSCIVE) presents this Draft Study Material, a provisional yet comprehensive resource, designed to support the teaching-learning process until the official study materials or textbooks are released by the National Council of Educational Research and Training (NCERT).

This draft study material provides a structured, accessible, and curriculum-aligned framework for both teachers and students during the interim period. The content has been carefully developed to ensure continuity in learning and to help students achieve the prescribed learning outcomes. The content of the draft study material covers essential concepts, practical competencies, and skill-based knowledge in accordance with the curriculum and established educational standards.

The primary objective of this material is to sustain the momentum of skill education and facilitate effective classroom transactions while the finalized textbooks are under preparation. It serves as a guiding resource that can be adapted and enriched to meet the diverse learning needs of students.

We express our sincere gratitude to the academicians, educators, subject matter experts, industry professionals, academic consultants, and all other contributors whose expertise and valuable insights have made the development of this draft study material possible.

Teachers are encouraged to use this draft study material as a guiding resource and to supplement it with additional learning materials, practical activities, and contextual examples that cater to the unique needs and learning styles of their students. We welcome constructive feedback and suggestions, particularly from teachers and practitioners, to further enhance the content and effectiveness of this study material.

We hope that this draft study material serves as a valuable resource in fostering knowledge, skills, and employability among learners, while supporting the successful implementation of skill education programmes across the country.

Deepak Paliwal
Joint Director
PSS Central Institute of Vocational Education

28 July 2026

ABOUT THE BOOK

Animation today is one of the fastest-growing sectors within the media and entertainment industry. This book on *Animator* for Class XI is a comprehensive resource material designed for students who aspire to build knowledge and practical skills in the field of animation and digital media. This book is organised into four structured units that introduce learners to the foundational concepts, techniques, and applications of animation and 3D content creation.

Unit 1 on Introduction to Animation provides a foundational overview of animation as a creative and technical discipline. Session 1 introduces the fundamentals of animation, explaining core ideas such as motion, illusion of life, and frame-based storytelling. Session 2 deals with the different techniques of animation, highlighting traditional and digital approaches used in the industry. Session 3 covers the various types of animation, offering insight into styles such as 2D, 3D, stop motion, and motion graphics, along with their distinguishing characteristics.

Unit 2 on Essentials of Animation focuses on the conceptual and production principles that guide effective animation. Session 1 covers the principles of visual storytelling, emphasizing composition, narrative flow, and emotional communication. Session 2 introduces the core principles of animation, including timing, spacing, squash and stretch, anticipation, and exaggeration, which are essential for creating believable motion. Session 3 explains the basics of the production pipeline, outlining the stages of animation development from pre-production through to final output.

Unit 3 on Digital 2D Animation introduces learners to the concepts and practices of two-dimensional animation in digital environments. Session 1 explains the concept of 2D animation and its role in modern media production. Session 2 describes different types of 2D animation, including traditional hand-drawn, vector-based, and cut-out animation styles. Session 3 deals with the applications of 2D animation across various media platforms such as film, television, advertising, education, and digital content creation.

Unit 4 on Introduction to 3D Modelling provides an entry point into three-dimensional digital creation. Session 1 covers the fundamentals of 3D modelling, including geometry, vertices, edges, and faces. Session 2 is on the process of creating and editing 3D models using standard modelling techniques and tools. Session 3 deals with the applications of 3D modelling in animation and media, demonstrating its use in gaming, visual effects, product visualization, and virtual environments. By combining theoretical understanding with software-based practical exercises, the book prepares students to meet the creative and technical demands of the modern animation and media industry.

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CONTENT

Unit 1 | Introduction to Animation

The Unit on "*Introduction to Animation*" takes you into the fascinating and ever-evolving world of animated media. It builds a strong conceptual foundation by introducing the origin, growth, and increasing importance of animation as a powerful medium of storytelling and visual communication. It helps you to understand how simple sketches and sequential drawings gradually evolved into advanced digital productions that today influence entertainment, education, advertising, social media, gaming, and virtual experiences across the world.

Session 1 on Fundamentals of Animation introduces the fundamentals of animation, explaining animation as the art of creating the illusion of movement through a rapid sequence of images or frames. It discusses the importance and uses of animation in entertainment, education, advertising, gaming, medicine, and digital media.

The session traces the historical development of animation from early visual storytelling methods and optical devices to modern animation technologies. It also highlights the evolution of Indian animation, key pioneers, major milestones, career opportunities in the animation industry, and the growing role of Artificial Intelligence (AI) in animation production.

Session 2 on Techniques of Animation deals with the various techniques used in animation. It explains traditional animation methods such as cel animation, stop motion, cut-out animation, shadow puppetry, and flipbook animation, as well as modern computer-based techniques including 2D animation, 3D animation, CGI, live-action animation, and rotoscoping. The session also introduces the animation production pipeline, covering stages such as concept development, modelling, texturing, rigging, animation, lighting, rendering, compositing, sound design, and final editing.

Session 3 on Types of Animation covers the different types of animation, including flipbook animation, traditional animation, cut-out animation, clay animation, stop-motion animation, puppet animation, silhouette animation, and computer-generated animation. It explains the characteristics, working methods, and applications of each type. The session also introduces the concepts of frames, key frames, and tween frames, which form the basis of creating smooth motion in animation.

Session 1: Fundamentals of Animation

Animation is the art and technique of creating the illusion of movement through a rapid sequence of images, drawings, models, or digital frames. When these frames are shown continuously at a certain speed, typically 24 frames per second for film and 25–30 frame per second for television and digital media, the human eye perceives them as smooth motion. Animation combines creativity, visual design, storytelling, acting, sound, timing, and technology to create engaging visual experiences.

The word "animation" comes from the Latin word *anima*, meaning "soul" or "to give life." In animation, artists essentially give life to still objects, characters, and environments through movement and expression.

1. Importance of Animation

Animation plays a major role in modern media and communication. It is widely used not only for entertainment but also for education, business, medicine, science, architecture, and digital communication.

2. Uses of Animation

Animation has become an essential part of modern communication, entertainment, education, and technology. It is used to simplify complex ideas, create engaging visual experiences, and improve audience understanding.

From films and video games to medical simulations and social media content, animation is widely applied across various industries. Some categories are listed below.

- Films and television series
- Video games
- Advertising and marketing
- Educational videos
- Scientific visualization
- Medical simulations
- Social media content
- Mobile applications
- Virtual Reality (VR) and Augmented Reality (AR)

3. Working of Animation

Animation works on the principle of "Persistence of Vision", where the human eye retains an image for a fraction of a second after it disappears. When multiple

images are displayed rapidly with slight changes in position, the brain interprets them as continuous movement. For example, a bouncing ball animation may contain hundreds of slightly different images. When shown quickly, the ball appears to move naturally.

Animation is the art of bringing drawings, objects, or digital designs to life through movement. It transforms imagination into motion, turning simple sketches into characters that can dance, fly, or explore new worlds. From movies and video games to advertisements and learning apps, animation is everywhere around us.

Animation is the process of displaying a sequence of images to create the illusion of movement. Before the invention of film, the depiction of figures in motion through static art existed as far back as the 'Palaeolithic'. The Palaeolithic era is also known as the 'Old Stone Age'. During this time, early humans created some of the first forms of art, including cave paintings and carvings. Interestingly, some of these artworks, such as those found in places like Lascaux Caves, located in south-western France, show animals with multiple overlapping limbs. This technique is often interpreted as an early attempt to represent movement, making it a distant precursor to the concept of animation.

In the 19th century, there were several devices which successfully displayed animated images. The first film recorded on standard picture film to include animated sequences was "The Enchanted Drawing". It is a 1900 silent trick film directed by J. Stuart Blackton. The Enchanted Drawing used a combination of live-action performance and stop-camera substitution which is a variation of the "stop trick" to create the illusion that drawn objects can become real. This was followed by the first entirely animated film, "Humorous Phases of Funny Faces" in 1906, created by J. Stuart Blackton, who is often regarded as the father of American animation. In Humorous Phases of Funny Faces, Blackton used stop-motion techniques along with hand-drawn chalk illustrations to create the illusion of movement, such as faces changing expressions and characters performing simple actions. This pioneering work laid an important foundation for the future development of the animation industry.

4. Evolution of Indian Animation

Indian Animation is a captivating tale that spans over a hundred years from inception to a thriving industry that is recognised internationally and has won awards.

5. Early pioneers and theatrical releases (before 1950)

India has a rich history of visual storytelling that predates modern animation. Traditional forms such as shadow puppetry, like '*Tholu bommalata'*, magic lantern shows, and other visual devices were used to narrate stories long before film emerged. *Tholu bommalata* roughly translates to 'dance of the leather puppets',

and is a centuries-old form of shadow puppet theatre from the state of Andhra Pradesh. Regarded as the father of Indian cinema, Dadasaheb Phalke was also an early pioneer of animation. In 1912, he released a short film titled "The Growth of a Pea Plant", which used time-lapse photography to depict the gradual process of a plant growing, an innovative technique for its time. By the 1930s, animated films began to be screened in theatres. The Pea Brothers (1934), directed by Gunamoy Banerjee, is considered a landmark as the first Indian animated work to be shown in a cinema. In the same year, *Jambu Kaka* was animated by Raghunath K. Kelkar, further contributing to the early development of animation in India.

6. State-funded Animation Studios between 1950s-1980s

A major turning point came in 1956, when Clair Weeks was invited to India to help establish and train professionals for the country's first animation studio at the Films Division of India in Mumbai. This initiative marked the beginning of a more structured and institutional approach to animation in India. The studio's first significant production was 'The Banyan Deer' in 1957, widely regarded as India's first colour animated film. Based on a Jataka tale, it was created by a team of animators trained under Clair Weeks. This period produced several influential figures, including Ram Mohan and Bhimsain Khurana, both of whom are often regarded as pioneers of Indian animation. While the origins of animation in India can be traced back to the early 1900s with pioneers like Dadasaheb Phalke and Gunamoy Banerjee, it was the establishment of this studio in 1956 that catalysed the development of a formal animation industry. The team also set technical and creative standards for future animators.

A major milestone followed with *Ek Anek Aur Ekta* in 1974, also known as *Ek Chidiya Anek Chidiya*. Produced by the Films Division of India, this short educational film became a cultural landmark. It demonstrated the power of animation as a tool for education, teaching children the values of unity and teamwork while promoting the idea of "Unity in Diversity" (*Anekta mein Ekta*).

7. Rise of Private Studios and Television Series between 1990s to 2000s

The mid-1990s marked a significant shift with the arrival of satellite television in India, bringing dedicated cartoon channels like "Cartoon Network" and "Nickelodeon". This opened up a new market for animation, although foreign-produced content initially dominated the space. A landmark moment came in 1992 with "Ramayana: The Legend of Prince Rama", an Indo-Japanese co-production that blended Indian storytelling with Japanese animation techniques. Despite its global success and popularity on television, the film struggled to secure widespread theatrical distribution in India at the time. This period established a strong trend, with many early Indian animated films and series drawing from mythology and traditional narratives and the notable examples include the following:

- The Krishna cartoon series
- Hanuman, a commercially successful animated film
- My Friend *Ganesha*

By the 2000s, original animated series featuring distinctly Indian characters and settings began to gain traction. Among them, "*Chhota Bheem*" emerged as a defining success and continues to be widely regarded as a classic in Indian children's animation.

8. Modern Era : 3D, VFX, and a Growing Animation Industry

The Indian animation industry has undergone a major transformation, shifting from traditional 2D (two-dimensional) to advanced 3D (three-dimensional) techniques and Computer-Generated Imagery (CGI). While 2D animation has two-dimensional space, meaning it has only height and width, with no depth, 3D animation creates characters and environments in a three-dimensional digital space, adding depth. Today, Indian studios are not only creating original content but also contributing significantly to global film and television production, including projects for international industries such as Hollywood. While mythological themes continue to be popular, there is a growing diversification in genres and storytelling. Films such as *Krishna and Kans*, *Chhota Bheem and the Curse of Damyaan*, and *Mahavatar Narsimha* reflect this blend of tradition and modern narrative styles.

In recent years, India's Animation and Visual Effects (VFX) sector has established itself as a competitive presence on the global stage. With a rising number of studios, training institutes, and diverse content across films, television series, and advertising, the industry is expanding rapidly. By combining its rich cultural heritage with evolving technologies, Indian animation continues to redefine and strengthen its visual storytelling landscape.

Do you remember watching your favourite cartoon for the first time - whether it was *Chhota Bheem*, *Tom and Jerry*, or a Pixar movie and wondering how the characters could move, talk, and make you laugh? The magical world that captured your imagination is brought to life through the fascinating art and technique of animation.

9. Career Options in Animation and Media

The animation and media industry are one of the fastest-growing creative sectors worldwide, offering diverse and dynamic career opportunities for individuals with artistic, technical, and storytelling skills. With the rapid expansion of digital entertainment, gaming, film production, advertising, VFX, streaming platforms, and interactive media, the demand for skilled professionals in animation and media industries continues to increase significantly. As technology continues to evolve through advancements in VR, AR, AI, and immersive media, the scope of

careers in animation and media industries is expanding further, making it an exciting and promising field for aspiring professionals.

Careers in this field combine creativity with technology, enabling professionals to work in areas such as 2D and 3D animation, game design, motion graphics, storyboarding, visual effects, multimedia production, and technical animation. The people in various job roles contribute to the creation of engaging visual content for movies, television, video games, web platforms, educational media, and digital marketing campaigns. The roles and responsibilities of professionals in various job roles or occupations in the Animation industry are given in table 1.1.

Table 1.1: Roles and Responsibilities of Professionals in Various Job Roles in the Animation Industry

S.No.	Job Role	Roles and Responsibilities
1.	2D Animator	Create frame-by-frame or rig-based animations for characters and scenes; interpret storyboards and scripts into animated sequences; design movements, expressions, and lip-sync; collaborate with creative teams; refine animations based on feedback; ensure quality and timely delivery using tools such as Toon Boom Harmony and Adobe Animate.
2.	3D Modeller	Develop 3D models of characters, props, and environments based on concept art; perform UV mapping and texturing; optimize models for rendering and performance; collaborate with animators and developers; maintain asset libraries using software such as Blender, Maya, and ZBrush.
3.	Storyboard Artist	Create storyboard panels to visualize scripts and scenes; plan camera angles, compositions, and shot transitions; collaborate with writers and directors; develop animatics for timing and pacing; revise sequences based on feedback while ensuring visual continuity.
4.	Motion Graphics Designer	Design animated graphics, titles, transitions, and infographics for digital media; create promotional and explainer videos; combine graphic design with animation techniques; collaborate with editors and marketing teams; maintain brand consistency using tools like After Effects and Premiere Pro.
5.	Game Artist	Create visual assets such as characters, environments, props, and UI elements for games; design concept art and textures; optimize assets for real-time rendering; collaborate with designers and programmers; maintain artistic consistency using Unity, Unreal Engine, Blender, or Photoshop.

6.	VFX Artist	Produce visual effects including explosions, smoke, fire, simulations, and compositing effects; integrate CGI into live-action or animated footage; perform tracking, rotoscoping, and matte painting; collaborate with production teams; use tools such as Houdini, Nuke, and After Effects.
7.	Technical Animator	Develop character rigs and skeletal systems; bridge animation and programming workflows; create automation tools and scripts; optimize animation pipelines and performance; troubleshoot rigging and skinning issues; collaborate with animators and developers using Maya, Unity, Unreal Engine, and Python.

10. Advent of Artificial Intelligence in Animation

Artificial Intelligence is transforming the animation industry by enhancing almost every stage of the production process, including storyboarding, motion generation, lip-syncing, facial capture, rendering, and voice synthesis.

(i) Pre-production Phase

In the pre-production phase, AI-powered tools help artists and designers quickly generate concept art, storyboards, character variations, layout drafts, and motion references. This enables studios to explore a wider range of creative ideas and make decisions more efficiently during the early stages of production. During animation and motion creation, AI assists with tasks such as automated in-betweening, motion interpolation, facial animation, lip synchronization, and motion-capture clean-up. These technologies significantly reduce manual effort and can decrease production time for specific tasks such as rotoscoping and in-betweening.

(ii) 3D Animation and Visual Effects

In 3D animation and VFX pipelines, AI is increasingly becoming an integral part of real-time engines such as Unreal Engine and Unity. It supports real-time rendering, physics approximations, crowd simulations, procedural environment generation, and AI-assisted rigging, allowing creators to iterate and refine their work much faster than before.

(iii) Generative Video and Anime Production

AI is also driving innovation in generative video and anime production. Advanced generative models can now create short animated clips from simple text prompts, images, rough sketches, or existing footage. Ongoing research is further

expanding the possibilities of AI-generated animated avatars and cel-animation workflows.

(iv) Gaming Industry

In the gaming industry, AI-powered facial animation systems are helping studios streamline production by automating repetitive tasks and improving animation quality. The major benefits of AI in animation include faster production cycles, reduced costs, quicker prototyping, and real-time creative iteration, making animation more efficient and accessible than ever before.

Practical Exercise

Activity 1: Journey of Indian Animation

Materials Required:

1. Chart paper or A3/A4 sheets
2. Pens, pencils, erasers
3. Sketch pens / coloured markers
4. Ruler
5. Printed images (optional)
6. Glue or tape
7. Sticky notes (optional)
8. Access to a computer or tablet (for digital timeline, optional)

Procedure:

Step 1: Form small groups of 3–5 students each.

Step 2: Read the given material on the history of Indian animation carefully. Prepare a list of key milestones, including:

- Early pioneers and films (before 1950)
- Establishment of state-funded studios (1950s–1980s)
- Rise of private studios and TV series (1990s–2000s)
- Modern era: 3D, VFX, and global recognition

Step 3: Create a timeline on paper or digitally showing major events in Indian animation. Include:

- Names of important films (e.g., *The Pea Brothers*, *The Banyan Deer*, *Ek Anek Aur Ekta*, *Chhota Bheem*)
- Names of pioneers such as Dadasaheb Phalke, Ram Mohan, and Bhimsain Khurana

- Key technologies and styles (shadow puppetry, 2D, 3D, CGI, VFX)

Step 4: Enhance your timeline by adding sketches, printed images, or icons for each milestone. Use colours or symbols to differentiate between:

- Early animation
- State-funded era
- Private studios
- Modern era

Step 5: Present your timeline to the class in 3 to 5 minutes. Discuss the impact of Indian animation on culture, education, and global media.

Check Your Progress

A. Fill in the Blanks

1. Animation refers to the recording of any image which goes through changes over time to portray the illusion of _____.
2. The first Indian short cartoon by Dadasaheb Phalke in 1912 was called _____.
3. _____ is regarded as the first Indian animated work to be screened in a cinema in 1934.
4. The first colour animated film of India was _____ (1957), based on a Jataka tale.
5. The popular Indian cartoon series _____ gained immense popularity in the 2000s and is still considered a classic.

B. Multiple Choice Questions

1. Animation refers to:
   a) Recording still images only
   b) Recording images that change over time to create motion
   c) Only hand-drawn cartoons
   d) Recording sound with moving images

2. Which Indian animator created The Pea Brothers (1934)?
   a) Raghunath K. Kelkar
   b) Gunamoy Banerjee
   c) Dadasaheb Phalke
   d) Ram Mohan

3. *Ek Anek Aur Ekta* was released in which year?
   a) 1957
   b) 1965

c) 1974
d) 1992

4. The Indo-Japanese co-produced film *Ramayana*: The Legend of Prince Rama was released in:
   a) 1986
   b) 1990
   c) 1992
   d) 1998

5. The first Indian animation studio was set up in 1956 at:
   a) Kolkata
   b) Chennai
   c) Mumbai
   d) Delhi

C. State Whether the Following Statements are True or False

1. *Humorous Phases of Funny Faces* (1906) is considered the first entirely animated film.
2. Phalke's animated film "The Growth of a Pea Plant" used stop-motion animation.
3. The Banyan Deer (1957) was India's first black-and-white animated film.
4. *Ek Anek Aur Ekta* emphasized the theme of "Unity in Diversity".
5. In the 2000s, Indian animation focused only on mythology and did not create original series.

D. Subjective Questions

1. You have been invited to curate a museum exhibition on the history of Indian animation. Prepare a presentation highlighting the major milestones in the development of animation in India. Include important films, television series, studios, and the contributions of key creators who shaped the industry.
2. Suppose you are creating a documentary on the origins of animation. Explain how ancient and pre-modern societies attempted to represent movement before the invention of film. Use examples of cave paintings, sequential art, shadow play, or optical devices to show how people experimented with depicting motion in static images.

What have you learned?

After completing this session, you will be able to:

- describe the early attempts to represent movement before the invention of film, including examples from the Paleolithic era and pre-modern visual storytelling traditions;

- identify important milestones in the global development of animation, including early animated films;
- relate the historical development of Indian animation from traditional storytelling forms to the modern digital era;
- recognize the contributions of pioneers in shaping Indian animation;
- differentiate between 2D and 3D animation and understand the role of CGI and VFX in modern animation production; and
- describe the roles and responsibilities of professionals working in the animation industry.

Session 2: Techniques of Animation

Animation employs a variety of techniques to create the illusion of movement, each offering unique advantages depending on the project's artistic and production requirements. Among these, "Full Animation" and "Limited Animation" are two of the most significant techniques. Full animation involves creating detailed drawings or frames for nearly every movement, resulting in smooth, realistic, and highly expressive motion. Although it produces superior visual quality, it requires considerable time, effort, and production cost. In contrast, limited animation reduces the number of drawings by reusing frames and animating only essential movements, making it a more cost-effective and efficient approach. While limited animation may offer less fluid motion than full animation, it is widely used in television series, web animations, and projects with budget or time constraints. Both techniques have played an important role in the evolution of animation and continue to be used based on the creative and practical needs of production.

1. Traditional and Classical Animation Techniques

Traditional or classical animation is the oldest form of animation, in which every frame is created manually, either drawn or traced, on paper or transparent sheets known as *cels*. Before the advent of computer animation, this method was the industry standard and formed the foundation of modern animation practices. Some key traditional techniques include the following:

(i) **Cel Animation:** A classic method where each frame is hand-drawn on transparent sheets (cels) and layered over a static background. This technique was widely used in early animated films and television.
(ii) **Stop Motion:** Animation created by physically moving objects in small increments and capturing each movement frame-by-frame using a camera. When played in sequence, the objects appear to move on their own.
(iii) **Cut-out Animation:** It involves using flat characters, shapes, or figures cut from paper, cardboard, or fabric. These pieces are moved slightly between frames to simulate motion.

(iv) **Shadow Puppetry:** An ancient storytelling technique, popular in forms like *tholu bommalata*, that uses flat figures to cast shadows on a screen with a light source, creating the illusion of animated movement.

(v) **Flipbook Animation:** A simple form of animation made by drawing sequential images on the pages of a book. When the pages are flipped quickly, the images appear to move.

2. Computer Animation Techniques

Computer animation includes a diversity of methods. The uniting factor is that the animation is created digitally. 2D animation methods focus on image manipulation, while 3D methods usually develop the virtual world where various types of developed characters and objects move and interact with each other.

(i) 2D Computer Animation: This animation creates movement in a Two-Dimensional (2D) space using only height and width. It is widely used in cartoons, ads, explainer videos, mobile apps, and web animations. Traditional 2D animation involves drawing each frame (24 per second) with slight changes to create motion. Earlier, drawings were painted on transparent sheets called cels and layered over backgrounds to make films. Popular 2D animated films/characters include *My Friend Ganesha*, *Hanuman, Chhota Bheem*, *Bugs Bunny, Daffy Duck, Elmer Fudd*, and *Snow White.*

(ii) 3D Computer Animation: This animation creates moving images in a three-dimensional space (x, y, z), giving depth, perspective, lighting, and shadows for a realistic look. It is widely used in films, games, ads, architecture, simulations, and Virtual Reality/ Augmented Reality. 3D models can be rigged with bones for movement, textured, lit, and viewed from any angle, making them more dynamic than 2D models. It allows creators to design lifelike objects and blend them seamlessly into live-action. Popular 3D animated films include *Roadside Romeo, Delhi Safari, Mahabharat 3D, Toy Story, Shrek, The Incredibles, Frozen, Finding Nemo, Kung Fu Panda and Coco.*

(iii) Live-Action Animation: A Live-Action Animation film combines live-action film with animation. It is a technique that combines 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), "*Space Jam*" (US, 1996) and "*Osmosis Jones*" (US, 2001).

(iv) Rotoscoping: 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 stylised 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).

(v) Computer-Generated Imagery or Computer Graphical Images Animation: Computer-Generated Imagery or Computer Graphical Images Animation uses computer graphics to create still or moving images, mainly in 3D for realism, though 2D is also used. It has replaced many traditional methods by allowing animators to model, rig, texture, and add effects without sets or actors. Motion is shown through frames, with in-betweens generated automatically and frames rendered for final output. CGI can be pre-rendered for films or rendered in real time for games, Virtual Reality (VR), and web content. CGI has largely supplemented and, in many productions, replaced traditional stop-motion and hand-drawn techniques. It makes large-scale or complex visuals possible without sets, props, or actors.

3. Animation Development Pipeline (Production Pipeline)

The Animation Development Pipeline, also known as the Production Pipeline, is a structured workflow that guides the creation of an animated project from concept to final delivery. It is generally divided into three main stages: pre-production, production, and post-production. The 10 most common steps involved in producing a 3D animation project are given below:

(i) Concept and storyboards
(ii) 3D Modelling
(iii) Texturing
(iv) Rigging
(v) Animation
(vi) Lighting and camera setup
(vii) Rendering
(viii) Compositing and special VFX
(ix) Sound, voice-over and Foley
(x) Editing and final output

The pipeline begins with the conceptualization of ideas, script development, and the creation of storyboards that visually represent the sequence of events and shots in the animation. Once the storyboard is finalized, artists create 3D models of characters, props, and environments. These models are then textured to add colours, materials, and surface details. In the rigging stage, a digital skeleton and control system are added to the models so that they can be animated. Animators then create movements and performances for the characters and objects. After animation, lighting and camera settings are applied to establish the mood, depth, and visual composition of each scene. The rendered images or frames are then generated and combined with special effects during the compositing stage. Sound effects, voice-over, background music, and Foley recordings are added to enhance

the viewing experience. Finally, all elements are edited together and exported into the desired format for distribution. The complete process of the 3D production pipeline is illustrated in Figure 1.1.

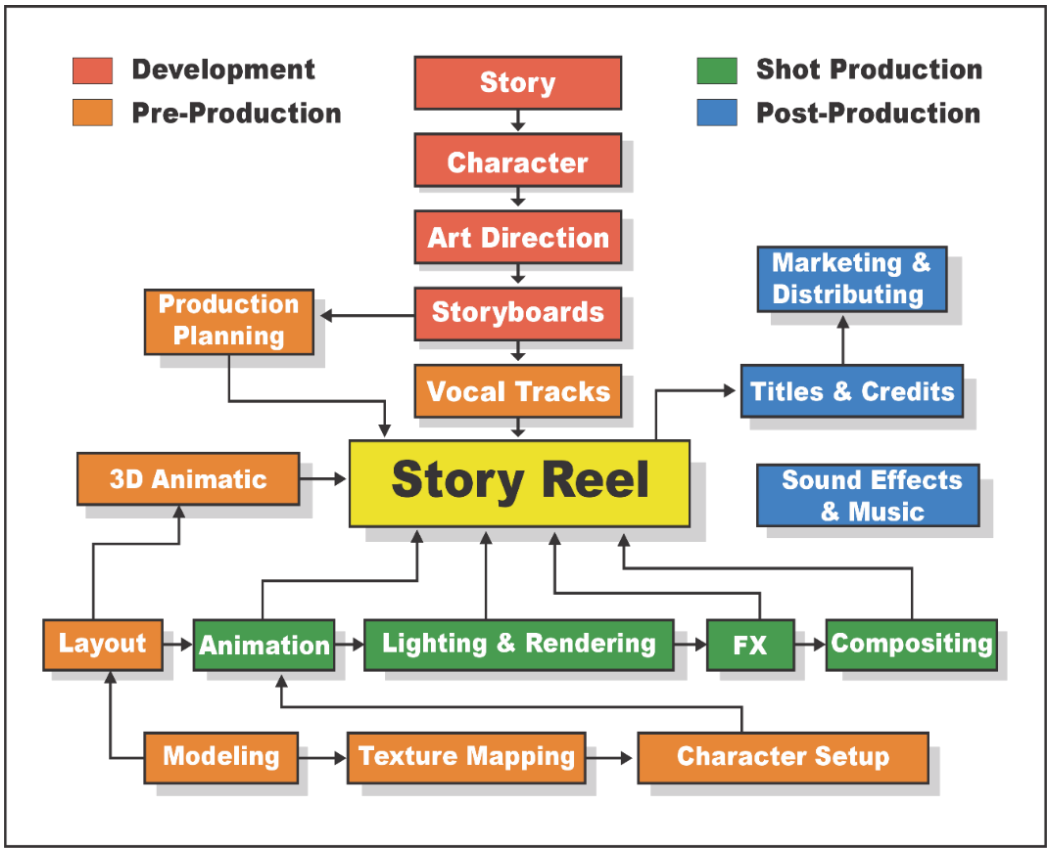

Fig.1.1: 3D production pipeline

Practical Exercise

Activity 1: Exploring traditional and classical animation.

Materials Required:

1. Small stack of paper, sticky notes, or index cards
2. Pencils and erasers
3. Black chart paper or cardstock
4. Scissors
5. Glue or tape
6. Wooden sticks, straws, or skewers
7. Torchlight or flashlight
8. White screen, white chart paper, or a plain wall
9. Clay or playdough
10. Mobile phone or tablet with a camera
11. Plain background sheet or chart paper

12. Tables and chairs/workspace with adequate lighting

Procedure:

Step 1: Flipbook animation (hand-drawn)

- Arrange a small stack of paper or sticky notes.
- Draw a simple object (like a bouncing ball, a flower blooming, or a walking stick figure) with slight changes on each page.
- Once complete, flip the pages quickly to see the illusion of motion.
- Spin it and watch the moving images through slits.

Step 2: Shadow puppetry (silhouette animation)

- Cut out simple shapes (animals, people, trees) from black chart paper.
- Shine a torchlight on the cut-outs behind a white screen/wall.
- Perform a short scene showing movement (walking, flying, etc.).

Step 3: Stop-motion clay animation

- Form groups and arrange clay or playdough.
- Each group will create a simple character (like a snake).
- Using a phone camera, the group will capture photos of small movements frame by frame.
- Play the sequence to watch the clay figure "come alive".

Check Your Progress

A. Fill in the Blanks

1. 2D animation is the _____ animation.
2. Computer animation encompasses a _____ of techniques.
3. Modern computer animation usually uses _____ computer graphics.
4. The texture, lighting and colour of the 3D objects are modified using _____ programmes.
5. 3D allows you to do things that simply are not possible in _____ animation.

B. Multiple Choice Questions

1. Full Animation refers to the process of:
   a) Producing high-quality traditionally animated films
   b) Producing low-quality traditionally animated films
   c) Producing experimental animated films
   d) Producing stop-motion animated films

2. Rotoscoping is a technique patented by Max Fleischer in:
   a) 1927
   b) 1917

c) 1937
d) 1907

3. Limited Animation involves the use of:
   a) Less detailed and/or more stylised drawings and methods of movement
   b) High detail and/or more stylised drawings and methods of movement
   c) Less detailed and/or less stylised drawings and methods of movement
   d) Highly realistic drawings with complex movement

4. Live-Action/Animation is a technique combining hand-drawn characters with:
   a) Picture
   b) Live-action shots
   c) Graphs
   d) Computer-generated backgrounds

5. 3D allows you to create:
   a) False objects
   b) Imaginary objects
   c) Realistic objects
   d) Cartoon sketches

C. State Whether the Following Statements are True or False

1. 3D objects, once modelled, can be treated almost as a physical object.
2. 2D animations are not the base of 3D animation.
3. The process of a 3D animation pipeline is complex.
4. In 3D animations, all frames do not need to be rendered after modelling is complete.
5. CGI animation mainly uses 3D computer graphics to create realistic images.

D. Subjective Questions

1. You have been hired by an animation studio to create a 10-second traditional cel animation sequence for a children's cartoon. Explain how you would plan the storyboard, organise frames, prepare backgrounds, and animate characters to achieve smooth and believable motion.
2. Compare 2D or 3D animation in terms of production techniques, visual appearance, and practical applications, using examples of well-known animated films or characters to justify your recommendation.
3. Suppose you are directing a fantasy film that includes magical creatures, imaginary worlds, and large-scale action scenes. Explain which aspects of the film would benefit most from CGI and describe how you would organise the animation production process from concept development to final rendering.
4. You have joined a 3D animation studio as a production assistant. Prepare a workflow report explaining the complete 3D animation pipeline, including stages such as concept art, modelling, texturing, rigging, animation, lighting,

rendering, and compositing, and discuss how each stage contributes to the final animated film.

What have you learned?

After completing this session, you will be able to:

- differentiate between traditional animation and computer animation based on production methods, tools, and visual style;
- explain the features and applications of 2D computer animation with suitable examples from films, television, and digital media;
- compare 2D and 3D animation techniques in terms of realism, flexibility, production process, and audience experience;
- explain the concept of live-action animation and identify examples where animated characters are integrated with real-world footage;
- describe the process and significance of rotoscoping in animation production; and
- explain the importance of creativity, technology, and teamwork in the animation production process.

Session 3: Types of Animation

Animation can be classified into various types based on the techniques and tools used to create motion. Traditional animation involves drawing each frame by hand, while 2D animation uses digital tools to create flat, two-dimensional characters and scenes. 3D animation creates three-dimensional models that can be moved and viewed from different angles, giving a realistic appearance.

1. Types of Animation

The methods of creating animation include the traditional animation creation techniques and those involving stop-motion animation of two and three-dimensional objects, such as paper cut-outs, 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. Puppet animation
7. Silhouette animation
8. Computer Graphics (CG) animation

(i) Flipbook Animation: Flipbook animation is known to be a very original way which has been used to develop the animation just with a pencil, eraser and the stack of drawing pads (Fig.1.2).

Flip books use a series of images rather than just simple drawings for creating animation. The drawing pads are inexpensive and easily accessible at all stationery stores. It helps you to use your existing drawing skills and to understand the basic concept of animation.

Fig. 1.2: Flipbook animation

Flipbook animation is a simple, original form of animation made from a series of images that change slightly from page to page. When flipped quickly, the pictures appear to move, creating the illusion of motion through persistence of vision. Flipbooks are easy and inexpensive to make using index cards, Post-it notes, or any flippable media, requiring no special devices. They encourage creativity, as even simple shapes like dots or lines can be animated into stories. The process forms the foundation of modern animation techniques by showing how sequential images create movement.

(ii) Traditional Animation: Traditional Animation (also called cel, classical, or hand-drawn animation) is a technique where each frame is drawn by hand. Each drawing differs slightly from the previous one to create the illusion of motion. Animators' sketches are traced onto transparent acetate sheets (*cels*), painted, and then photographed over painted backgrounds using a rostrum camera.

By the 21st century, traditional cel animation largely moved to computers. Sketches and backgrounds are now scanned or drawn digitally, coloured using software, and animated with camera effects. This 'tradigital' (combining

traditional hand-drawn animation with digital tools and techniques) approach preserves the classic hand-drawn look while using modern technology.

(iii) Cut-out Animation: Cut-out animation is a stop-motion technique to produce the animations by flat characters, props and backgrounds made by different materials, such as paper, card, stiff fabric or even photographs.

(iv) Clay Animation: Clay animation, also known as Claymation, is any animation done by means of a character or characters created by using clay (Fig. 1.3). Claymation is a registered trademark but commonly used generically.

Fig. 1.3: Characters created using clay

Traditionally, claymation has been related to the time-consuming techniques of stop-motion video, but with the advent of inexpensive computers, digital cameras, and easy-to-use software like "Frames", Claymation is accessible to almost every classroom. Each object or character is sculpted from clay or other, 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.

(v) Stop-motion Animation: Stop-motion animation is created by physically moving real objects and photographing them one frame at a time to produce the illusion of motion. Objects are slightly repositioned between frames, and when played back rapidly, they appear to move independently. Though computer software can simulate stop-motion, the traditional method is often simpler and less expensive, relying on sequential photography of real objects or characters.

(vi) Puppet Animation: 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 (Fig. 1.4).

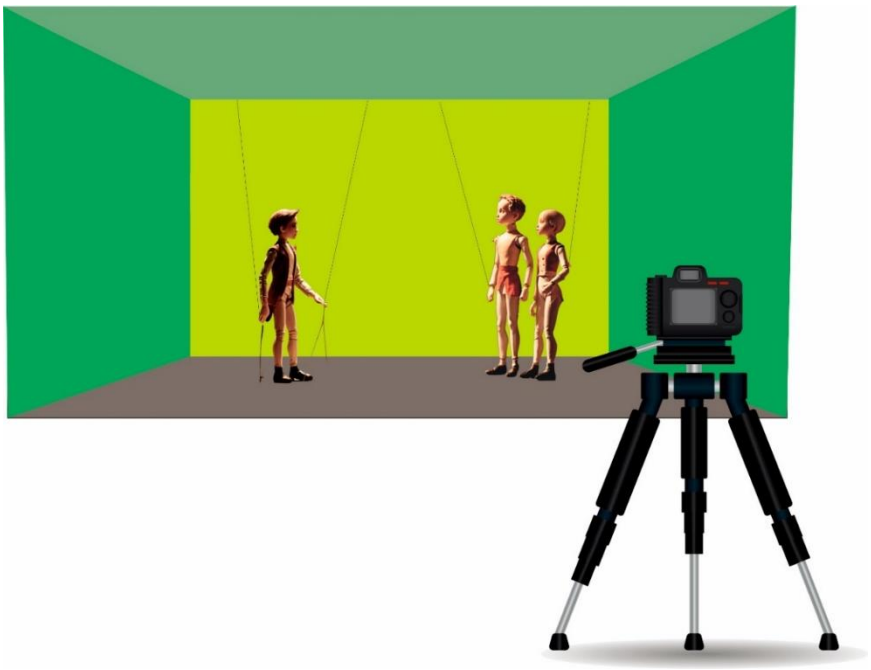

Fig. 1.4: Making of puppet animation film

(vii) Silhouette Animation: Silhouette Animation is a variant of cut-out animation in which the characters are backlit and only visible as silhouettes (Fig. 1.5). Silhouette animation is a type of stop-motion animation where characters and objects are represented as solid,

Fig. 1.5: Silhouette animation

dark shapes against a lighter background. The animation is created by moving these flat, two-dimensional cut-out figures frame-by-frame to simulate motion.

Only the outline or shape of the characters is visible, giving a stylised and dramatic visual effect. This technique is often used for storytelling or fairy tales. A famous example of silhouette animation is *Goopi Gawaiya Bagha Bajaiya* (2013), directed by Shilpa Ranade and adapted from Satyajit Ray's film. This movie features stylised visuals that draw inspiration from traditional Indian art forms, including silhouette-like elements.

(viii) 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-Generated Imagery 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 Graphics 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 (Fig. 1.6). Classical 2D animation is also known as hand-drawn 2D animation or traditional animation**.**

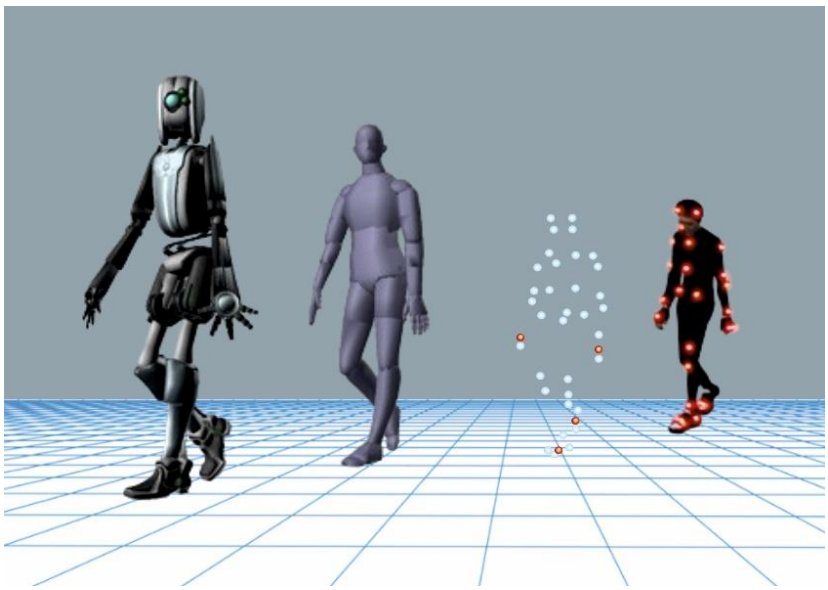

Fig. 1.6: Computer graphics animation

2. Animation Through Frames and Motion

Animation is the process of creating the illusion of motion by rapidly displaying a sequence of static images. The perception of motion in animation is primarily based on two important psychological principles: "Phi Phenomenon" and **"**Beta Movement". The Phi Phenomenon**,** first described by psychologist Max Wertheimer, refers to the illusion of movement that occurs when stationary images are displayed in rapid succession. In this phenomenon, the viewer

perceives motion even though no actual object is moving between the images. Beta Movement is a closely related visual illusion in which a sequence of still images is interpreted by the human brain as continuous movement. Unlike the phi phenomenon, beta movement creates the impression that an object itself is moving from one position to another, making it the fundamental principle behind films, television, and digital animation. Together, these perceptual phenomena form the basis of animation by enabling audiences to perceive smooth and continuous motion from a series of static frames displayed at high speed.

3. Phi phenomenon

The phi phenomenon is the optical illusion of perceiving continuous motion between separate objects viewed rapidly in succession. The base method for doing animation rests on a continuous loop comprising the following two steps:

1. Loading a "frame"
2. Displaying the "frame" on screen

A frame is a single still image shown on the screen for a brief duration. Animation is created by displaying a sequence of such frames in rapid succession, where each frame slightly differs from the previous one. As each new frame replaces the previous one, it creates the *illusion of motion*.

Key points to understand:

- It forms the basis of frame-by-frame animation.
- It enables the illusion of movement using still images.
- It is closely related to the concept of Persistence of vision, where the human eye retains an image for a fraction of a second, allowing continuous motion to be perceived.

Since each frame is displayed for only a very short time, animation can be understood as a continuous sequence of images shown at regular intervals.

4. Types of Frames

(i) Key Frame: These are the main frames that define important positions or actions in an animation (e.g., the start and end of a movement). A single motionless image (frame) in an animated sequence that happens at an important point in that sequence. Key frame is always drawn or constructed by the user. Key frames are well-defined throughout the animation, and they define critical points of motion (Fig.1.7).

Fig. 1.7: Key frames defining the critical points of motion

For example, the start of a motion and the end of that same motion. In animation that is drawn by hand, a skilled animator would first draw the key frames, and the beginner animator must draw tween frames (also known as in-between frames). In animation that is developed by computer, users of the animation programme must draw the key frames, and the computer automatically inserts the tween frames.

(ii) Tween Frames (In-between Frames): These frames fill the gaps between key frames, creating smooth transitions and continuous motion. Tween frames truly create the illusion of motion. Tween frames are middle frames with the main purpose of creating the smooth transitions between the two key frames defined above.

Professional film animation is commonly displayed at 24 fps (frames per second). For example, it is our objective to create only the required three key frames, one to begin, one for the mid movement and one to end a movement. Afterwards, the software will create the outstanding 21 frames (tween frames). The final output will be a one second of smooth jerk-free animation with a minor effort from the user. For example, the bouncing ball animation consists of the following six frames (Fig. 1.8).

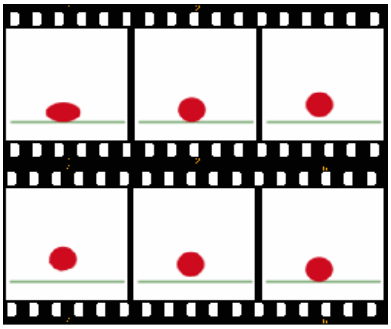

Fig. 1.8: Bouncing ball animation

Practical Exercise

Activity 1: Animation types role-play skit.

Materials Required:

1. Name tags or badges
2. Chart paper or cardstock
3. Markers, sketch pens, and pencils
4. Scissors
5. Glue or tape
6. Cue cards for dialogues
7. Notebook and pen for script preparation
8. Camera or smartphone for taking group photos
9. Open classroom space for practice and performance

Procedure:

Step 1: Discuss the idea with classmates and organise the activity. Each participant would represent a type of animation in a skit.

Step 2: Assign or let everyone choose from animation types such as:

- Traditional 2D animation
- 3D animation
- Stop-motion animation
- Clay animation
- Rotoscoping
- Cut-out animation
- Motion graphics
- Experimental animation

Step 3: Prepare a short dialogue describing participants in first person, as if they were that animation type.

For example:

"Hi, I'm Traditional Animation! I've been around since the early Disney days, where every frame was hand-drawn!"

Step 4: Create a sequence where each participant would speak. Add a short opening and closing line to connect the parts smoothly.

Step 5: You can make simple name tags and, where possible, bring props or images related to the animation type to make it more fun and visual.

Step 6: You should practice the skit together, making sure everyone knows their part, spoke clearly, and stayed within their time limit.

Step 7: Perform the skit in front of the class. Each member steps forward, introduces as a character, and share interesting facts about the animation type.

Step 8: After the performance, invite classmates to ask questions or share what they liked or learned. Also take a group photo with your name tags!

Check Your Progress

A. Fill in the Blanks

1. Computer animation is essentially a digital successor to the _____ techniques.
2. It is now possible for animators to draw directly into a computer using a _____ tablet.
3. Computer animation is also known as _____ animation.
4. Silhouette animation is a variant of _____ animation in which characters are backlit.
5. For a flip book you first need a _____.

B. Multiple Choice Questions

1. Clay Animation is also known as:
   a) Plasticise animation
   b) Claymation
   c) Both of a) and b)
   d) Stop-motion drawing

2. Silhouette Animation is a variant of:
   a) Cut-out animation
   b) Clay Animation
   c) Go Motion
   d) Puppet animation

3. Traditional animation is also called:
   a) Cel animation
   b) Classical animation
   c) Hand-drawn animation
   d) All of these

4. Classical 2D animation is also known as:
   a) Hand-drawn 2D animation
   b) Traditional animation

c) Both a) and b)
d) Digital sketch animation

5. Computer-generated Imagery animation is the process used for:
   a) Generating animated images by using computer graphics
   b) Non-drawn flat visual material
   c) Flat visual graphic material
   d) Stop-motion photography

C. State Whether the Following Statements are True or False

1. Computer-generated animations are more controllable than other; the process of this animation is more physically based.
2. Puppets in puppet animation have an armature inside them to hold their shape and control movement.
3. Graphic Animation does not use non-drawn flat visual graphic material.
4. Computer animation is also called Computer Generated Imagery.
5. Puppet Animation does not involve stop-motion puppet figures.

D. Subjective Questions

1. An animator wants to create a realistic movie scene with characters that can move in all directions and look lifelike. Which animation technique should be used and why? Explain the role of tools and frames in this process.
2. While creating an animation of a bouncing ball, a student only draws the starting and ending positions. Explain how the animation can still appear smooth. What role do key frames and tween frames play in this situation?

What have you learned?

After completing this session, you will be able to:

- classify animation into different types based on techniques, tools, and production methods;
- explain the characteristics and process of flipbook animation and its role in understanding motion;
- describe traditional (hand-drawn or cel) animation and identify its contribution to the animation industry; and
- differentiate between cut-out, clay, stop-motion, puppet, and silhouette animation techniques.

UNIT 2 | Essentials of Animation

The Unit on "*Essentials of Animation*" introduces the fundamental concepts and principles that form the foundation of animation practice. It focuses on the core techniques that bring movement, realism, emotion, and personality to animated characters and objects, enabling animators to create convincing and engaging visual experiences.

Session 1 on Principles of Visual Storytelling introduces the concept of visual storytelling, which is the process of communicating ideas, emotions, messages, and narratives through visual elements such as images, colours, composition, movement, facial expressions, and camera angles. Unlike verbal storytelling, which relies mainly on spoken or written words, visual storytelling allows audiences to understand stories through what they see.

The session explains the importance of storytelling in media, films, animation, advertising, and digital communication. It highlights key features of storytelling, including audience engagement, emotional connection, cultural preservation, and effective communication of ideas.

Session 2 on Principles of Animation explains the twelve principles of animation, these principles serve as the foundation of both traditional and modern animation and help create realistic, appealing, and believable motion. The principles include Squash and Stretch, Anticipation, Staging, Straight Ahead Action and Pose-to-Pose Animation, Follow Through and Overlapping Action, Slow In and Slow Out, Arcs, Secondary Action, Timing and Spacing, Exaggeration, Solid Drawing, and Appeal.

Session 3 on Basics of Production Pipeline deals with the animation production pipeline, a structured workflow used to transform an idea into a finished animated film or project. The pipeline is divided into three major stages: pre-production, production, and post-production. Pre-production is the planning stage where the story, script, storyboard, animatic, visual development, and concept designs are created. This stage establishes the creative vision and provides a blueprint for the entire production process. The production stage is where the actual animation is developed. It includes modelling, texturing, rigging, layout creation, character animation, crowd animation, character effects, visual effects, matte painting, lighting, and rendering. Post-production is the final stage, where all elements are assembled and refined through compositing, sound design, music integration, editorial updates, and colour grading.

Session 1: Principles of Visual Storytelling

Storytelling is the art of presenting ideas, experiences, emotions, and messages through a structured narrative. It is one of the oldest forms of human communication, used to preserve culture, share knowledge, entertain audiences, and inspire people.

1. Visual Storytelling

Visual storytelling is the process of conveying ideas, emotions, narratives, and messages through visual elements rather than relying solely on words or dialogue. It uses images, colours, composition, lighting, movement, facial expressions, body language, camera angles, and visual symbolism to communicate meaning and engage audiences. Visual storytelling is widely employed in animation, films, television, comics, advertising, photography, video games, and digital media, where visuals play a central role in shaping the audience's understanding and emotional response.

A well-developed story typically consists of characters, setting, plot, conflict, and resolution, which work together to create a meaningful and engaging experience. Storytelling can take many forms, including oral traditions, literature, theatre, cinema, animation, music, and interactive digital media.

In contemporary media, storytelling extends beyond spoken or written language by integrating visuals, sound, music, movement, and emotional expression to create immersive experiences. Visual storytelling enhances audience engagement by presenting information in a compelling and memorable way, making complex ideas easier to understand and emotionally connect with.

2. Key Features of Storytelling

Storytelling is a powerful method of communication that has been used throughout history to share ideas, emotions, experiences, and knowledge. It enables creators to connect with readers or listeners on both emotional and intellectual levels by presenting information in an engaging and meaningful way. Effective storytelling combines elements such as characters, settings, conflicts, and resolutions to create narratives that capture attention and convey messages clearly. The key features of storytelling include the following:

- Communicates ideas, emotions, and experiences effectively.
- Engages audiences emotionally and intellectually.
- Includes characters, setting, conflict, and resolution.
- Can be delivered through oral, written, or visual media.

- Preserves culture, traditions, and knowledge.
- Makes information memorable and meaningful.
- Fosters imagination, empathy, and readers or listeners engagement.

3. Difference between Verbal and Visual Storytelling

Storytelling can be communicated in different forms, primarily through verbal and visual methods. Verbal storytelling relies mainly on spoken or written language to narrate events, describe characters, explain emotions, and communicate ideas. It uses words, dialogue, narration, and descriptions to help listeners imagine the story in their minds. Examples of verbal storytelling include novels, speeches, podcasts, poetry, and oral storytelling traditions.

Visual storytelling, on the other hand, communicates ideas and emotions through images, visuals, colours, composition, movement, facial expressions, lighting, and visual sequences. Instead of explaining everything through words, visual storytelling allows audiences to understand the narrative by observing actions and visual elements. Films, animation, photography, comics, advertisements, and video games are common examples of visual storytelling. The key differences between verbal and visual storytelling are given in table 2.1.

Table 2.1: Key Differences between Verbal and Visual Storytelling

Verbal Storytelling	Visual Storytelling
Uses spoken or written words to tell a story	Uses images, visuals, and movement to tell a story
Depends on dialogue, narration, and descriptions	Depends on visuals, expressions, colours, and composition
Audience imagines scenes mentally	Audience directly observes scenes visually
Common in books, speeches, and podcasts	Common in films, animation, comics, and photography
Relies heavily on language skills	Relies heavily on visual design and presentation
Explains ideas through text and speech	Communicates ideas through visual elements
Creates imagination through words	Creates emotional impact through visual imagery
Usually slower in delivering visual details	Quickly conveys information visually
Suitable for detailed explanations and descriptions	Suitable for emotional and visual engagement
Often combined with visual media	Often supported by dialogue and sound in media

4. Importance of Visuals in Communication

Visuals play a vital role in communication because they help people understand information quickly, clearly, and effectively. The human brain processes images much faster than written text. Visual elements such as photographs, illustrations, diagrams, symbols, videos, animations, charts, and graphics simplify complex information and make communication more engaging and memorable.

In education, visuals help students understand difficult concepts more easily by presenting information in a clear and interactive manner. In media and advertising, visuals attract audience attention, create emotional impact, and improve information retention. In films and animation, visuals are essential for expressing emotions, mood, atmosphere, character actions, and storytelling without relying completely on dialogue.

Visual communication also helps overcome language barriers because images and symbols can often be understood universally by people from different cultures and backgrounds. Effective use of visuals improves audience engagement, enhances learning, strengthens storytelling, and creates a lasting impression.

5. Significance of Visuals in Communication

Visuals play a crucial role in modern communication by enhancing the way information is presented and understood. Images, illustrations, diagrams, animations, and other visual elements help convey messages more effectively than text alone. They capture attention, increase audience engagement, and make communication more appealing.

The significance of the visuals in communication includes the following:

a) Help audiences understand information quickly and clearly.
b) Simplify complex ideas and improve learning and memory.
c) Capture attention and make communication more engaging.
d) Create emotional connections and support visual storytelling.
e) Overcome language and cultural barriers.
f) Enhance the effectiveness of presentations, advertising, education, and media.

6. Role of Emotions in Storytelling

Emotions are at the heart of effective storytelling because they help audiences connect deeply with characters, situations, and messages. Stories that evoke emotions such as happiness, sadness, fear, excitement, suspense, or empathy become more memorable and meaningful. Emotional storytelling creates a

psychological connection between the audience and the narrative, allowing viewers or readers to feel involved in the story.

Examples of emotions from Indian Animation include the following:

a) *Hanuman* – The bond between Hanuman and his mother Anjana, along with Hanuman's courage and self-discovery, evokes empathy and inspiration.
b) *Arjun:* The Warrior Prince Arjuna's inner conflict, determination, and growth create an emotional journey that connects audiences with his character.
c) *The Legend of Hanuman* – The series combines action with emotional themes of duty, sacrifice, loyalty, and devotion, making *Hanuman* a relatable hero.
d) *Motu Patlu* – Friendship, humour, and teamwork generate feelings of joy and affection, especially among younger audiences.
e) *Delhi Safari* – The plight of displaced forest animals creates empathy while raising awareness about wildlife conservation and environmental issues.

Emotional engagement not only keeps audiences interested but also helps communicate themes and messages more effectively. Strong emotional storytelling can inspire, educate, entertain, and influence audience perspectives in powerful ways.

Practical Exercise

Activity 1: Group discussion on principles of visual storytelling.

Materials Required:

1. Notebook or writing sheets
2. Pens and pencils
3. Chart paper or whiteboard
4. Markers/coloured pens
5. Smartphone, tablet, or computer with internet access
6. Projector or smartboard (optional)
7. Presentation software
8. Short animation clips or movie scenes
9. Sample storyboards
10. Visual storytelling videos or tutorials
11. Images, comics, or illustrations
12. Drawing materials (sketchbook, pencils, erasers, colours)
13. Storyboard or drawing applications
14. Reference materials on visual storytelling, films, comics, and animation examples.

Procedure:

Step 1: Ask your classmates:

- Who is interested in storytelling, films, animation, or visual media?
- Have they noticed how visuals express emotions and stories?

Step 2 Invite them to share:

- Their favourite stories or movies
- Why they like visual storytelling
- Any experience with drawing, videos, storyboards, or animation
- Which storytelling medium interests them most

Step 3: Create a group named: "Principles of Visual Storytelling"

Step 4: Use the group to:

- Discuss storytelling techniques
- Share visual storytelling examples
- Talk about emotions, colours, and visuals in stories
- Share useful videos, apps, and tutorials
- Help each other with storyboard or creative activities

Step 5: Every student should contribute one storyboard or visual example during the activity.

- A drawing or storyboard
- A movie scene analysis
- A visual storytelling examples
- A question or creative idea

Step 6: Use a projector or smartboard to show:

- A short animation or movie clip
- A storyboard example
- A video on visual storytelling techniques

Check Your Progress

A. Fill in the Blanks

1. Storytelling is the art of communicating ideas and emotions through a structured _____.
2. Visual storytelling mainly uses images, colours, and _____ to communicate stories.
3. _____ help audiences understand information quickly and clearly.
4. Emotions make stories more engaging and _____.
5. Films, animation, comics, and photography are examples of _____ storytelling.

B. Multiple Choice Questions

1. Which of the following is an example of visual storytelling?
   a) Podcast
   b) Speech
   c) Animation
   d) Essay

2. Which element helps create emotional connection in storytelling?
   a) Emotions
   b) Calculations
   c) Grammar
   d) Tables

3. Verbal storytelling mainly depends on:
   a) Images
   b) Movement
   c) Spoken or written words
   d) Colours

4. Which of the following helps simplify complex information?
   a) Visuals
   b) Noise
   c) Random symbols
   d) Silence

5. Which medium commonly uses visual storytelling?
   a) Animation
   b) Poetry
   c) Debate
   d) Speech writing

C. State Whether the Following Statements are True or False

1. Visual storytelling uses only written text to tell a story.
2. Emotions help audiences connect with stories.
3. Visuals can improve communication and understanding.
4. Storytelling is used only in films and entertainment.
5. Colours and facial expressions are important in visual storytelling.

D. Subjective Questions

1. What is storytelling? Explain its importance in communication.
2. Differentiate between verbal storytelling and visual storytelling.
3. Explain the importance of visuals in communication.
4. Describe the role of emotions in storytelling, with examples.
5. How does visual storytelling help in films, animation, and digital media?

What you have learned?

After completing this session, you will be able to:

- describe the concept of visual storytelling;
- identify the core principles of visual storytelling;
- analyse how visuals communicate emotions and narratives;
- apply storytelling techniques in animation, film, and digital media; and
- create simple visual story concepts using frames and sequences.

Session 2: Principles of Animation

All animators need to learn the 12 basic principles of animation. Created for hand-drawn techniques, these principles are timeless and serve as the indispensable standard for all modern computer animation. Basic principles of the animation were established by the Nine Old Men of Walt Disney Studios in the 1930s and amongst them were Frank Thomas and Ollie Johnston, authors of "*Illusion of Life*".

1. Principles of Animation

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

(i) Squash and Stretch

The key principle is "Squash and Stretch", the primary purpose of which is to give the sense of weight and the flexibility to draw objects. This can be functional to simpler objects, like a bouncing ball, or more complex constructions, like the muscles of a human body. 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 (Fig. 2.1).

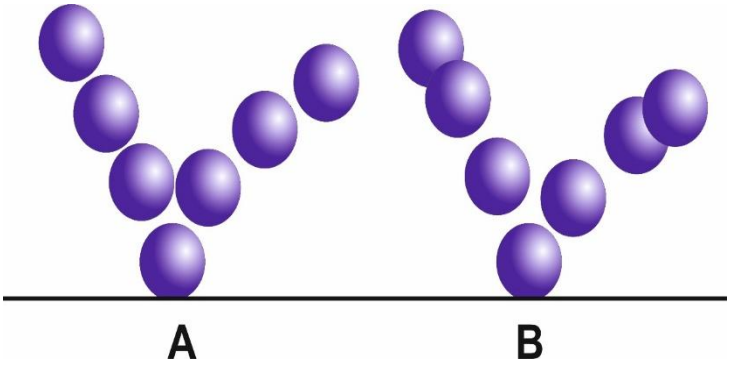

Fig. 2.1: Squash and stretch

Figure 2.1 shows how a bouncing ball changes shape during motion. A demonstrates the ball squashing when it hits the ground and stretching as it moves upward, while B shows a similar sequence with slightly different timing. This principle gives objects weight, flexibility, and a more natural sense of movement.

(ii) Anticipation

In 2D animation, the anticipation of a movement is just as important as the movement itself (Fig. 2.2). The moment of anticipation informs the audience that an object or character is about to act 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 skilful use of gesture, motion curves like primary and secondary actions, expanding or contracting pieces of animation to create the anticipatory effect.

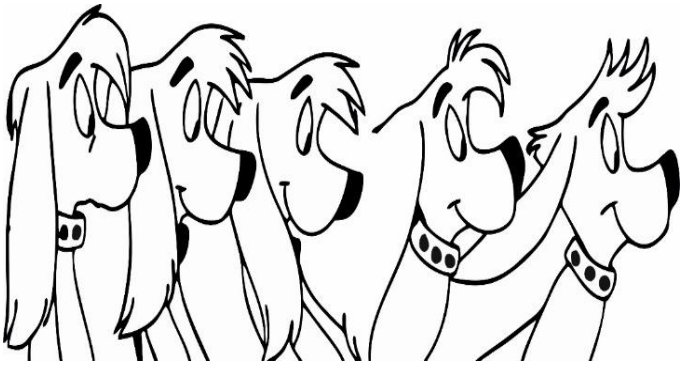

Fig. 2.2: Illustration of the Anticipation Principle in Animation

(iii) 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 animatic, which establishes a scene's core movements before primary animation gets underway (Fig. 2.3). 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.

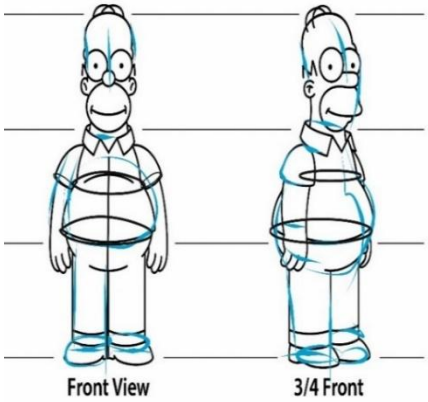

Fig. 2.3: Character positioning and staging in an animated scene

(iv) 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 (Fig. 2.4).

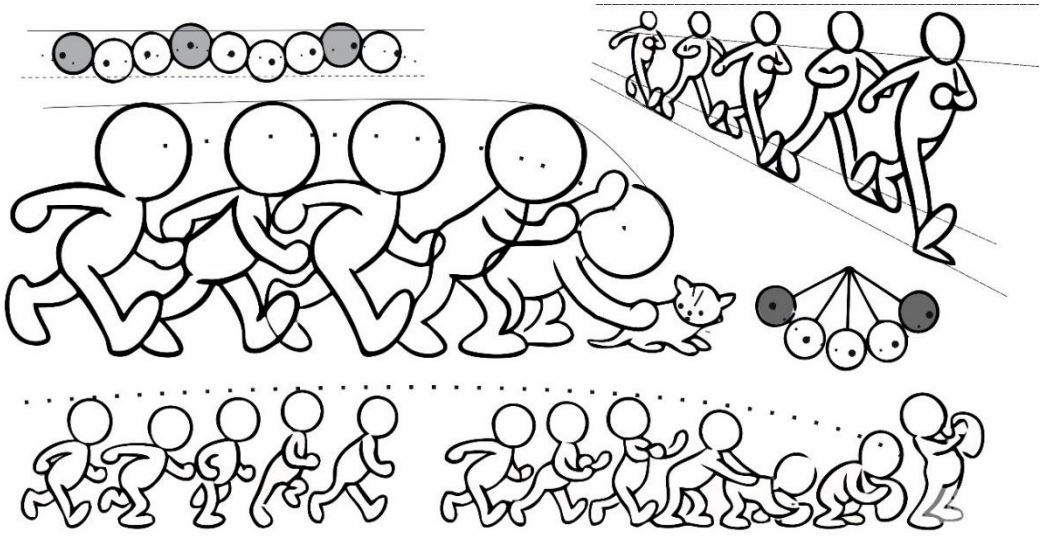

Fig. 2.4: Pose-to-pose animation

Straight ahead action involves animating frame-by-frame from start to finish, creating fluid, dynamic, and spontaneous movement. It works well for wild or energetic actions, but can make maintaining proportions and precise poses difficult. Pose-to-Pose involves planning key poses first and then filling in the in-between frames. It is ideal for dramatic or emotional scenes where composition,

timing, and relations to surroundings are important. Many animators use a combination of both techniques. In computer animation, pose-to-pose is often preferred, as software can generate in-between frames, while straight ahead action adds creativity and spontaneity.

(v) 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 at a different timing than the head and so on). A third related technique is "drag", where a character starts to move and parts of the character take a few frames to catch up.

(vi) 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 utilise 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.

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

(viii) 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.

(ix) Timing and Spacing

Timing is the number of frames or drawings used for an action, determining its speed on film. Proper timing makes objects obey physics and conveys weight, motion, and impact. It is also essential for expressing a character's mood, emotion, and reactions. Timing is a key element that distinguishes animation from still art, allowing movement to communicate feelings and messages that static images cannot. 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 (Fig. 2.5).

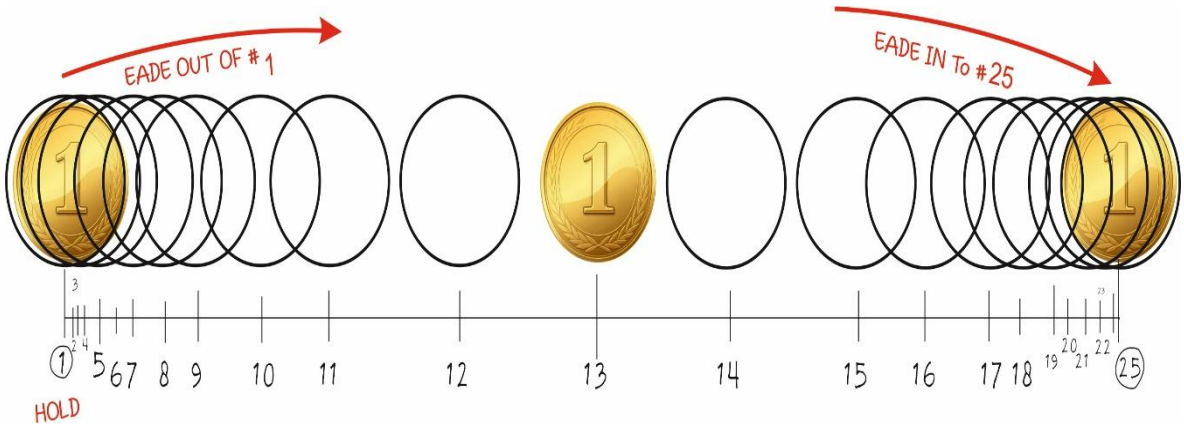

Fig. 2.5: Visual representation of timing and spacing in animated motion

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.

(x) Exaggeration

Exaggeration is an effect especially useful for animation, as a 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 overwhelming the viewer.

(xi) Solid Drawing

Solid drawing is about creating an accurate drawing with volume and weight, 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 avoid this issue.

(xii) Appeal

Appeal corresponds to what would be called charisma in an actor. A character who is appealing does not necessarily have to be sympathetic, such as villains or monsters can also be appealing, but 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.

Practical Exercise

Activity 1: Group discussion on 12 principles of animation.

Materials Required:

1. Notebook and pen/pencil
2. Chart paper or poster sheets
3. Sketch pens, markers, and coloured pencils
4. Whiteboard and markers/chalk
5. Computer or smartphone (if available)
6. Internet access for viewing animation videos and tutorials
7. Reference materials on the 12 Principles of Animation

Procedure:

Step 1: Begin by asking your classmates:

"How many of you are interested in becoming animators or working in the animation industry in the future?"

Step 2: Invite interested classmates to talk briefly about:

- Why they like animation
- What inspired them
- If they've tried animation apps or made short clips
- What type of animation they are curious about (2D, 3D, stop-motion, etc.)

Step 3: Once the interested classmates are identified, create a group named: "12 Principles of Animation"

Step 4: Use the group to:

- Share experiences, thoughts, and questions about animation
- Recommend useful videos, apps, tutorials, or short films
- Help each other with mini-projects, ideas, or animation challenges
- Discuss the "12 principles of animation" and how they apply in real projects
- Stay connected for school activity and future workshops

Step 5: Everyone in the group should try to post at least once a week — it could be a drawing, a clip they made, a cool fact, or even a question.

Step 6: If your class has access to a smartboard or projector, you can present a short YouTube video or animation explaining the 12 Principles of Animation to kick off the group discussion.

Check Your Progress

A. Fill in the Blanks

1. Appeal corresponds to what would be called _____ in an actor.
2. The moment of anticipation informs the audience that a character is about to take _____.
3. Exaggeration is a _____especially useful for animation.
4. Timing is an important principle because it gives meaning to _____.
5. The key to appeal is making the viewer feel that the character is _____ and interesting.

B. Multiple Choice Questions

1. Solid drawing is about creating an accurate drawing with:
   a) Volume
   b) Weight
   c) Both of these
   d) Perspective

2. Separate parts of a body will continue moving after the character has stopped comes under:
   a) Slow-out and Slow in
   b) Follow through
   c) Arcs
   d) Squash and Stretch

3. To make the leading characters in any project as appealing as possible to captivate the audience is known as:
   a) Timing
   b) Appeal

c) Staging
d) Anticipation

4. The layout of objects and characters in a scene that draws the audience's attention to the subject of the scene is known as:
   a) Staging
   b) Solid drawing
   c) Appeal
   d) Exaggeration

C. State Whether the Following Statements are True or False

1. A character who is appealing is necessary to be sympathetic.
2. There are several tricks for making a character connect better with the audience.
3. The level of exaggeration depends on whether one seeks realism or a particular style.
4. Secondary action does not refer to creating actions.
5. Staging is not useful in animatic.

D. Subjective Questions

1. A gaming company is creating a new animated mascot for its mobile app. During testing, users feel that the character's movements look stiff and unnatural. As an animation designer, explain which principles of animation you would apply to improve the character's motion and user engagement.
2. You are animating a basketball bouncing on the ground for a sports advertisement. Describe how you would use the principle of Squash and Stretch to make the movement look realistic and visually appealing.

What have you learned?

After completing this session, you will be able to:

- apply the 12 Principles of Animation to enhance the realism, quality, and visual appeal of animated scenes and character performances;
- explain and utilize all twelve animation principles in both traditional hand-drawn animation and modern digital/CGI animation workflows;
- classify the 12 Principles of Animation into functional categories such as motion, timing, and appeal, and implement them effectively during the animation production process;
- create and demonstrate animations using the principle of Squash and Stretch to convey weight, flexibility, elasticity, and realistic movement in characters and objects; and

- develop short animation exercises that integrate multiple animation principles to improve expressive and believable motion.

Session 3: Basics of Production Pipeline

A production pipeline is a systematic, multi-stage workflow used by a team to transform an initial idea or concept into a final, polished product, such as an animated film, video game, or software application. A production pipeline is required in all logical organisations to develop an animated film.

1. Stages in Animation Production Pipeline

The animation production pipeline is broadly divided into three main stages: pre-production, production, and post-production. Each stage plays a crucial role in transforming an idea into a finished animated film or sequence.

I. PRE-PRODUCTION

Pre-production is the first and most important stage of the animation pipeline, where all the planning and designing take place before actual animation begins. This stage includes story development, storyboarding, editorial work, and visual development. It serves as the foundation of the entire animation project, ensuring that the production team has a clear vision before moving into the animation process.

(i) Story or Script: The first step in pre-production is writing and developing the story or script. The script serves as the reference point for all the elements involved in the production pipeline. It defines the plot, characters, dialogue, settings, and sequence of events. A well-written story provides direction to the entire animation team and ensures that everyone works toward the same creative vision.

(ii) Storyboarding: Storyboarding is the stage where the script is broken down into individual scenes and illustrated as a sequence of panels, similar to a graphic novel or comic strip. It helps the director visualize the film before production begins, allowing them to determine what works effectively and what needs improvement. This process also helps the team plan camera angles, character movements, scene transitions, and timing. The storyboarding process begins with an initial rough draft. One of the developers or storyboard artists presents the story by acting out scenes and explaining the sketches to the team in order to gather feedback. Based on the suggestions received, the storyboard is revised and redrawn with the necessary improvements. This review-and-revision cycle

continues until the team agrees on the final storyboard, which then serves as the visual blueprint for the animation.

The storyboard is a sequence of pictures with captions that define the outline of the story (Fig. 2.6). It also helps in the location and position of cameras and the timing of animation later on in the production procedure.

Fig. 2.6: Storyboard illustrating scene planning and sequence development

(iii) Editorial Work: Once the storyboard has been finalised, it is passed to the editorial team, who create an animatic based on the approved boards. Working closely with the director, the editor assembles the sequence to illustrate the key story beats, establishing rough timing, pacing, and any necessary dialogue to communicate the narrative effectively.

(iv) Visual Development

Visual development and concept artists develop the film, which will actually look like, including fully scheming elements such as characters, environments, props, colour pallets and backgrounds.

(v) Concept Design

Concept art is a form of illustration used to convey an idea for use in animation, video films, or other media before it is put into the final product. Concept art usually refers to world-building artwork used to inspire the development of media products, and is not the same as visual development art or concept design,

though all three are often confused. The term "concept art" was used by Disney as early as the 1930s. A concept artist does a preliminary artwork.

Concept design is the process which artists visualise what the director wants the film to look like. In this process, the characters and environment are created through sketches. Later on, the modellers use these sketches as guidelines when they create models on the computer (Fig. 2.7).

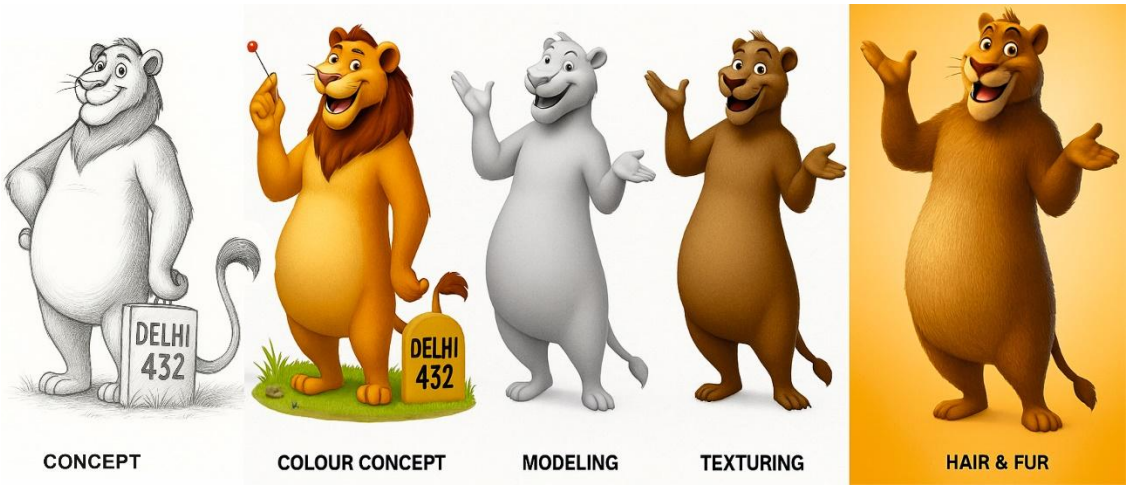

Fig. 2.7: Concept design in animation pre-production

II. PRODUCTION

The production stage in animation is where all the planning from pre-production is brought to life. In this phase, animators begin creating the actual animated scenes using the storyboard, character designs, and animatics as a guide. The process typically includes modelling (in 3D animation), background creation, layout design, and character animation. Artists add motion to characters, apply timing and movement, and ensure the scenes flow smoothly.

(i) Modelling

Modelling in 3D computer graphics is the process of creating a mathematical representation of a three-dimensional object or surface. Modelling artists transform the 2D concept art into 3D models. These models can include characters, environments, props, or abstract elements. Specialized software is used to shape, sculpt, and refine these digital objects.

(ii) Texturing

Texturing artists apply colours, textures and shaders for the characters, props and sets. Shaders are used to define how surfaces react to light. They ensure the textures match the approved concept art and designs created by the art

department, i.e. visual development. The goal is to match the final look with the approved visual designs from pre-production.

(iii) Rigging

Rigging is the process of preparing models for animation. Riggers build and attach 3D skeletons to the characters. Riggers create a digital skeleton (rig) inside the character model. This rig acts like a puppet system that animators can control. Controls are added to move joints, facial expressions, and body parts, allowing characters to act and emote naturally. This skeleton becomes the “puppet” that the animators use to bring the characters to life. Riggers thus create and place the controls that move the joints of the “puppet” and allow the animators to move the face and body so that the character can act and emote per the needs of the story.

(iv) Layout/Set dressing/Animation Preparation

Artists place characters, props, and environments into a 3D space. They set dressing adds details to make scenes look complete and realistic. Camera angles and composition are finalized and everything is ready for animators to begin adding motion.

(v) Character Animation

Character animation artists bring the characters to life. 3D animators use a computer to pose the character using the rig that was created by the rigging department. A character animation artist's job is to figure out how to tell the story through movements and expressions.

(vi) Crowds

The crowd department is responsible for the “extras” in large crowd scenes in the movie. They work to create realistic-looking actions for the crowd characters in the movie.

(vii) Character Effects

Character effects artists are responsible for everything that is moving on a character, including clothing, hair, fur, or feathers. They also develop interactions of the character with objects.

(viii) VFX (Visual Effects)

Visual Effects artists are responsible for all the little details you take for granted in live productions, such as what happens when there is an explosion or an action that leaves traces, such as footprints. In animation, the VFX artists must ensure

that these details provide realism and support to the story. They are the general problem solvers who make the production work as a film.

(ix) Matte Painting

The matte painting department develops everything outside of the set, including mountains, oceans, skies, vistas, and cityscapes. They use colour keys created by the art department and models built by the modellers. They create paintings that are the images that slide into the background of the animation. To create the look of the world that lives inside the animation.

(x) Lighting

Lighting is a key element that takes the 3D elements and 2D visual development work to create the look and tone. There is a great deal of technical direction that happens at this stage.

(xi) Rendering

Rendering is the final step in the production process where all the work from modelling, texturing, lighting, and animation is combined to produce the final images that viewers see. This stage transforms the 3D scenes into realistic or stylised visuals, simulating real-world effects such as light, shadows, reflections, refractions, depth, and motion. Rendering ensures that every detail, from the movement of characters to the interaction of objects with their environment, is accurately captured, making the animation visually complete and ready for post-production.

III. POST-PRODUCTION

Post-production is the final stage in the animation pipeline, where all the elements created during production are refined, assembled, and enhanced to create the finished product. It involves several crucial processes that polish the animation, ensuring it is visually appealing, emotionally engaging, and technically sound for distribution. Here are the key components of post-production in animation:

(i) Compositing

Compositing is where supplementary elements are brought together with the final rendered frames from lighting, such as atmospheric elements. Depth of field and colour tweaking happens at this stage. This is where the final look of a film really comes together.

(ii) Music and sound

The final edit must be locked before sound design and music are fully integrated. Even minor changes of a few frames can disrupt carefully timed sound effects,

dialogue, and score cues, all of which are synchronised to specific frames within the edit. For this reason, sound design and scoring are typically reserved for the final stages of production, once the picture has been approved and no further editorial changes are expected.

(iii) Editorial work

As new animation, lighting, and compositing work becomes available for review, the editorial team integrates these updates into the edit. Their role is to ensure the film remains aligned with the latest approved material and accurately reflects the current state of production. The process begins with the storyboard-based edit, which serves as the foundation of the film. As production progresses, storyboard panels are gradually replaced by animation, followed by lighting and compositing, creating an increasingly refined version of the final film.

(iv) Colour grading

Colour grading is the last stage of a production's look. The colour grader's job is to ensure the picture is consistent throughout each sequence, so there are not jarring changes in light or look.

Practical Exercise

Activity 1: Group discussion on stages of production in animation.

1. Materials Required
2. Notebook and pen/pencil
3. Chart paper or poster sheets
4. Sketch pens, markers, and coloured pencils
5. Whiteboard and markers/chalk
6. Reference books or study materials on animation production
7. Computer or laptop with internet access
8. Projector or smart board (optional)

Procedure:

Step 1: Form three groups within the class.

Step 2: Each group will take one of the three stages of production:

- Pre-production
- Production
- Post-production

Step 3: Discuss within group and gather information about your assigned stage. Think about:

- What happens in this stage?
- Who is involved?
- What tools or techniques are used?
- Why is this stage important?

Step 4: One by one, each group will come forward and explain their stage to the class. You can use:

- Simple sketches
- Short examples
- Real-life comparisons

Check Your Progress

A. Fill in the Blanks

1. The process of turning 2D concept art into 3D models is called _____.
2. The last step in the animation pipeline that ensures consistency in lighting and colour is _____.
3. _____ artists are responsible for all the small details like explosions, footprints, or dust in animated films.
4. In the pre-visualisation stage, the artist works in a 3-dimensional environment using _____.
5. The _____ department creates background elements like mountains, oceans, and cityscapes.

B. Multiple Choice Questions

1. Which of the following is responsible for creating the 'puppet' structure of characters?
   a) Animator
   b) Rigging artist
   c) Concept artist
   d) Editor

2. What is the primary purpose of storyboarding in the animation production pipeline?
   a) To render final images
   b) To create detailed 3D models
   c) To visualise scenes and camera angles before animation
   d) To add background music

3. Which stage comes immediately after Visual Development?
   a) Lighting
   b) Pre-Visualisation
   c) Texturing
   d) Compositing

4. Which team is responsible for “extras” in large crowd scenes?
   a) Simulation
   b) Compositing
   c) Crowds
   d) VFX

5. Which of the following happens in post-production?
   a) Modelling
   b) Storyboarding
   c) Compositing
   d) Rigging

C. State whether the following statements are True or False

1. Every animated film uses the same production pipeline.
2. Texturing artists create colours, and shaders to match the approved concept art.
3. Storyboard is the final step before the film is released.
4. Lighting plays a major role in setting the look and tone of the animation.
5. Compositing combines all final elements and applies tweaks like depth of field.

D. Subjective Questions

1. A new animation studio has been hired to create a short-animated film for children about environmental conservation. The story should communicate the importance of saving forests and protecting wildlife.

Task:

   a) Write a short story (150–200 words) based on this theme.
   b) Divide the story into key scenes.

2. A 3D animated character must perform an action scene where the character jumps into water during a storm while wearing loose clothing and long hair. Describe how the character animator creates believable movement and acting.

3. After completing animation, lighting, and rendering, a studio releases an animated short film without proper colour grading. The final output appears visually inconsistent, with some scenes looking too dark while others appear oversaturated. Explain the purpose of colour grading in the animation pipeline and suggest methods the studio could use to improve the final visual quality of the film.

What have you learned?

After completing this session, you will be able to:

- describe the meaning and importance of the animation production pipeline;
- identify and explain the stages of pre-production, production, and post-production; and
- demonstrate the sequence and functions of departments involved in creating an animated film.

Unit 3 | Digital 2D Animation

The Unit on Digital 2D Animation deals with the principles, techniques, and industry applications of digital 2D animation, providing you with both conceptual understanding and practical exposure to the animation production process.

Session 1 on Concept of 2D Animation introduces the concept of 2D animation, which creates the illusion of movement in a flat, two-dimensional space through the rapid display of sequential images. Unlike 3D animation, which uses digital models and depth, 2D animation relies on drawing skills, keyframes, in-between frames, timing, and smooth motion. The session also explains the three major stages of the 2D animation production pipeline: pre-production, production, and post-production.

Session 2 on Types of 2D Animation deals with various types of 2D animation and their applications in films, games, advertisements, and digital media. It begins with Cel Animation, the traditional technique where each frame is redrawn on transparent sheets called cels to create motion. The session also explains Path Animation, which moves objects along predefined paths, and Stop-motion Animation, which creates movement by capturing individual frames of physical objects.

Session 3 on Applications of 2D Animation in Animation and Media covers the practical application of 2D animation through walk cycles, tweening techniques, and animation software. The concept of in-betweening is introduced as a method for creating smooth transitions between key poses.

Session 1: Concept of 2D Animation

Unlike 3D animation, 2D animation does not engage any fancy digital models, but uses a straighter, forward approach. Huge digital drawing tablets allow animators to draw their key frames digitally and develop the tweens automatically using

software for 2D animation. Several modern animation studios (such as Red Chillies) use 3D animation tools to develop 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.

1. Concept of 2D Animation

2D Animation creates movement in a flat, two-dimensional space by animating characters, objects, and backgrounds over time. Motion is achieved by displaying a sequence of images (frames) rapidly, typically 24 frames per second. Modern 2D animation is developed and edited on computers using bitmap or vector graphics, including techniques like morphing and onion-skinning.

The 2D animation has having lot of applications, including analogue computer, Flash and PowerPoint animation. The complete procedure of developing a 2D animation, 3D animation or any work is divided into three parts: pre-production, production and post-production.

2. Pre-Production

Pre-production includes creating the plot of the finalised animation. Because each shot in animation is so labour-demanding, it is mandatory to get shots right during pre-production. Redoing the animation of a shot is very expensive, particularly compared to live-action filming; therefore, almost every care needs to be taken while taking shots (Fig. 3.1). Most of the animations are primarily storyboarded, where the key action of individual scene is drawn in comic book form. Storyboards are basically glued on large poster board sheets, which allow us to read them quickly and thoroughly by the team. During the pre-production procedure, the staff reviews the storyboard for consistency, and parts of the storyboard may be redrawn multiple times.

Fig. 3.1: Pre-production sketching shot

3. Production

Production in 2D Animation is the stage where the actual animation is created. Animators draw key frames (main poses) and in-betweens to make the motion smooth. Artists clean up lines, add colours, and synchronise the animation with dialogue, sound, and backgrounds. Each shot consists of multiple frames, similar to taking rapid photographs of a moving subject, which together create continuous, expressive motion. Some software can automate in-between movements using digital “puppet” characters.

A single shot may cover only one picture (especially in forms like anime, they are "limited animation"), but frequently contains approximately ten to twenty drawings. These drawings are all separated into "keys" and "in-betweens." Keys are the important category drawings that convey between the extremes in the character's movement--the first drawing is usually always a key, while in-betweens (also called “tweens") are the remaining they fall in less important category drawings in the shot (Fig. 3.2).

Fig. 3.2: A coloured tween

Usually, each drawing begins with a sketch, which is developed using pencil to draw the character's pose. It is the particular point at which computers often step in. Some companies’ hand-ink each drawing, writing over the cleaned pencil lines with a pen. Others specifically studios where artists can easily draw very clean pencil lines, where we can scan the pencils directly into a readable file for a computer, and then we can easily ink the drawing digitally.

4. Post-Production

Post-production in 2D animation is the final stage of the animation pipeline where all the created elements are polished and combined to produce the finished film or video. This stage includes adding VFX, sound effects, voice-over, and background music, as well as editing and compositing the animated scenes.

Colour correction, titles, and credits are also added during this phase. The goal of post-production is to ensure that the animation looks seamless, sounds professional, and is ready for distribution to the audience.

This drawing will now be considered as a "cel." Before computer age, the drawing was photocopied onto the clear sheet of celluloid or acetate, then hand-painted by the artists. This created the "cel" (Fig. 3.3). We can place it on top of a background painting and later film it with the click of a film camera. These kinds of cels are still very highly prized by various collectors; yet, very rare true cels persist. Many of them are still in the market for reproductions.

Fig. 3.3: A coloured cel

Today, animation cels are digitally coloured, and backgrounds are either drawn on the computer or scanned from hand-drawn art. Cels are layered over backgrounds in animation software and saved as a single video file. In production, key frames are drawn by senior animators, scanned, and compiled into a rough cut.

Junior animators create the in-between frames (tweens) and make small adjustments under guidance to ensure smooth motion and proper flow of each

shot and scene. Adobe Animate is a multimedia authoring and animation software application developed by Adobe. For example, rich script animation for various Internet applications like introduction of a dynamic website, desktop applications, mobile applications like advertisement banners, mobile games and embedded web browser video players so that any .swf file can be played easily. Flash is a multimedia software platform that was developed by Adobe Inc. (originally by Macromedia) for creating interactive content, animations, games, and web applications. Flash can display various types of content in an output file, including text, vector graphics, and raster graphics. It is widely used for creating smooth animations, video games, and interactive applications. Flash also supports audio and video streaming and can capture input from devices such as the mouse, keyboard, microphone, and camera through scripting.

Artists can create 2D graphics and animations using Adobe Animate, a software application designed for multimedia authoring and computer animation. Adobe Animate is a powerful 2D animation program that enables the development of interactive and visually engaging content.

Practical Exercise

Activity: The 2D Animation Pipeline and Tools.

Materials Required:

1. Chart paper or A4 sheets
2. Notebook and pen/pencil
3. Whiteboard and markers/chalk
4. Sketch pens and coloured pencils
5. Ruler and eraser
6. Printed images/examples of 2D animations
7. Computer with presentation software
8. Projector or smart board (optional)
9. Reference materials on 2D animation and Adobe Animate

Procedure:

Step 1: Divide the class into four groups.

Step 2: Assign one topic to each group as follows:

Group 1- Concept of 2D Animation
Group 2- Pre-Production in 2D Animation
Group 3- Production and Post-Production in 2D Animation
Group 4- Concept and Applications of Adobe Animate

Step 3: Each group will discuss their assigned topic and prepare points based on the following guiding questions:

a) What is the main idea of the topic?
b) What processes or steps are involved?
c) What tools, software, or techniques are used?
d) Why is this topic important in 2D animation?
e) Can you give one simple example (real-life or animation-based)?

Step 4: Each group will present their discussion to the class one by one. Presentations may include:

a) Simple sketches or flow diagrams
b) Key terms on the board
c) Examples from cartoons, films, or software like Adobe Animate

Step 5: After all presentations, the teacher will summarise the complete 2D animation workflow, connecting concept, production stages, and software tools.

Check Your Progress

A. Fill in the Blanks

1. 2D animation refers to the creation of movement in a _____ space.
2. Each drawing begins with a _____ in pencil, of the character's pose.
3. Pre-production involves establishing the _____ of the completed animation.
4. Each photograph corresponds to an _____ drawing in an animation.
5. Each shot in a 2D animation involves _____ single drawings of characters.

B. Multiple Choice Questions

1. Storyboards are usually pasted on:
   a) Large foam-core boards
   b) Poster board sheets
   c) Both large foam-core boards and poster board sheets
   d) Animation drawing tablets

2. 2D animation figures are created and/or edited on the computer using:
   a) 2D bitmap graphics
   b) 2D vector graphics
   c) Both bitmap and vector graphics
   d) 3D polygon graphics

3. 2D animation creates movement in a:
   a) Four-dimensional space

b) Three-dimensional space
c) Two-dimensional space
d) Virtual reality environment

4. Adobe Animate is a:
   a) Multimedia software platform used for animation production
   b) Hardware device used for animation production
   c) Video editing machine used for broadcasting
   d) Printing software for graphic design

5. Today, digital cels are coloured:
   a) On a computer using digital tools
   b) By using coloured pens manually
   c) By using coloured pencils on paper
   d) Only through photographic printing techniques

C. State Whether the Following Statements are True or False

1. Flash Adobe is 2D Animation Software.
2. Flash cannot animate filter effects.
3. A shot may contain only one drawing, but usually contains about ten to twenty drawings.
4. Parts of the storyboard may not be redrawn multiple times.
5. Artists may produce Flash graphics and animations using Adobe Animate.

D. Subjective Questions

1. If a shot in an animation needs correction after completion, why is it costlier compared to live-action filming?
2. In what way can onion-skinning improve the smoothness of character movement in animation software?
3. How can scanned pencil drawings be used effectively in digital animation production?
4. Explain the differences between 2D and 3D animation in terms of techniques and tools used in production.
5. Describe the three main stages of the animation production pipeline and highlight the importance of the pre-production stage in 2D animation.

What have you learned?

After completing this session, you will be able to:

- explain the concept and fundamentals of 2D animation;
- identify the stages of the 2D animation production pipeline; and
- demonstrate the use of basic tools and techniques in creating a simple 2D animated sequence.

Session 2: Types of 2D Animation

The 2D animation is developed with the help of a computer by using bitmap images, or it can also be developed and edited using various 2D software for vector graphics. 2D animation can easily be used for various things, like video games, advertisements or creating an animated film. The types of 2D animation are as follows:

1. Cel Animation

This is basically based on the series of frames or cels in which the object is constantly redrawn in each successive cel to portray motion. The Cel originates from the word celluloid, which means a see-through sheet material. It was primarily used to sketch the images and place them on a motionless background (Fig. 3.4).

Fig. 3.4: Preparation of Transparent Cels for Animation

2. Digital Animation

Digital animation is the paperless version of traditional animation, where drawings are created directly on a computer using specialized animation software instead of being drawn on paper. Artists use digital tools to design characters, backgrounds, and motion, making the animation process faster, more efficient, and easier to edit. Digital animation also allows for the use of advanced features such as layers, effects, and colour correction, resulting in high-quality animated films, television shows, advertisements, and video games.

3. Path Animation

It is basically the simplest form of animation, and it is also easy to learn. It moves the object along a programmed path on the screen. The path can be a straight line or it may include a few kinds of curves in it. Often, these objects do not change, although they might be resized or reshaped.

4. Stop-motion Animation

This animation can easily be defined as a 3D animation, the stop-motion animations are those of a kind which can easily work with 2D objects, for example, illustrations and photos.

5. Sand Animation

In this kind of animation, sand is moved around on a back- or front-lighted piece of glass table to create each frame for an individual animated film. This develops an interesting effect when animated because of the light contrast.

6. Cut-out Animation

This kind of animation is made by using cut pieces of paper, card, fabric, etc. They are directly placed under glass, and then a particular frame is taken and cut out and then moved slightly and again a new frame is taken.

7. Rotoscoping

It is done by tracing over live video taken from a camera to generate realistic movements. Every frame is traced individually, then later the reel footage is removed, leaving us with just the traced drawing. For example, flying cars used with wires, flying Superman, removal of green or blue chroma screen is a part of Rotoscoping.

8. Cinemagraphs

Cinemagraphs are a unique fusion of photography and video, designed to create the illusion of a living picture. At first glance, they appear to be still photographs, but on closer observation, one notices subtle, continuous motion in a specific part of the image, like the flicker of a flame, the ripple of water, or a strand of hair moving in the wind. This delicate interplay of stillness and motion creates a captivating "living photograph" that draws the viewer's attention while maintaining a sense of calm. Unlike traditional photographs that freeze time entirely, or videos that animate everything in motion, cinemagraphs strike a perfect balance by highlighting just one dynamic element. This makes them highly effective in storytelling, as they allow the audience to focus on mood, detail, and atmosphere in a way that feels both natural and artistic. Widely used in advertising, fashion, journalism, and social media, cinemagraphs stand out as an engaging medium that is more eye-catching than static images yet less overwhelming than full-motion video. They represent a powerful and modern form of visual expression that blends timeless photography with the energy of animation.

Practical Exercise

Activity 1: Field visit to animation centre.

1. Notebook or observation sheet
2. Pen or pencil
3. Camera/mobile phone (if permitted)

4. Chart paper or poster sheet
5. Sketch pens, markers, and coloured pencils
6. Ruler and eraser
7. Glue stick and scissors
8. Printed photographs (if available)

Procedure:

Step 1: Form a team with your classmates for a visit to a nearby computer animation centre.

Step 2: During the visit, pay close attention to how animation is created. Try to understand:

- What software and tools are used?
- What steps are followed from idea to final animation?
- What roles do different team members play?
- How are teamwork and creativity combined?

Step 3: Write down important points or interesting facts. If allowed, take photos or make quick sketches while observing the work process.

Step 4: After the visit, work together with your team to make a pictorial chart or poster that explains:

- The steps of animation you observed
- The tools and software used
- The people and roles involved in production

You can use drawings, flowcharts, labels, or symbols to present the information creatively.

Step 5: Present your pictorial chart to the rest of your class and explain what you learned during the visit.

Check Your Progress

A. Fill in the Blanks

1. Stop-motion Animation can be classified also as _____ animation.
2. In Digital Animation the drawings are drawn _____ on the computer.
3. Cel comes from the word _____.

B. Multiple Choice Questions

1. Cinemagraphs are:
   a) Still photographs with subtle repeated motion
   b) Static black-and-white photographs
   c) Hand-drawn animation frames
   d) Images without any movement

2. Rotoscoping is a technique created by tracing over:
   a) Recorded sound effects
   b) Live-action video footage
   c) Background paintings
   d) Printed photographs

3. Digital animation is:
   a) A paper-based animation method
   b) A paperless form of traditional animation using digital tools
   c) A type of stop-motion animation
   d) Animation created without software

4. Path-based animation:
   a) Moves an object along a predefined path on the screen
   b) Creates animation only in circular motion
   c) Prevents objects from moving in animation
   d) Uses only hand-drawn sketches for movement

5. Cel animation is primarily based on:
   a) A sequence of frames displayed rapidly to create motion
   b) Recording real-life movements directly
   c) Editing photographs frame-by-frame
   d) Applying sound effects before drawing characters

C. State Whether the Following Statements are True or False

1. Rotoscoping is made by tracing over live video to create unrealistic movement.
2. In Sand Animation**,** sand is moved around on a back- or front-lighted piece of glass.
3. Celluloid is a transparent sheet material.
4. Cel Animation is not a traditional animation.
5. In Path Animation, the path could be a straight line or it could include any number of curves.

D. Subjective Questions

1. Explain the Animation production process.
2. Explain the difference between traditional cel animation and digital animation in 2D animation production.

3. Describe the process and unique features of rotoscoping and its significance in visual effects creation.
4. How does path animation work, and why is it considered one of the simplest forms of animation?
5. What is sand animation, and how does it create unique visual effects in animation?
6. Discuss the purpose of green and blue screens in animation and filmmaking, including the challenges related to green spill.

What have you learned?

After completing this session, you will be able to:

- explain the concept of 2D animation using bitmap and vector graphics;
- differentiate between various types of 2D animation such as Cel, Digital, Path, Stop Motion, Sand, Cut-out, Rotoscoping, and Cinemagraphs; and
- demonstrate a basic understanding of how different 2D animation techniques are applied in films, advertisements, video games, and digital media.

Session 3: Applications of 2D Animation in Animation and Media

This session explains the basic procedure of creating 2D animation in Adobe Animate using keyframes, walk cycles, and tweening to produce smooth motion. It also covers its applications and other common 2D animation tools used in digital animation production.

1. Walk Cycle 2D Animation

In the process of animation, when a character walks it is known as a walk cycle. This means a series of frames or illustrations drawn in an appropriate sequence that loops, leading to the development of an animated character walking. The animated walk cycle of any character is properly looped over and over again. Doing loops can easily avoid animating each step again and again.

Creating a Walk Cycle

The basic walk cycle can be easily split up into the following 4 key frames:

- Forward Contact Point,
- Passing Pose1,
- Back Contact Point, and
- Passing Pose 2

The frames that are drawn in between key poses (usually known as Inbetweening) are either drawn by hand or by the use of computer software to interpose them (Fig. 3.5).

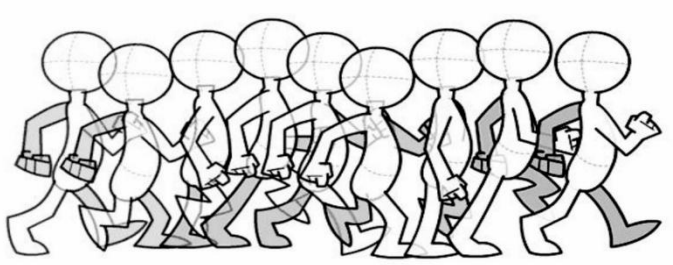

Fig. 3.5: Character walk cycle showing sequential movement

Besides the outward movement of legs, many more necessary details are available for a considerable walk cycle, like animation timing, arms movement, head movement and torso movement of the developed 3D body model (Fig. 3.6).

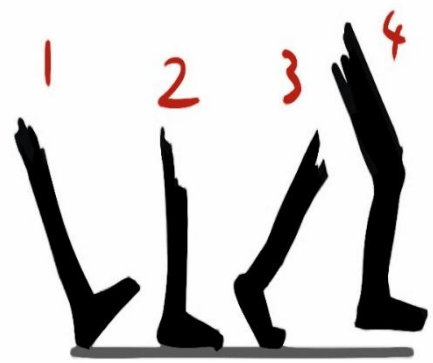

Fig. 3.6: Leg movement in character animation

There are many techniques that exist to develop any character's walk cycles. Usually, walk-cycles for different characters were drawn by hand, but as time flew, the new technologies introduction including new mediums in the field, allowed walk cycles that can be easily developed in pixel art, 2D computer graphics, 3D computer graphics, stop-motion method, cut-out animation or a few unique techniques like rotoscoping.

The 2D animation, as it sounds, only has two dimensions which means it is all flat animation and each and every action happens in the X and Y axis only, where 3D animation includes an extra dimension, and that is the Z axis (depth).

2. Software for 2D Animation

(i) Pencil

Pencil (often known as Pencil 2D Animation) is a free and open-source 2D animation software designed to replicate the traditional experience of hand-drawn, frame-by-frame animation. Its workflow closely resembles the classic flipbook technique, making it an excellent tool for learning the fundamentals of animation.

The software features a simple and intuitive user interface that allows beginners to focus on the creative process without being overwhelmed by complex controls.

It provides essential drawing and animation tools, including layers, keyframes, onion-skinning, and timeline-based editing, which help users create smooth and natural motion. The onion-skinning feature enables animators to view previous and subsequent frames simultaneously, making it easier to plan movements and maintain consistency throughout an animation sequence.

Pencil supports both raster and vector graphics, giving users flexibility in creating artwork according to their preferred drawing style. The software is widely used in educational settings because it helps learners understand core animation principles such as timing, spacing, squash and stretch, anticipation, and frame-by-frame drawing.

(ii) Adobe Animate

Adobe Animate is one of the most widely used software applications for creating 2D animations, interactive content, and motion graphics for the web, television, education, and digital media industries. It provides a comprehensive set of drawing, animation, and publishing tools that enable artists and designers to produce professional-quality animations efficiently.

The software offers a natural and intuitive drawing experience, especially when used with digital drawing tablets and stylus devices. Artists can create characters, backgrounds, and visual effects using vector-based and bitmap drawing tools, allowing for precise control and scalability. Its user-friendly interface makes it suitable for both beginners and experienced animators, while its advanced features support professional animation workflows.

Adobe Animate includes powerful animation tools such as keyframe animation, motion tweening, shape tweening, inverse kinematics, and asset libraries. These features help animators create smooth and dynamic movements while reducing the time and effort required for frame-by-frame animation. The software also supports character rigging, lip-syncing, and reusable animation assets, enabling the efficient production of complex animated projects.

One of the notable features of Adobe Animate is its interactive camera system, which allows users to create cinematic effects such as zooms, pans, and rotations within a scene. Combined with advanced timeline controls and animation tools, these features help achieve high-quality studio-style visuals. The software also integrates seamlessly with other Adobe Creative Cloud applications, making it easier to incorporate graphics, audio, video, and visual effects into animation projects.

Adobe Animate is widely used for creating web animations, animated advertisements, educational content, cartoons, game assets, and multimedia presentations.

(iii) Synfig

Synfig is a popular open-source 2D animation software that is freely available to everyone. Users can easily download, install, and use the program without any licensing costs. Developed as a professional-grade animation tool, Synfig enables artists, students, and independent animators to create high-quality animations while reducing the need for frame-by-frame drawing. One of the key strengths of Synfig is its powerful vector-based animation system. The software uses a technique known as tweening, which automatically generates intermediate frames between keyframes. This feature saves time and effort while producing smooth and fluid motion. Synfig also supports bitmap artwork, skeletal animation, layers, filters, gradients, and advanced effects, allowing animators to create complex scenes and character movements efficiently.

(iv) Toon Boom Hormony

It is a widely used, multipurpose 2D animation software suitable for both beginners and professionals. It provides a comprehensive set of tools for drawing, rigging, compositing, and animation, allowing learners to understand the complete animation production process as they develop their projects. Its structured workflow helps users gradually master the principles and techniques of 2D animation.

(v) CreaToon

CreaToon is a free 2D animation software package designed for creating cut-out and vector-based animations. It provides animators with a simple and efficient environment for producing animated films, cartoons, educational content, and multimedia presentations. The software allows users to create characters and objects from separate parts and then animate them by manipulating individual components, reducing the need to redraw every frame. The software supports keyframe animation, layering, transparency effects, camera movements, and basic compositing features, which help users create smooth and visually appealing animations. CreaToon is particularly useful for learning the principles of cut-out animation, character rigging, motion control, and scene composition.

3. Cut-out Animation

Cut-out animation is one of the oldest animation techniques and gained new creativity with the arrival of computers. Using software like Adobe Animate, animators can work with timelines, keyframes, and pose-to-pose methods, making this style easier and more accessible. Adobe Animate, originally Flash, is widely used for web animations, banners, and even feature films. Flash animations are often created with vector graphics for clean visuals, though poorly made ones show jerky movements or awkward tweening. Animations can be built frame-by-frame or with tweening, where the software generates in-between

frames. Flash animations, shared online as internet cartoons or web toons, remain a popular digital animation style.

4. Tweening

Tweening, short for "in-betweening," is a core technique in 2D animation that involves creating the intermediate frames between two keyframes to produce smooth motion. In traditional animation, assistants would manually draw these in-betweens, while the lead animator created the key poses. With digital tools, tweening is often automated by software, saving time and ensuring fluid transitions.

In 2D animation, tweening helps objects, characters, or shapes move naturally across frames without requiring every frame to be drawn by hand. For example, if a character's arm is raised in one keyframe and lowered in another, tweening fills in the gradual movement between those positions. There are three common types of tweening in digital 2D animation:

(i) Motion Tweening

A motion tween is the tween that basically animates the symbols that will be moving in between frames. When we develop the motion tween, then we can select any frame by clicking on it in the tween, moving the symbol on that frame, and developing a path for motion, which helps us animate the frames between those frames and the very next 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.

(ii) Classic Tweening

A classic tween works in the old way, where motion tweens were used to be in versions of Adobe CS3 and earlier. In this type of motion tween, we have to physically develop all our keyframes and connect them with the motion tweens, followed by point A to point B. A shape tween, therefore, is a transformation tween, while the motion tween/classic tween affects the position and rotation.

(iii) Shape Tweening

On the other hand, Shape tweens perform various kinds of alterations on non-symbol shapes/vector kind of graphics. If we develop one shape on one keyframe and another shape on another keyframe, we can connect those two shapes with a shape tween. This tween will do the required calculations and morphs, which are desirable to convert the first shape into the second.

Practical Exercise

Activity 1: 2D and 3D animation exploration and walk cycle creation.

Materials Required:

1. Notebook and pencil
2. Drawing sheets or A4 paper
3. Eraser and ruler
4. Sketch pens or coloured pencils
5. Chart paper for group presentations
6. Computer with internet access
7. Animation software
8. Printed examples of 2D and 3D animations
9. Projector or smart board (optional)

Procedure:

Step 1: Divide the class into three groups:

Group A: 2D v/s 3D animation
Group B: Walk cycle (key poses and in-betweens)
Group C: 2D animation software and tweening techniques

Each group will explore and present one part of the topic.

Step 2: Do research and explore your topic.

Group A: 2D and 3D animation
You will:

- Understand the X-Y (2D) and X-Y-Z (3D) axes.
- Compare the appearance of depth, movement, and style.
- Collect examples of 2D and 3D animations from books or online sources.
- Sketch simple diagrams showing how 2D and 3D differ.

Group B: Walk cycle

You will:

- Study the four key frames of the walk cycle:
    a) Forward contact point
    b) Passing pose 1
    c) Back contact point
    d) Passing pose 2
- Observe a friend walking and note head, arms, and torso movement.
- Draw the 4 key frames and add in-between frames to create a smooth walking motion.

- Learn how looping avoids redrawing every step.

Group C: By 2D Animation software and tweening, you will explore:

- Software like pencil, Adobe Animate, Synfig, Toon Boom Studio, CreaToon.
- Types of tweening:
  a) Motion tween
  a) Classic tween
  b) Shape tween

- Identify how tweening helps in creating smooth movement.
- Draw a simple example showing point A to point B movement using tweening.

Step 3: Each group prepares a visual representation that includes:

- Key concepts they learned
- Diagrams, sketches, flowcharts
- Labels for key terms (e.g., Keyframe, Inbetweening, Shape Tween, Z-axis)
- Examples of 2D or 3D animations or walk cycle drawings

Step 4: Each group presents their poster to the class, explaining:

- What they learned.
- How the process works.

Step 5: After all presentations, you can write a short reflection on which part of animation you found most interesting.

Check Your Progress

A. Fill in the Blanks

1. Toon Boom Studio is an all in one animation application for _____.
2. A motion tween animates symbols moving in _____.
3. _____ is the most widely used software for animations.
4. The difference between 2D and 3D animation is the appearance of _____.
5. The Pencil software is a _____ designed to resemble the traditional flipbook style animation.

B. Multiple Choice Questions

1. In animation, a walk cycle is a:
   a) Series of frames showing repeated walking movement
   b) Sequence of illustrations drawn to create walking motion

c) Combination of frames and sequential illustrations for movement
d) Static drawing of a character pose.

2. Creatoon is a:
   a) Free and powerful animation software
   b) Hardware device used for animation
   c) Video editing application
   d) 3D modelling machine

3. Walk cycles can generally be broken up into:
   a) 2 key frames
   b) 5 key frames
   c) 3 key frames
   d) 4 key frames

4. Walk cycles are categorized into stages such as:
   a) Forward Contact Point and Passing Pose 1
   b) Back Contact Point and Passing Pose 2
   c) Both forward/back contact points and passing poses
   d) Jump pose and landing pose

5. 3D animation includes an additional dimension known as the:
   a) X-axis
   b) Y-axis
   c) Z-axis
   d) Rotation axis

C. State Whether the Following Statements are True or False

1. Synfig is a free, open source programme for 2D animators.
2. Toon Boom Studio does not teach you the fundamentals of 2D animation as you work.
3. Adobe Animate is the most widely used software for animations and motion graphics on the web.
4. The Pencil software is not a studio application.
5. 2D animation includes an extra dimension, and that is the z-axis.

D. Subjective Questions

1. Describe the steps involved in creating a 2D walk cycle and highlight the importance of inbetweening.
2. If a character's shape changes from a circle to a square, how would shape tweening be applied to achieve this transformation?

What have you learned?

After completing this session, you will be able to:

- compare and apply the differences between 2D and 3D animation by working with dimensions and depth (X, Y, Z axes) in practical examples;
- create and explain a basic 2D walk cycle using key frames and in-between frames to show natural movement;
- identify, construct, and loop key poses in a walk cycle to produce continuous animation sequences;
- explore and use various 2D animation software to create simple animations; and
- demonstrate tweening techniques by creating motion, classic, and shape tweens in digital animation projects.

Unit 4 Introduction to 3D Modelling

The Unit covers the fundamentals of 3D modelling, including different modelling techniques, polygonal modelling, NURBS modelling, digital sculpting, and procedural modelling, along with industry-standard software tools such as Autodesk Maya, Blender, 3ds Max, ZBrush, and Cinema 4D.

The foundational concepts and techniques of 3D modelling, specifically basic 3D geometry, primitives and blocking, form and proportion, refining shapes, and hands-on modelling practice have been covered in the present unit. 3D modelling involves using software to create the size, shape, and appearance of objects in three-dimensional space, starting with primitive shapes such as cubes, spheres, and cylinders, which are manipulated through tools to extrude, sculpt, and combine forms. In character design, such as creating a realistic shark in Autodesk Maya, the workflow includes modelling the body, tail, fins, nose, mouth, eyes, and gills using polygon and subdivision surfaces, inserting edge loops, extruding faces, merging vertices, and refining details to match reference images.

After completing the base model, initial UV mapping is applied for texturing, followed by mesh clean-up and conversion to subdivision surfaces for further sculpting. Texturing involves UV unwrapping and painting either on the 2D map or directly on the 3D model to add realistic colour, patterns, and surface details using maps like diffuse, bump, normal, roughness, and metallic.

Rigging prepares the model for animation by building skeletal structures, connecting joints with forward and inverse kinematics, adding controls, and painting weights, while facial expressions are created with blend shapes or

deformers. Finally, animation involves setting key frames, adjusting timing in the dope sheet, and refining movement using the graph editor, resulting in a fully modelled, textured, rigged, and animatable shark ready for rendering.

Session 1: Fundamentals of 3D Modelling

3D modelling is the process of creating three-dimensional objects in a digital environment using specialized computer software. These objects have height, width, and depth, making them appear realistic and interactive. 3D models are widely used in animation, films, video games, architecture, product design, virtual reality, engineering, and medical visualization.

In 3D modelling, artists build digital objects by manipulating points, edges, and polygons to create shapes and structures. A model can represent anything from simple objects like cups and tables to complex characters, vehicles, buildings, and entire virtual worlds. Modern industries rely heavily on 3D modelling because it helps visualize ideas, improve creativity, and create realistic digital experiences.

Popular software used for 3D modelling includes Blender, Autodesk Maya, Cinema 4D and 3ds Max.

1. Features of 3D Modelling

3D modelling is an important process in digital design and animation that helps create realistic and interactive virtual objects. Unlike 2D graphics, 3D models have depth and can be viewed from multiple angles, making them more immersive and visually accurate. Modern industries such as animation, gaming, architecture, engineering, medicine, and virtual reality widely use 3D modelling for designing, visualization, and simulation purposes. The following are the major features of 3D modelling that make it an essential part of digital media and design.

(i) Creates Objects with Depth, Height, and Width

One of the most important features of 3D modelling is that it creates objects in three dimensions: height, width, and depth. This gives digital objects a realistic structure and physical appearance similar to real-world objects. Unlike flat 2D images, 3D models can be rotated, zoomed, and viewed from different perspectives.

Key Points

- Creates realistic three-dimensional objects
- Adds depth and perspective to designs
- Allows viewing objects from multiple angles
- Makes objects appear more lifelike and interactive

- Helps create immersive digital environments

(ii) Allows Realistic Visualization

3D modelling enables artists and designers to create highly realistic visual representations of objects, characters, buildings, and environments. With the help of textures, lighting, shadows, and materials, 3D models can closely resemble real-life objects. This realistic visualization helps industries present ideas clearly before actual production or construction begins.

Key Points

- Produces realistic digital representations
- Uses textures, colours, and lighting for realism
- Helps visualize projects before final production
- Improves presentation and design quality
- Creates immersive visual experiences

(iii) Supports Animation and Rendering

3D models can be animated to create movement and actions for films, games, and simulations. Rigging techniques allow characters and objects to move naturally. Rendering converts, the 3D scene into a final image or video with realistic lighting and visual effects.

Key Points

- Allows movement and animation of objects
- Supports character rigging and motion
- Used for creating animated films and games
- Rendering produces final high-quality visuals
- Enhances realism through lighting and effects

(iv) Used in Films, Games, Architecture, and Simulations

3D modelling is widely used across multiple industries because of its flexibility and realism. In films and animation, it helps create characters, environments, and visual effects. In gaming, it creates interactive worlds and objects. Architects use 3D models to visualize buildings and interiors, while simulations are used in medicine, engineering, and training applications.

Key Points

- Used in animated movies and visual effects
- Helps create realistic video game environments
- Supports architectural and interior visualization
- Used in medical and engineering simulations

- Important in VR and AR applications

(v) Enables Detailed Object Design and Modification

3D modelling software allows designers to create highly detailed objects and make modifications easily. Artists can edit shapes, textures, proportions, and structures without rebuilding the model from scratch. This flexibility improves creativity and saves time during the production process.

Key Points

- Allows precise object detailing
- Easy to edit and modify designs
- Supports creative experimentation
- Saves time during production changes
- Helps improve design accuracy and quality

2. Elements of 3D Modelling

3D modelling is built upon several fundamental components that work together to create digital objects and environments. Every 3D model, whether it is a simple object like a cup or a complex character used in films and video games, is constructed using these basic elements. Understanding these elements is essential because they form the foundation of all 3D design, animation, and rendering processes. The primary building blocks of 3D modelling include vertices, edges, faces, polygons, and meshes. These components help artists shape, structure, and refine digital objects with precision and realism.

(i) Vertex: A vertex (plural: vertices) is the most basic element in 3D modelling. It is a single point positioned in three-dimensional space and is defined by coordinates along the X, Y, and Z axes. A vertex does not have length, width, or depth by itself, but it acts as a reference point that helps define the structure and shape of a 3D object.

(ii) Edge: An edge is a straight line created by connecting two vertices. Edges define the outline and structure of a 3D object and help determine its shape and form. Without edges, vertices would remain isolated points with no visible connection.

(iii) Face: A face is a flat surface formed when three or more edges are connected together. Faces give a 3D model visible surfaces and make objects appear solid instead of wireframe structures. In most 3D software, faces are usually triangular or quadrilateral in shape.

(iv) Polygon: A polygon is a geometric shape formed by multiple connected edges and vertices. In 3D modelling, polygons are the primary building blocks used

to create digital objects. Most 3D models are made up of thousands of polygons arranged together to form detailed structures.

(v) Mesh: A mesh is a complete collection of vertices, edges, faces, and polygons combined together to form a full 3D object. It represents the overall structure and geometry of the model. Every 3D object, whether simple or complex, is essentially a mesh.

3. Techniques of 3D Modelling

3D Character modelling is a CG technology, multi-stage process performing by various 3D artists through different software and tools to form a character in film, video games and other media. The main objective of 3D modelling is to provide life to the character in a 3D space. As per the requirements, several modelling techniques are used to create various models. Some fundamental techniques are described below.

(i) Polygonal Modelling

Polygon is a fundamental technique consisting of several shapes likes triangle quadrilateral, pentagon, hexagonal and octagon where designers used them to create a 3D character. These polygons are flat, 2 dimensional and having 3 or additional sides. The main purpose of technique is to create large-scaled 3D character by the help of interconnected polygons which may be classified triangle (tris) or quadrilateral (quads). These polygons are undergone through extrusion, cutting, combined, merging, manipulating and well shaping process to create a required shape of the character.

In this technique, computer generated shapes are formed. One can create a polygon mesh using vertices (individual and pairs of points generally represented by X, Y and Z), edges (straight line connecting vertices), and faces (smallest polygonal unit) and make a particular 3D character. It's like a broad puzzle of building blocks playing in a 3D graphics. However, accuracy and detailing of the model depends upon number of polygons that are used to make an individual character. Polygonal modelling technique is for multipurpose used in several visual media like films, gaming and animation. Here are some advantages and disadvantages of polygon modelling discussed below.

Advantages of Polygonal Modelling	Disadvantages of Polygonal Modelling
1. Realistic appearance: Polygonal modelling creates natural-looking models with high accuracy and detailed surface topology.	**1. Time-consuming:** Adding fine details, cutting, editing, and shaping individual polygons requires significant time and effort.

2. Easy editing: Individual polygons can be selected, modified, refined, or reshaped without affecting the entire model, making editing flexible.	**2. Difficult to achieve smooth curves:** Creating perfectly smooth and sharp curved surfaces can be challenging using polygonal modelling techniques.
3. Highly versatile: It is suitable for creating characters, animals, objects, and environments for video games, animations, and films. It is also widely supported by modern game engines and 3D software.	**3. Large file size:** Highly detailed models with a large number of polygons require more storage space and system memory, which can affect performance and storage capacity.

(ii) ***Spline Modelling (NURBS Modelling)***

Spline modelling technique, is also called NURBS (Non-Uniform Rational B-Splines) modelling, is applicable for 3D designing. It explains 3D geometry by the help of mathematical representation of smooth curves and surfaces which is also called NURBS curves and NURBS surface. Spline modelling requires the knowledge of curves, surfaces and their mathematical proportions. It regulates a high level of smoothness in curves and surface by which characters appear more solid and organic in the terms of natural flow.

A character designer uses spline modelling techniques to achieve smooth learning curves. NURBS modelling is a kind of spline working process to form a specific shape. Spline modelling basically works between at least two points. Thus technically, it states as B-Spline. For example, if we need to draw a cube in a 3D space, then we must acknowledge the correct distance between the points and faces and connect points with line. In such modelling, surfaces are separated from the curves for better controlling during the complete process.

NURBS technique is a sub divisional part of surface modelling technique where designer practice over 3D space. Let us focus on various advantages and disadvantages of spline modelling to understand their applications.

Advantages of NURBS Modelling	Disadvantages of NURBS Modelling
1. Smooth and precise surfaces: NURBS modelling produces smooth curves and highly accurate surfaces, making it ideal for engineering, industrial, automotive, and product design.	**1. Complex editing:** NURBS models are often composed of multiple individual surface patches, making editing and maintaining seamless connections more difficult.
2. Convertible to polygons: NURBS surfaces can be converted into polygon meshes when required for animation, rendering, or game development.	**2. Limited fine detailing:** Creating intricate surface details is more challenging in NURBS modelling compared to polygonal modelling.

]

Practical Exercises

Activity 1: Creating a 3D character using modelling software.

Materials Required:

1. Computer or laptop
2. 3D modelling software
3. Sketchbook or drawing sheets
4. Pencil, eraser, and ruler
5. Character design reference images
6. Projector or smart board for demonstrations (optional)
7. Notebook for recording observations and modelling steps

Procedure:

- Begin with a brief tutorial or demonstration on navigating and using the selected 3D modelling software, focusing on the basic tools and techniques of polygon modelling.
- Sketch initial character concepts on paper, considering factors such as appearance, personality, proportions, and visual style.
- Plan the character's construction by identifying the polygonal components required for each body part. Consider the approximate number of vertices, edges, and faces needed to create the desired form.
- Create a new project in the 3D software and begin modelling the character using basic geometric shapes and polygon-editing tools.
- Refine the model by adjusting the vertices, edges, and faces to achieve the intended character design and proportions.
- Collaborate with classmates and provide peer support while working on individual designs. Discuss modelling techniques and help resolve technical challenges or design-related questions.
- Once the basic character model is complete, apply appropriate materials, colours, and textures to enhance its appearance and realism.
- Review and refine the model by making necessary adjustments to the geometry, textures, and overall design.
- Save the completed project and present the final character model to the class, explaining the design choices, modelling process, and challenges encountered during development.

Check Your Progress

A. Fill in the Blanks

1. 3D modelling creates objects with height, width, and _____.
2. A _____ is a straight line connecting two vertices.
3. _____ modelling uses connected polygons to create 3D objects.

4. A complete collection of polygons forming a 3D object is called a _____.
5. _____ modelling is also known as NURBS modelling.

B. Multiple Choice Questions

1. The purpose of 3D modelling is
   a. To provide life to the character in 3D space
   b. To provide movements to the character
   c. To create different poses of a character
   d. To maintain unevenness of personality

2. What is the full form of NURBS?
   a. Numeric Uniform Rendering B-Splines
   b. Numeric Uniform Rational B-Surface
   c. Non-Uniform Rendering B-Surface
   d. Non-Uniform Rational B-Splines

3. Which statement is correct about spline modelling?
   a. It offer mathematical representation of smooth curves and surfaces
   b. It provides highly smooth curves and surface by which characters appear more organic
   c. It is useful to display engineering works, industrial and engineering objects
   d. Both (a) and (b)

4. The term used for primary points of polygonal modelling is
   a. Surface
   b. Mesh
   c. Vertex
   d. Spline

5. What is the advantage to make games characters by polygonal modelling?
   a. It takes less to design a game character
   b. It limits the level of accuracy and detailing in the character
   c. It provide more flexibility and optimized performance to the character
   d. All of the above

C. State Whether the Following Statements are True or False

1. 3D models can only be viewed from one angle.
2. A face is formed by connecting multiple edges.
3. Polygonal modelling is widely used in games, films, and animation.
4. Spline modelling is also called NURBS modelling.
5. A mesh is made up of vertices, edges, faces, and polygons.

D. Subjective Questions

1. What is 3D modelling? Explain its importance in animation and media industries.
2. Describe the key features of 3D modelling.
3. Explain the basic elements of 3D modelling with examples.
4. Differentiate between polygonal modelling and spline (NURBS) modelling.
5. Discuss the advantages and disadvantages of polygonal modelling.

What have you learned?

On the completion of this session, you will be able:

- define 3D modelling and explain its importance in digital content creation;
- identify the key characteristics of three-dimensional objects, including height, width, and depth;
- recognize the role of specialized software in creating 3D models;
- describe the basic process involved in developing 3D objects in a digital environment;
- explain how 3D models contribute to creating realistic and interactive digital experiences; and
- demonstrate an understanding of the significance of 3D modelling in modern media and industry.

Session 2: Creating and Editing 3D Models

The animation can be broadly classified as 2D and 3D animation. The major difference between them is the appearance of depth in the latter. The 2D animation, as it sounds, only has two dimensions which means it is all flat animation and each and every action happens in the X and Y axis only, where 3D animation includes an extra dimension, and that is the Z axis.

3D Modelling involves the use of software to create the size, shape and look of an object in 3D space. At first, using primitive shapes like cubes, spheres, and cylinders, you manipulate them with various tools to extrude, sculpt, and combine objects into forms.

Character Designing - "Shark"

Through the procedure of Modelling, UV Mapping, Texturing, Rigging and Rendering a believable and real-life Shark can be modelled using Maya's exceptional toolset. Let us create a Realistic Shark in Maya using Subdivision Surfaces.

1. Beginning the Creation

Step 1: Before initiating the development of a shark, let us discuss a little bit about Subdivision surfaces and polygon modelling. In Autodesk Maya, Subdivision surfaces have unique surface types available for modelling procedures that have characteristics of both polygon and NURBS surface types. NURBS (Non-Uniform Rational B-Splines) is a 3D modelling technique that uses mathematical equations to create smooth, precise curves and surfaces. According to NURBS surfaces, subdivision surfaces are capable of producing smooth, organic forms and can be shaped using relatively few control vertices. As per polygon surfaces, subdivision surfaces allow you to extrude specific areas and create detail in your surfaces when it is required. This is accomplished by having the ability to work at different component levels of detail on the subdivision surface. You can switch between the different levels of detail as often as necessary, and you can convert existing NURBS and polygon surface types to subdivision surfaces and vice versa. We will first start with the polygon modelling process and then convert it into a Subdivision surface so we can use the Subdivision Surface Controls.

Step 2: In the Image Plane Attribute settings, use the Centre X, Y, Z and Width values as needed to match the images (Fig. 4.1).

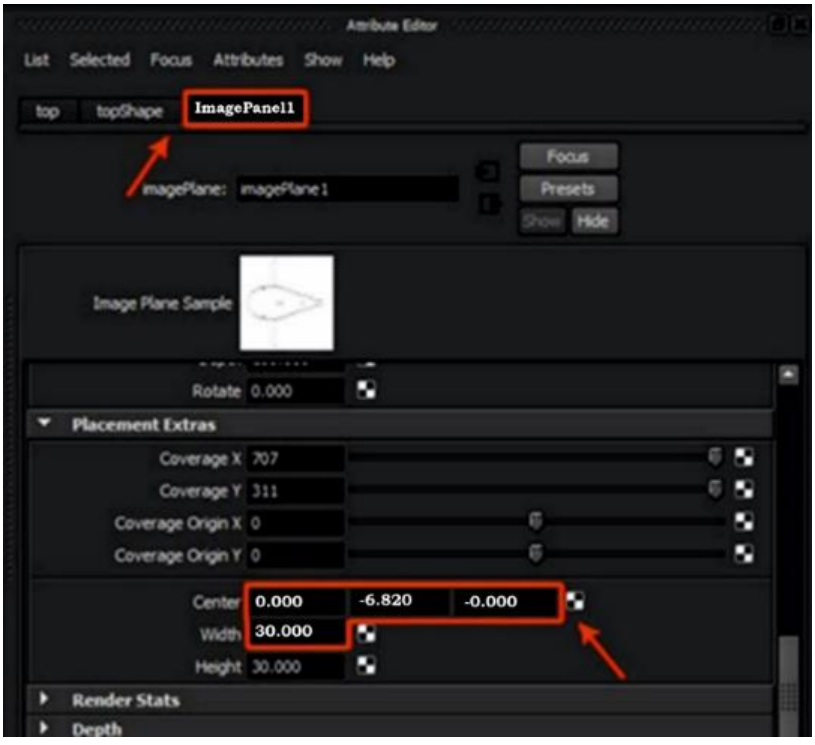

Fig. 4.1: Setting animation attributes for an object

2. Modelling the Body

Step 1: Now, to begin the modelling process, create a Cylinder poly primitive in the Frontview **(Fig. 4.2)**.

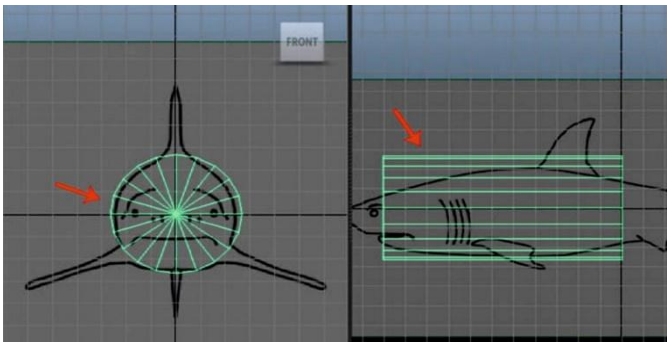

Fig. 4.2: Creating a cylinder poly primitive in the frontview.

Now with the poly Cylinder selected, press **Control-A** to open its Channels Settings attributes. Go to the **INPUTS tab** and keep the **Subdivisions Axis value at 8**, and the **Subdivisions Height value at 4**.

Then press the **F9 key** to jump into **Vertex selection mode**, and arrange the vertices according to the Front and Side reference images. Arrange the vertices according to the Top reference image also (Fig. 4.3).

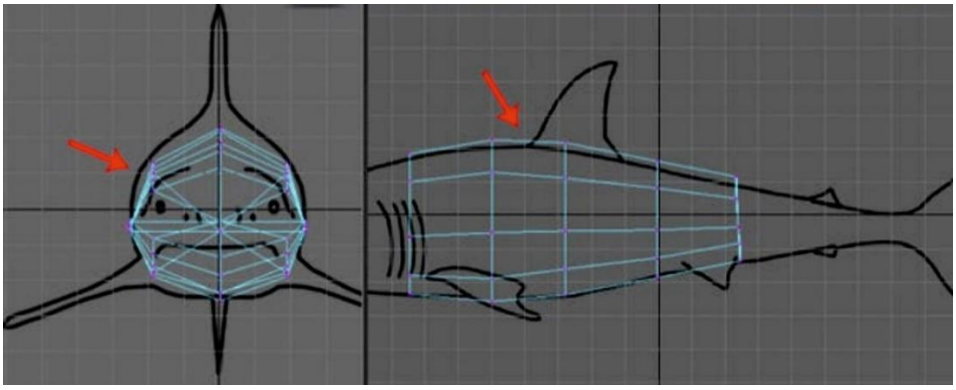

Fig. 4.3: Vertex arrangement for creating a 3D Model

Step 2: Now, in the Perspective view and with the polyCylinder mesh still selected, **press F11** to jump into Face selection mode, and select the front and the back cap faces. Then press the Delete key to delete the selected faces (Fig. 4.4).

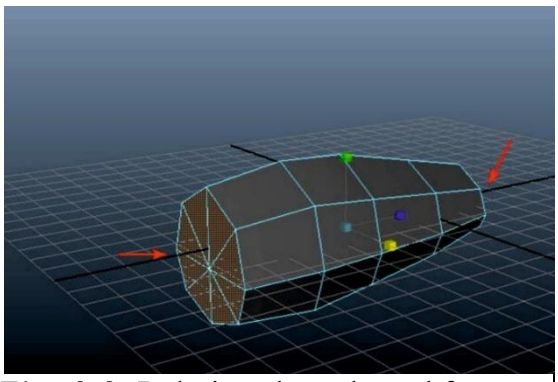

Fig. 4.4: Deleting the selected faces

Next, jump into the Front view and select half of the polyCylinder mesh. And press the **Delete key** to delete the selected faces.

Step 3: After deleting half of the side faces, select the remaining half and press the F8 key to jump into Object selection mode. Then go to the Edit menu and click on the **Duplicate Special options** box (Fig. 4.5).

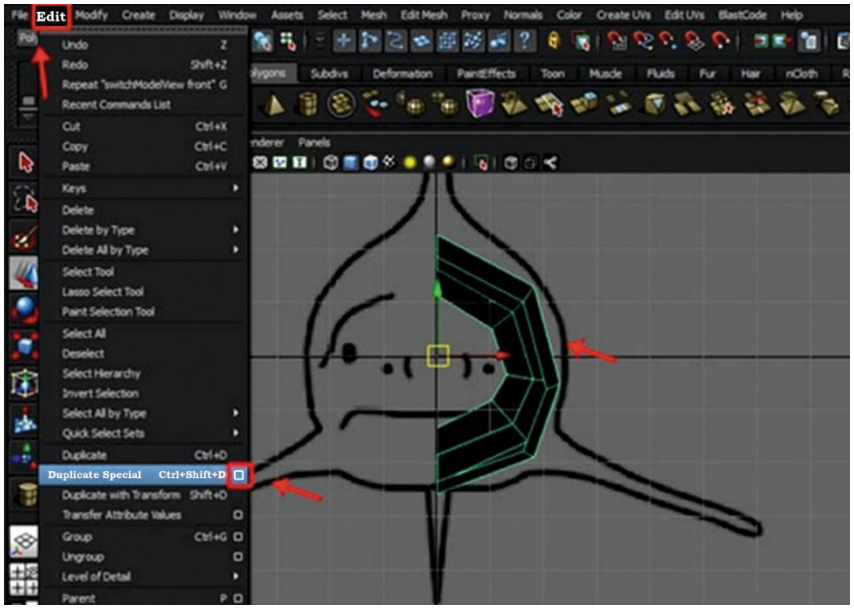

Figure 4.5: Using duplicate special options

Step 4: In the **Duplicate Special Options**, turn on the Instance radio button and keep the **Scale value for the X Axis at -1.00**, and then click on. Now an instanced copy of the mesh has been created along the **-X Axis**.

Now **press F10** to enter Edge selection mode, and select one half of the border edge on the front left side. Jump into the Side view, go to the **Edit Mesh menu** and click on the **Extrude** command. Using the same procedure, we can extruded the border edge five times towards the shark's head.

While still in the same Side view, **press the 4 key** to convert the selected mesh into Wireframe mode, and also **press F9** to jump into Vertex selection mode. Then, try to arrange the vertices according to the reference image shown (Fig. 4.6).

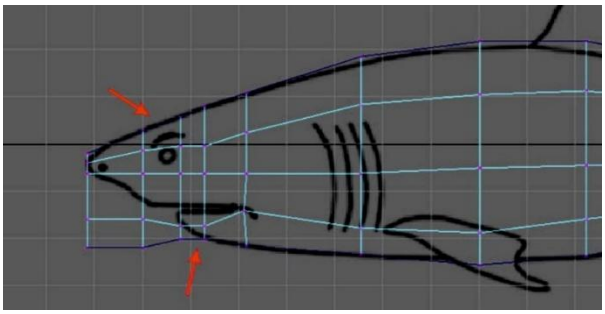

Fig. 4.6: Arrangement of the vertices

Step 5: Once done, go to the **Edit Mesh menu** and select the **Split Polygon Tool**. With the **Split Polygon Tool** selected, split and divide the faces indicated below for the upper and lower parts of the shark's mouth.

Press F11 to jump back into face selection mode, and then with the four lower unnecessary face selections (Marked below), press the **Delete key** to delete them.

Also, jump into the Top view and arrange the vertices by **pressing F9 (Fig. 4.7)**.

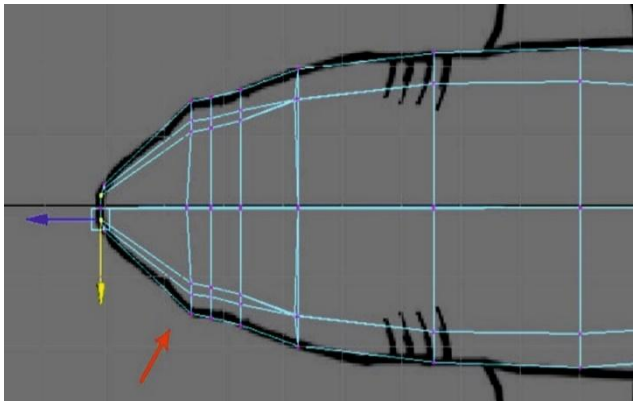

Fig. 4.7: Arrangement of vertices in top view

Step 6: Once again, press the **F11** to enter Face selection mode, and then select the faces inside the mouth (Indicated below) and delete them.

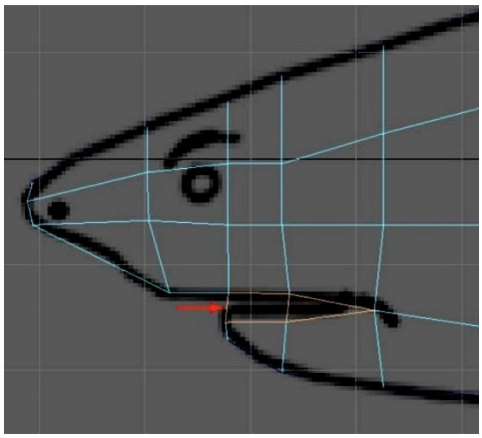

Fig. 4.8: Deleting the face selection mode

Now we need to insert several edge loops to add more detail. Go to the **Edit Mesh** and select the **Insert Edge Loop Tool (Figure 4.8)**.

With the Insert Edge Lop Tool selected, insert **two edge loops** along the upper and lower body.

Step 7: Jump into the Side view and insert **four more edge loops** around the mouth area, as shown (Fig. 4.9).

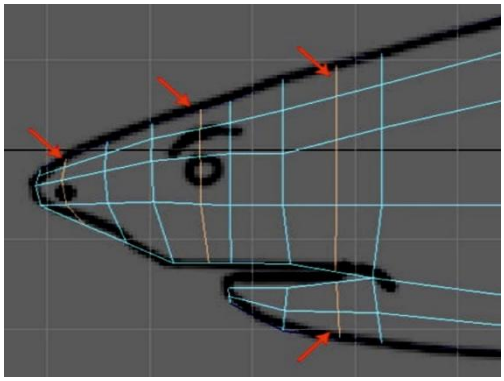

Fig. 4.9: Inserting four more edge loops

3. Modelling the Tail

Step 1: Now, **Extrude** the back-border edge **three times** for the shark's tail.

Press F9 for Vertex selection mode, and then arrange the tail vertices according to the reference image (Fig. 4.10).

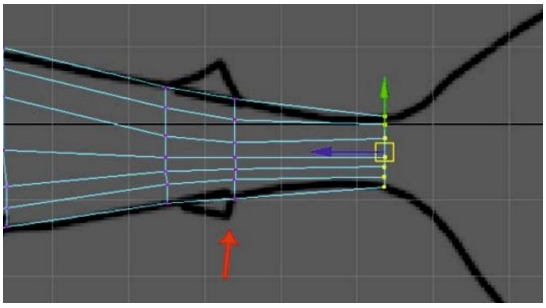

Fig. 4.10: Arrangement of the tail vertices

Also, jump into the Top view, and arrange the vertices here too.

Step 2: Press F9 to enter Vertex selection mode, and then expand and arrange the vertices.

Jump into the perspective view now and **press F11** to enter Face selection mode and then select both top faces.

With the top faces selected, jump into the Side view and then, using the **Extrude command**, Extrude them two times towards the end of the tail Fin. And do the same with the lower tail faces also.

After extruding, press the **F9 key** to enter front left side Vertex Selection mode, and arrange the tail fins according to the shape shown on the reference image (Fig. 4.11).

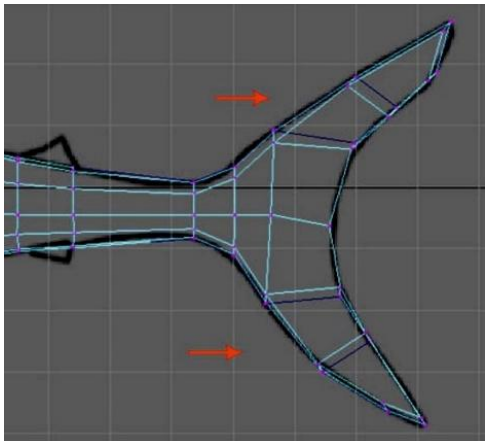

Fig. 4.11: Arrangement of the tail fins according to the shape

Step 3: Now, go back to the Perspective view and focus on the back of the tail mesh. Here, we need to fill the gap between the polygons, so first **press F10** for Edge mode and then select the **Two border edge**.

With the edge selected, **Extrude** them **two times** while maintaining the edge loops.

Now, we need to weld the vertices. With both of the vertices selected, go to the **Edit Mesh menu** and choose the **Merge** command to weld the selected vertices together **(Fig. 4.12)**.

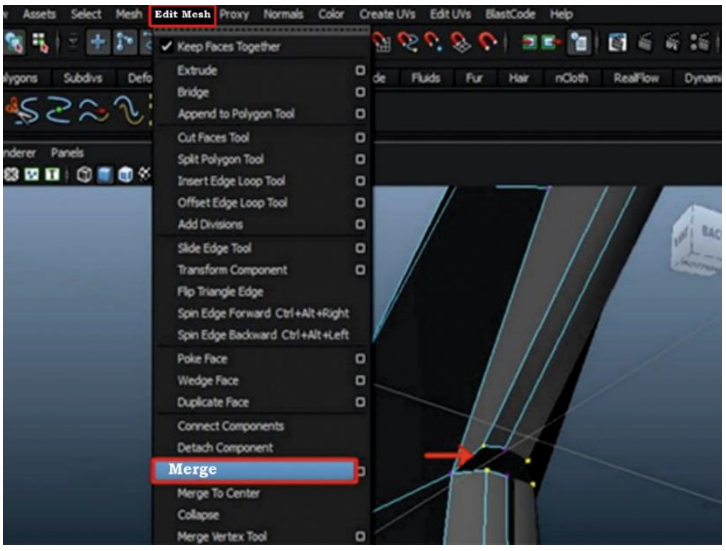

Fig. 4.12: Using the merge command

Following the same process, weld the vertices of the lower tail also.

4. Creating the Fins

Step 1: We need some more faces to create the dorsal fins. With the **Insert Edge Loop Tool** selected, insert **three edge loops** around the fin areas as shown in the image below. Now, in the Side view, **press F11** to enter Face selection mode and select the top faces around the area of the dorsal fin (Fig. 4.13).

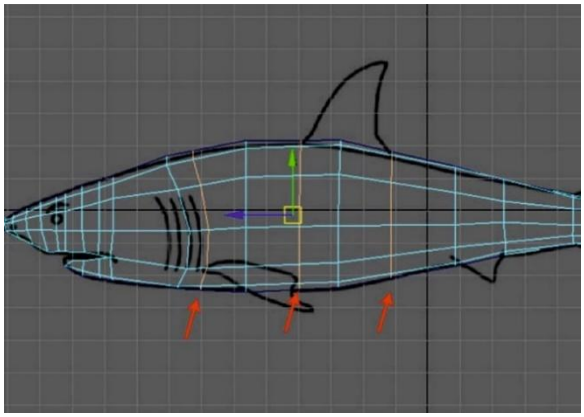

Fig. 4.13: Adding three edge loops and select top faces in side view

Step 2: With the faces selected. **Extrude** them upward two times. Again, **press F9** to access Vertex selection mode, and then arrange the vertices according to the background image. While in the Perspective view, select half of the shark model. Then go to the **Show menu**, and check on the **View Selected** check box inside the Isolate Select sub menu. This will isolate the half of the shark's body.

Step 3: This is done to select some of the unwanted faces which are hidden inside the body. You can see the dorsal fin faces are still there, which can create a problem. Hence, we need to delete these faces. So, **press the F11 key** for Face selection mode and select the dorsal fin faces from the inside. Then press the **Delete key** to delete them (Fig. 4.14).

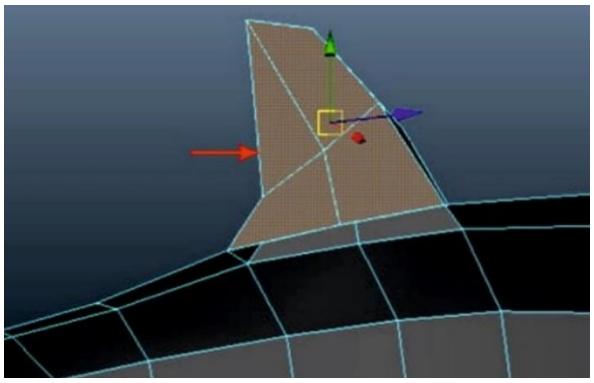

Fig. 4.14: Deleting inner dorsal fin faces in face mode

Step 4: Now we will make the anal fins of the shark. Select the top and bottom faces around these fins. With the faces selected, apply the **Extrude command** and then **Extrude** them once.

Back in **Vertex selection** mode, arrange the vertices properly.

Back in the Perspective view, select the inside faces of the anal fins and then delete them, as we did previously with the dorsal fin.

After that, bring the vertices closer to each other and make the required adjustments (Fig. 4.15).

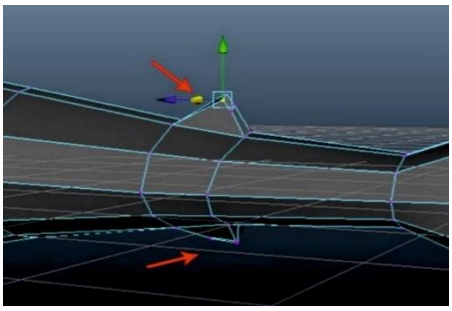

Fig. 4.15: Deleting inner anal fin faces in perspective view

Step 5: Now we will make the pelvic fin of the shark. Select the bottom face around the pelvic fin area. And **Extrude** the selected face once.

Head back to the Perspective view, and properly arrange the vertices of the pelvic fin. Also, jump into the Top view and then try to maintain the shape according to the top reference image (Fig. 4.16).

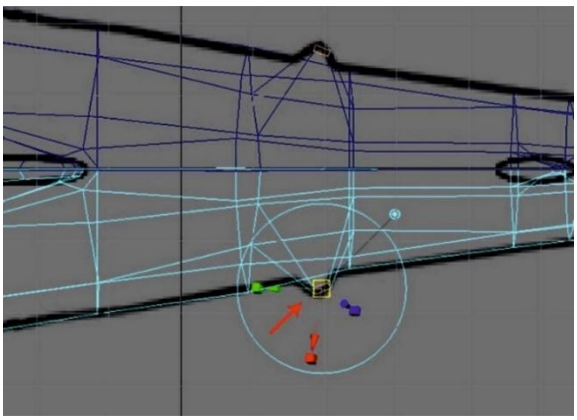

Fig. 4.16: Extruding bottom face and shape pelvic fin

Step 6: Now we will make the pectoral fins of the shark. Select the **two bottom faces** around the pectoral fin area following their placement.

With the faces selected, go to **Edit Mesh** and select the **Extrude tool**. In the Top view, Extrude the faces two times. To make the fin curved, we need to add several edge loops. Again, go to the **Edit Mesh menu** and select the **Insert Edge Loop Tool**.

Here we have inserted one edge loop and then arranged the vertices according to the reference (Fig. 4.17).

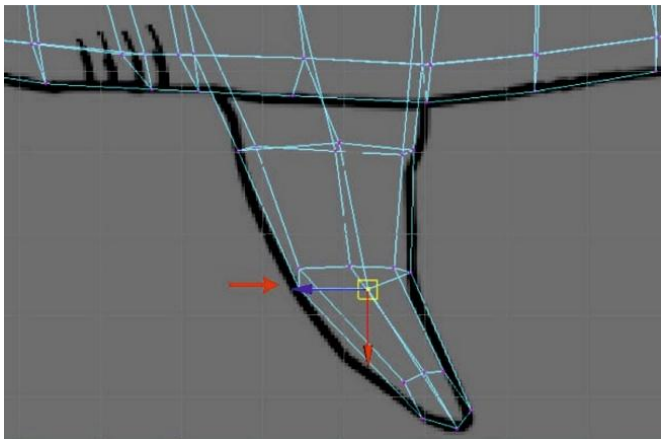

Fig. 4.17: Adding an edge loop and adjusting vertices

Step 7: Next, jump into the Front view and then try to match the fin's outline to the reference image (Fig. 4.18).

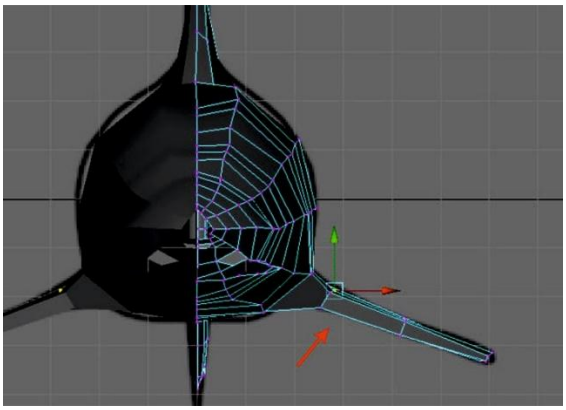

Fig. 4.18: Matching the fin outline in front view

5. Creating the Nose and Mouth

Step 1: Now we will work on the tip of the nose. Select the edge of the nostril and **Extrude** it once, as shown in the image.

With the help of the **Insert Edge Loop Tool**, insert one edge between the extruded faces as shown (Fig. 4.19).

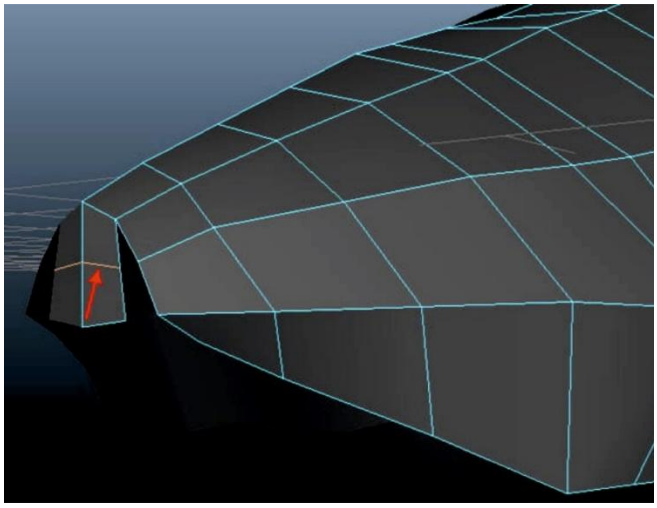

Fig. 4.19: Inserting an edge between the extruded faces

Step 2: Now select the two corresponding vertices and go to the **Edit Mesh menu**, and choose **Merge**. Using this method, complete the merging operation on the remaining pair of vertices. Now select the **eight border edges**.

Step 3: With the edge selected, **Extrude** them once towards the inside to fill the gap. We will do the same thing for the lower jaw. Select the **three edges** of the lower jaw. With the lower jaw edge selected, **Extrude** these inside the same way as we did with the upper jaw's edge (Fig. 4.20).

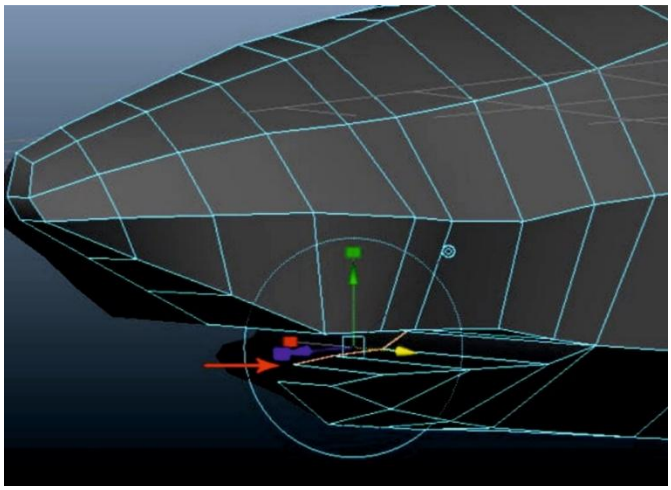

Fig. 4.20: Extruding selected edges inward to fill gaps for both jaws

Step 4: Now, let us isolate half of the shark body. So, with half of the shark body selected, go to the show menu (in the menu bar), and then check on the View Selected check box, from inside the Isolate Select submenu.

Now go to the **Edit Mesh menu** and select the **Append to Polygon Tool**.

With the **Append to Polygon Tool** selected, click on the parallel border edge to create a face to fill the gap. Press Enter to apply and finish with the **Append to Polygon Tool (Figure 4.21)**.

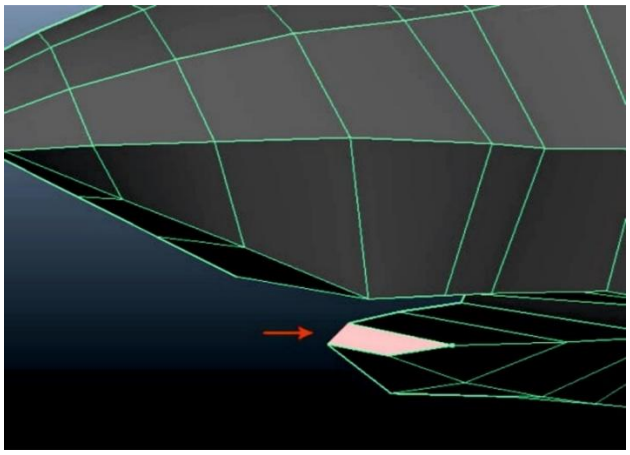

Fig. 4.21: Using Append to Polygon Tool to fill the gap

Step 5: Now we need to split some faces to add more detail. Go to the **Edit Mesh menu** and select the **Split Polygon Tool.** With the Split Polygon Tool selected, split the mouth border faces. Now, select the faces inside the mouth.

With the inner mouth polygons selected, **Extrude** them once, as shown in the image (Fig. 4.22).

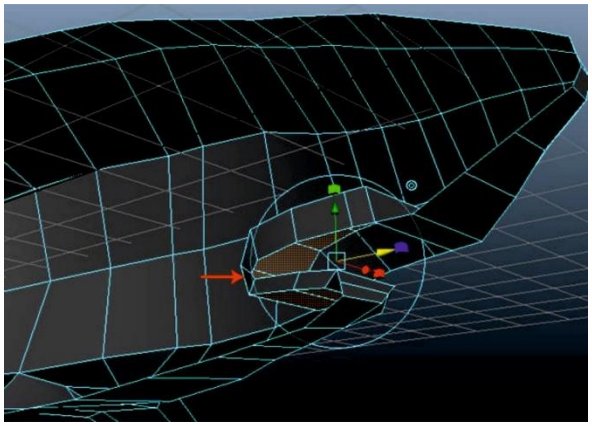

Fig. 4.22: Splitting mouth faces and extrude inner polygons

Step 6: After extruding the faces, select the unneeded border faces and Delete them. After deleting the faces, **press F9** for Vertex selection mode and then arrange the vertices to form a gap inside the mouth. Also, insert an extra edge loop with the **Insert Edge Loop Tool**.

Step 7: We have now completed the blocking of the shark mesh. Now we can convert it into Sub div mode to add more details. Or we can convert it later after completing the modelling of the eyes and nostrils.

6. Refining the Head

Step 1: In this case, we will complete the eye and nose parts first, and then convert them to subdivision later, to add extra detail with sculpting. Select the **Two faces** around the eye area, and then **Extrude** them inwards to make the eye socket. Also, add an edge loop to make the nose hole (Fig. 4.23).

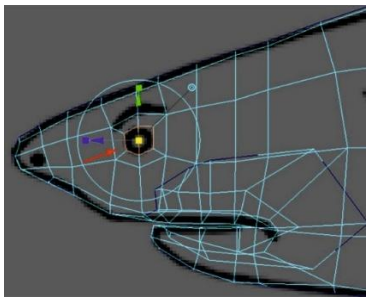

Fig. 4.23: Extruding eye faces and adding a nose edge loop in 3D modelling

Step 2: We will do the same thing for the nostrils as well. Select the **Two faces** around the nostril area, and **Extrude** them inwards to make a hole **(Fig. 4.24)**.

Fig. 4.24: Extruding nostril faces inward to create nostril openings

7. Adding the Gills

Step 1: Now we will make the gill slits for the shark. With the help of the **Insert Edge Loop Tool**, insert **Three edge** loops around the gill area, according to the reference image. Using the **Split Polygon Tool**, split each gill slit edge to add more detail.

Now **press F11** for Face selection mode, and with all the split faces selected, **Extrude** them inside to create a cavity (Fig. 4.25).

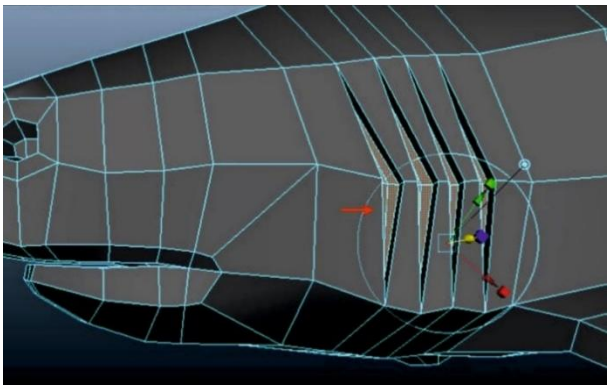

Fig. 4.25: Adding edge loops, splitting faces, and extruding gills inward

Step 2: We have now completed the base model of the shark. But we still need to add more details to it (Fig. 4.26).

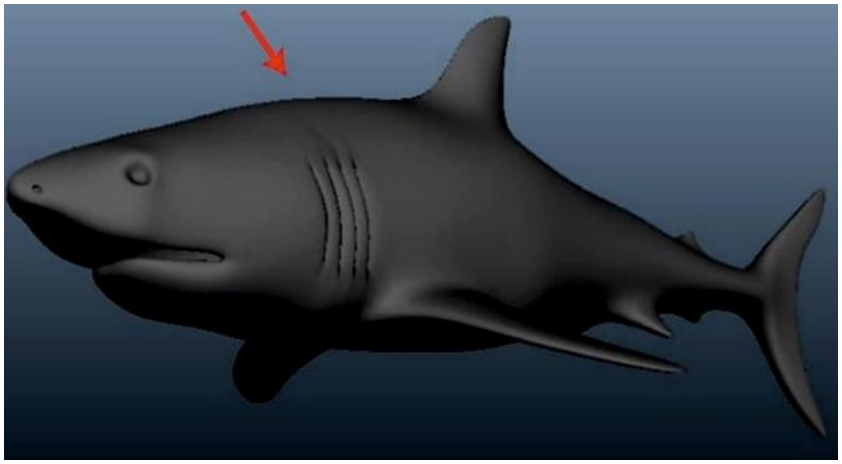

Fig. 4.26: Basic shark model prior to detailing

8. Combining Meshes

Step 1: Now we will use subdivision conversion to do sculpting and detailed modelling. First, select both side meshes, and then go to the **Mesh menu** and choose Combine to attach the **selected polygon meshes**.

Now select a pair of border vertices along the centre, and then go to the **Edit Mesh menu** and **select Merge** to weld the selected vertices.

In this way, select and merge all the centre border vertices one by one.

9. Creating Initial UVs

Step 1: Before converting from a polygon to a subdivision surface, we need to apply UV mapping for texturing. With half of the shark mesh selected, go to the **Create UVs menu** and click on the **Planar Mapping** options box.

In the Planer mapping Option box, turn on the Fit projection: Best Plan radio button. After applying a planar map, go to the **Edit UVs menu** and select **UV Texture Editor** to see the UV map.

You can see the result of the applied **planar map** from a side view of the shark body mesh **(Fig. 4.27)**.

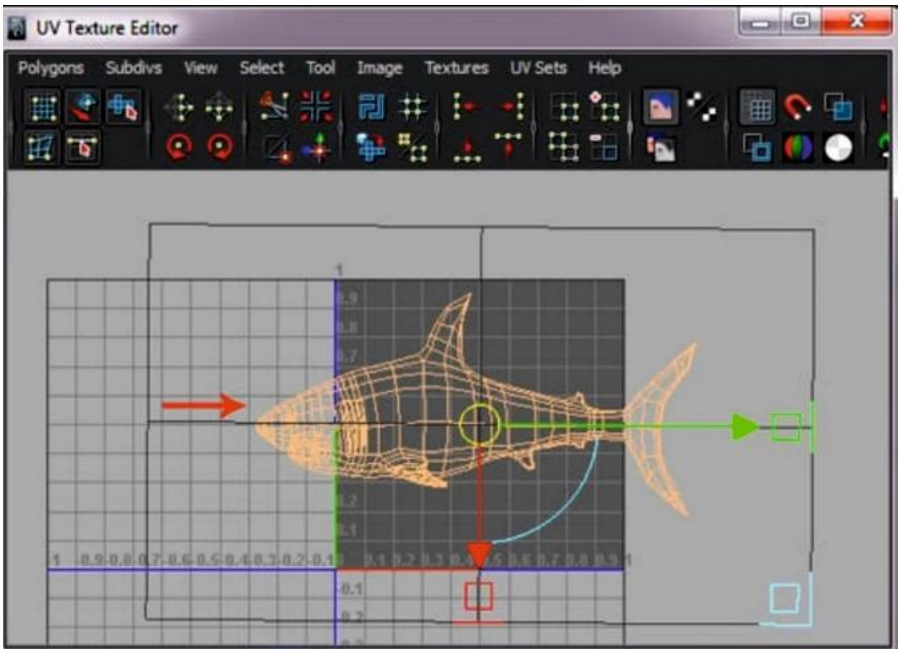

Fig. 4.27: Applying planar map and viewing UVs in UV Editor

Step 2: To apply the planar map to the other side, first select the half with the applied planar map, and then go to the **Edit menu** and select **Invert Selection**.

With the other side's faces selected, go to **Crete UVs** and select **Planar Mapping**. You can see the result in the UVs Texture editor window (Fig. 4.28).

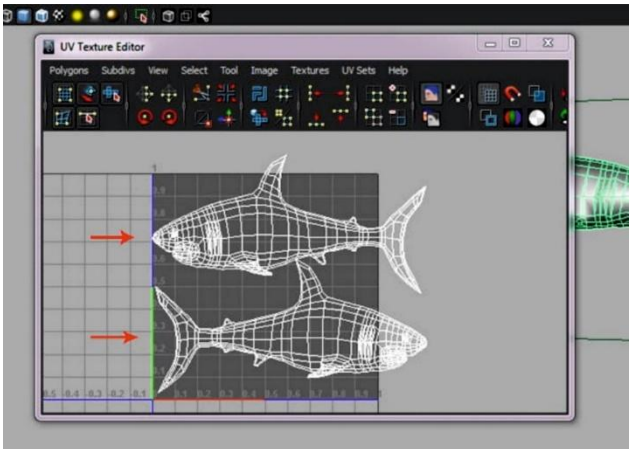

Fig. 4.28: Selecting mapped half and mirror planar map

10. Mesh Clean-up

Step 1: Now, with the shark body mesh selected, go to the **Edit menu** and select **History**, from inside the Delete by Type submenu to **delete the history**.

Now go to the **Mesh menu** and select the **Clean-up**.

In the **Cleanup Options** window, check on the **Nonmanifold geometry** option and then click on the Cleanup button to clean up the selected polygon mesh.

11. Converting to Subdivision

Step 1: After this, select the shark mesh and go to the **Modify** menu and click on the **Polygon to** Subdivision option box, from inside the **Convert** submenu.

In the Convert NURBS/Polygon to Subdivision Options window, keep the Maximum base mesh **faces value at 10000**, and then click on the Create button.

When we convert a polygon mesh to a subdivision surface, it may delete its shader node. In this case, we may need to apply the shader node again.

Step 2: With the shark polygon mesh selected, **Right Click** in the viewport and **select Blinn** from inside the **Assign Favorite Material** fly-out menu.

Once again, you can see the surface shader has been applied to the selected shark mesh.

Step 3: With the shark body selected, **Right Click** and hold, and then choose the **Polygon** option.

Again, **Right Click** on the shark body and **choose Standard mode**.

You will see some changes in the Standard mode; therefore, we can always interchange between both Standard and **Polygon mode** to use their tools as needed. So, here we have selected Standard mode to use subdivision tools **(Fig. 4.29)**.

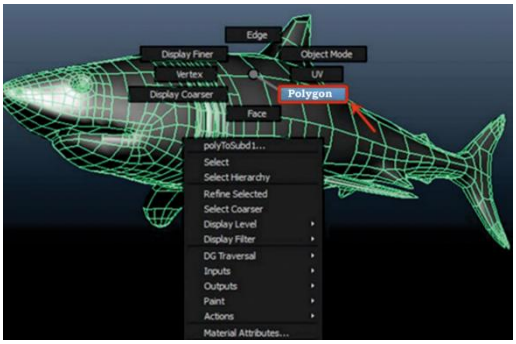

Fig. 4.29: Switching to standard mode for using subdivision tools

Again, **Right Click** and select **Vertex mode**, to select the vertices. Again, do a **Right Click** and select **Display Finer**, to display the finer component.

Step 4: After this, you'll see the finer vertices close to the subdivision surface as control vertices. Now select some vertices around the lip outline and then change the mode to Surface.

With the same vertices selected, go to the Subdivision Surface menu and select menu and select Refine Selected Components. You can see some changes after using the Refine Selected Components command. Now you can arrange the vertices or sculpt the area as you need **(Fig. 4.30)**.

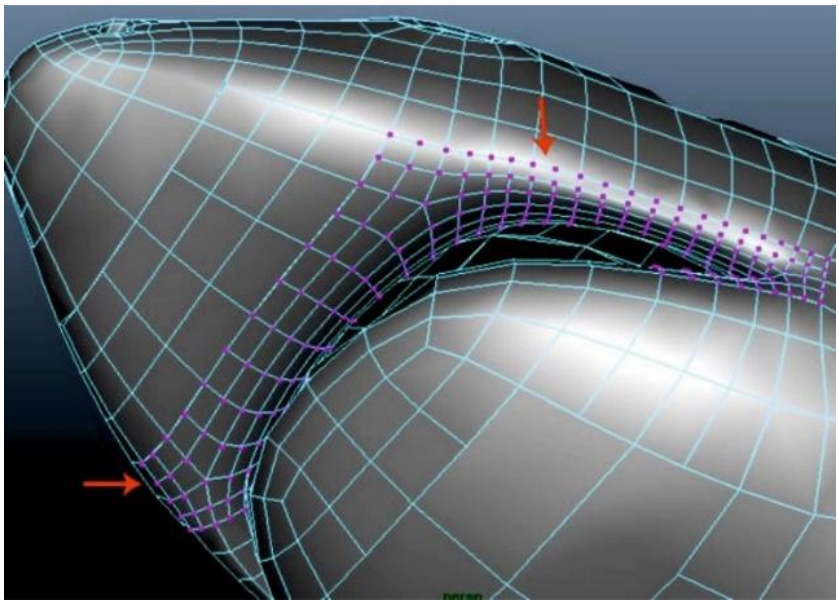

Fig. 4.30: Arranging vertices and sculpting the model surface

12. Adding Detail to the Mouth

Step 1: Now select a row of vertices around the lip outline and move them up a bit. If you want to check to see how it looks, just click on the **Current Render Frame button** on the main toolbar. You can then see the result in a rendered frame. Moving the row of the vertices has made a space for the teeth and gums.

Step 2: Just like this, keep arranging the vertices to sculpt the mesh as you need, and to add more detail. It will take a bit of time and your own creativity for you to come up with the teeth and gums space (Fig. 4.31).

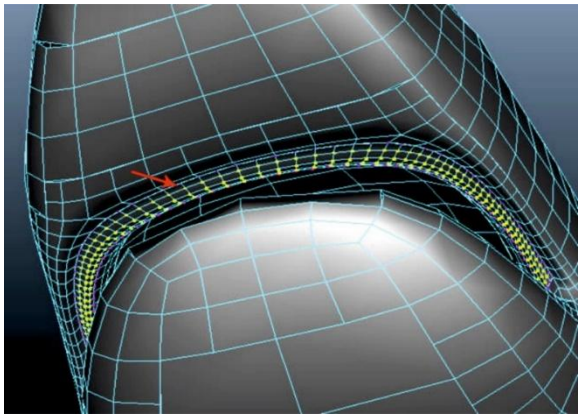

Fig. 4.31: Adjusting vertices to sculpt teeth and gum details

13. Creating and Positioning the Teeth

Step 1: Now it's time to create the teeth for the shark. Go to the **Create menu** and select the **Cone tool** from inside the **NURBS Primitives** submenu. Now draw a cone shape in the viewport with the following values: **Selection: 4**. And also, do not forget to **delete the bottom cap face (Fig. 4.32)**.

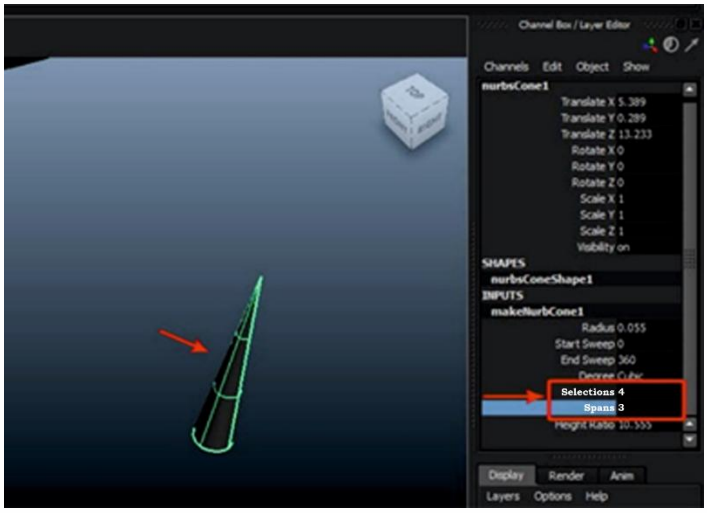

Fig. 4.32: Creating a cone and deleting the bottom cap for teeth

Step 2: With the cone mesh selected, **press F9** to enter Vertex selection mode and then arrange the vertices to form a shark's tooth. Make several copies of the tooth mesh and distribute them with random scale values onto the lower and upper gum areas (Fig. 4.33).

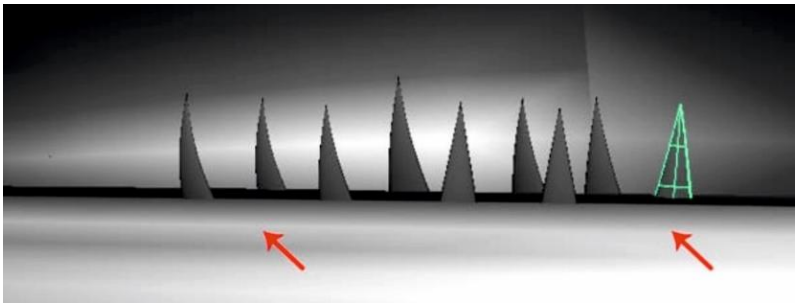

Fig. 4.33: Shaping a cone into a tooth and duplicating it across the gums

We are now done with the teeth arrangements (Fig. 4.34).

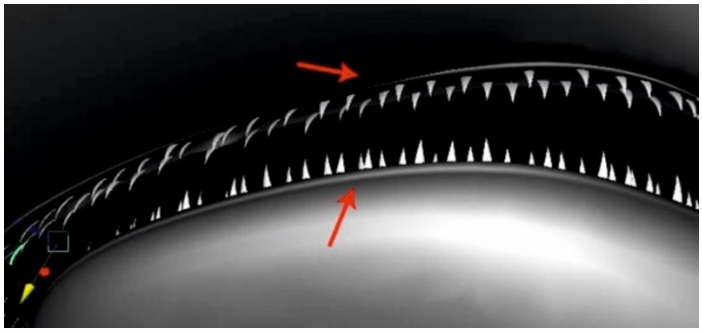

Fig. 4.34: Teeth arrangement along the gum line

14. Creating the Eyes

Step 1: Everything is almost complete, except for the eyes. Go to the **Create menu** and **select Sphere** from inside the **NURBS Primitives** menu. Jump into the Side view and draw a **Sphere** around the eye area, as shown in the background image. Finally, positioning the sphere properly so it looks like an eyeball (Fig. 4.35).

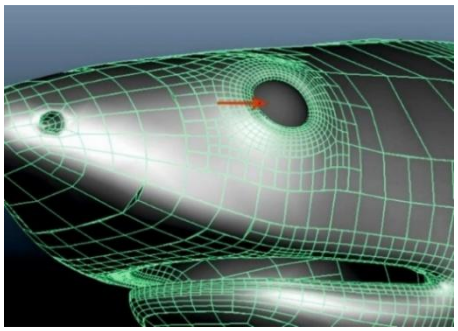

Fig. 4.35: Positioning the eye spheres in the 3D shark model

Finally, we have completed the modelling of the shark. Now, after modelling, we will learn about proper unwrapping and texturing, i.e. in the next session (Fig. 4.36).

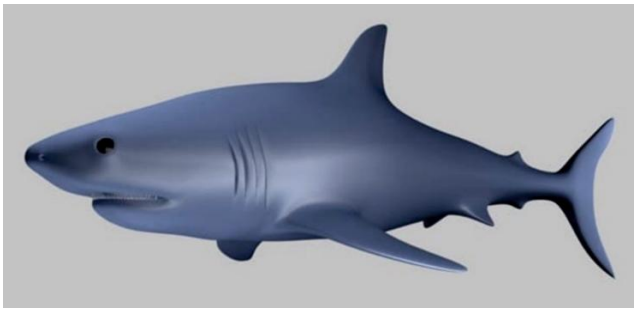

Fig. 4.36: Completed 3D shark model

15. Texturing

Texturing is the process of applying colours, patterns, and surface details to a 3D model to give it a realistic or stylised appearance. The first step in texturing is UV unwrapping, which involves mapping the 3D surface of the model onto a 2D plane. This "unwrapped" version, known as a UV map, allows artists to accurately paint textures as if they were applying a flat image to the 3D object. Once unwrapped, textures can be created in two primary ways:

- **2D Texturing**: Artists paint directly on the UV map using software like Photoshop, GIMP, or Substance Painter. This method allows precise control over details such as colour, patterns, and shading.
- **3D Texturing (Projection Painting)**: Artists paint directly on the 3D model in real-time using tools like Substance Painter, Blender, or Mari. This method provides a more intuitive workflow by letting the artist see the texture as it's applied in context.

Textures can include not just colour (diffuse/albedo maps), but also bump maps, normal maps, roughness, metallic maps, and more, each contributing to how light interacts with the surface. Together, these maps create realistic materials such as wood, metal, fabric, or skin, enhancing the visual richness of the 3D model. For texturing, one must "unwrap" the mesh into 2D and then paint in either 3D or 2D.

16. Rigging

There are two parts of rigging the character to do animation. One is developing the skeletal rig of the model. The skeletal rig is made by connecting joints. When rigging, we can choose to use a combination of inverse and forward kinematics. IK (Inverse kinematics) is basically used for legs since this lets the animators place the foot in the correct spot, and the rest of the leg will follow. FK (Forward kinematics) is usually used to rig the arms and the back of the skeleton. This type of rigging needs the animator to move every joint individually. Once the joints are connected, 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.

17. 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 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.

Practical Exercise

Activity 1: 3D object modelling.

Materials Required:

1. Computer or laptop
2. 3D modelling software
3. Reference object (cup, chair, toy, bottle, etc.)
4. Notebook and pen/pencil for notes
5. Sketch paper for planning the model
6. Projector or smart board for demonstrations (optional)
7. Internet access for tutorials and reference images

Procedure:

Step 1: Start by picking a simple object (e.g., a cup, chair, or toy) as their modelling reference.

Step 2: Create base shape:

- Open Autodesk Maya (or similar software).
- Use basic polygon primitives (cube, sphere, cylinder) to form the starting shape.

Step 3: Modify the model:

- Use scale, move, and rotate tools to adjust proportions.
- Apply the extrude tool to add features like handles, legs, or rims.
- Add headings, short notes, or fun facts to explain each part.

Step 4: Refine the surface:

- Smooth the model using subdivision surfaces.
- Add details by working at different levels of subdivision.

Step 5: Review and share:

- Present your 3D models to the class.
- Discuss which tools were most useful and what challenges they faced.

Check Your Progress

A. Fill in the Blanks

1. 2D animation works only on the _____ and _____ axes.
2. 3D animation includes an extra dimension called the _____ axis.
3. UV mapping converts a 3D model into a _____ surface.
4. The process of attaching the rig to the mesh is called _____.
5. The computer generates in-between frames called _____.

B. Multiple Choice Questions

1. The main difference between 2D and 3D animation is:
   a) Use of colours
   b) Presence of depth
   c) Speed of animation
   d) Number of frames

2. Which axis is added in 3D animation compared to 2D?
   a) X-axis
   b) Y-axis
   c) Z-axis
   d) W-axis

3. Which modelling technique uses mathematical equations to create smooth surfaces?
   a) Polygon modelling
   b) Subdivision modelling
   c) NURBS
   d) Wireframe modelling

4. Which tool is used to insert loops for adding detail to a mesh?
   a) Extrude Tool
   b) Split Polygon Tool
   c) Insert Edge Loop Tool
   d) Merge Tool

5. In rigging, which method is mainly used for legs?
   a) FK (Forward Kinematics)
   b) IK (Inverse Kinematics)
   c) UV Mapping
   d) Rendering

C. State Whether the Following Statements are True or False

1. Subdivision surfaces combine features of polygon and NURBS modelling.
2. In 2D animation, objects can move along the Z-axis.
3. The dope sheet is used to control the timing of animation.
4. Texturing only involves adding colour to a model.
5. FK requires moving each joint individually.

D. Subjective Questions

1. You want to create a smooth and realistic shark model using fewer control points. Which modelling technique would you choose and why?
2. While modelling a shark fin, which tool would you use to extend faces outward and why?
3. If you want a shark's fin to stay fixed while adjusting the rest of the body, which rigging method would you use? Explain.
4. During texturing, your design appears stretched or distorted. What might be the issue and how would you fix it?
5. After modelling the shark, you want to add finer details to the mouth area. What steps would you take?

What have you learned?

After completing this session, you will be able to:

- apply 3D modelling techniques to create a realistic shark model using appropriate tools and workflows;
- construct and refine the shark's body parts—including the body, fins, tail, mouth, teeth, and eyes—through hands-on modelling practice;
- perform UV mapping and apply textures to develop realistic surfaces using both 2D and 3D texturing techniques; and
- animate the model by using key frames, tweening, and timing tools to produce movement.

Session 3: Applications of 3D Modelling in Animation and Media

3D modelling plays a major role in the animation and media industry by helping artists and designers create realistic characters, objects, and environments. It is widely used in films, television, video games, advertisements, virtual reality, and digital media production. Through 3D modelling, creators can design detailed visual elements that improve storytelling, realism, and audience engagement. Modern animation and media industries rely heavily on 3D technology to produce high-quality visual content and immersive experiences.

1. Applications of 3D Modelling

Let us learn about the various application of 3D modelling.

(i) Animated Films and Movies: One of the most important applications of 3D modelling is in animated films and movies. Artists use 3D modelling software to create digital characters, props, vehicles, buildings, and environments. These models are later textured, rigged, animated, and rendered to produce realistic cinematic scenes. 3D modelling helps filmmakers create fantasy worlds, creatures, and effects that would be difficult or impossible to produce physically. It improves visual storytelling and allows filmmakers to achieve high levels of realism and creativity.

Applications in Films

- Character modelling
- Environment creation
- Creature and object design
- Visual effects and simulations
- Animated storytelling

(ii) Video Game Development: The gaming industry heavily depends on 3D modelling to create interactive and realistic game environments. Game designers use 3D models for characters, weapons, vehicles, buildings, landscapes, and other game assets. Detailed 3D models improve the gaming experience by making virtual worlds appear immersive and visually engaging. 3D modelling also allows developers to create realistic movements, actions, and animations that increase player interaction and excitement.

Applications in Gaming

- Game character creation
- Environment and world design
- Weapon and vehicle modelling

- Interactive game assets
- Realistic animations and effects

(iii) Visual Effects: 3D modelling is widely used in visual effects production for films, television, and advertisements. It helps create scenes and effects that are difficult, dangerous, or impossible to shoot in real life. VFX artists use 3D models to create explosions, creatures, natural disasters, futuristic cities, and space environments.

3D modelling combined with animation and rendering enhances realism and cinematic quality in media production.

Applications in VFX

- Fantasy creatures and monsters
- Destruction and explosion effects
- Space and futuristic scenes
- Crowd simulations
- CGI environments

(iv) Television and Web Series

Television productions and web series use 3D modelling for animated sequences, title graphics, virtual sets, and visual effects. News channels and entertainment media also use motion graphics and 3D visual elements to improve presentations and audience engagement.

Applications

- Animated television shows
- Digital title sequences
- Motion graphics
- Virtual studio environments
- Broadcast graphics

(v) Advertising and Product Promotion

Advertising agencies use 3D modelling to create visually attractive advertisements and product demonstrations. 3D product models allow companies to showcase products realistically before manufacturing. Animated commercials and explainer videos also use 3D modelling for engaging visual communication.

Applications in Advertising

- Product visualization
- Animated advertisements
- Commercial videos

- Brand promotions
- Explainer animations

Benefits

- Enhances audience attention
- Improves product presentation
- Creates realistic demonstrations

(vi) Virtual Reality and Augmented Reality: 3D modelling is the foundation of virtual reality and augmented reality experiences. It helps create interactive virtual environments and digital objects that users can explore and interact with in real time. These technologies are used in gaming, education, healthcare, training, architecture, and entertainment industries.

Applications in VR and AR

- Interactive gaming experiences
- Virtual simulations
- Educational environments
- Product visualization
- Training applications

(vii) Motion Graphics and Digital Media: Motion graphics designers use 3D modelling to create animated logos, text, transitions, and visual effects for digital media. Social media content creators and video editors also use 3D elements to improve visual quality and engagement.

Applications

- YouTube intros and animations
- Social media graphics
- Corporate presentations
- Television graphics
- Promotional videos

(viii) Architecture and Interior Designing

3D modelling is widely used for architectural visualization and interior design presentations. Architects and designers create digital building models and walkthroughs that help clients understand projects before construction begins.

Applications

- Building visualization
- Interior design modelling
- Virtual walkthroughs

- Real estate presentations
- Landscape design

2. Advantages of 3D Modelling in Animation and Media

3D modelling has emerged as one of the most significant technologies in the animation and media industries. It enables artists and designers to create realistic characters, objects, and environments with exceptional precision and flexibility. By enhancing visual quality and supporting compelling storytelling, 3D modelling provides greater creative freedom throughout the production process. Its applications span animated films, video games, advertisements, architectural visualization, and virtual reality, where it plays a vital role in delivering immersive and visually engaging experiences for audiences. The following are some major advantages of 3D modelling in animation and media.

(i) Creates Realistic Visuals: One of the biggest advantages of 3D modelling is its ability to create highly realistic characters, objects, and environments. Using textures, lighting, shadows, and materials, artists can design digital models that closely resemble real-world objects. This realism improves the visual quality of films, games, and animations.

(ii) Enhances Storytelling: 3D modelling helps storytellers create visually rich worlds and expressive characters that improve emotional connection with audiences. Realistic animations, environments, and effects make stories more engaging and impactful.

(iii) Provides Creative Flexibility; 3D modelling allows artists to experiment with shapes, textures, lighting, and designs easily. Designers can modify models, change colours, add details, or redesign objects without starting from the beginning.

(iv) Saves Time and Production Costs: Digital 3D models can be reused, edited, and updated multiple times, reducing production time and costs. Instead of building physical models or sets, industries can create digital environments quickly and efficiently.

(v) Supports Animation and Visual Effects; 3D models can be rigged and animated to create movement and actions for films, games, and simulations. Advanced rendering and visual effects improve the overall cinematic quality.

(vi) Improves Visualization and Presentation: 3D modelling helps industries visualize projects before final production. Architects, product designers, and media creators can present realistic previews and virtual walkthroughs to clients and audiences.

(vii) Widely Used Across Industries: 3D modelling is useful in multiple fields including animation, gaming, architecture, medicine, engineering, advertising, and virtual reality. Its versatility makes it an essential tool in modern digital media.

3. Future Trends of 3D Modelling in Animation and Media

The field of 3D modelling is evolving rapidly due to advancements in computing technologies, AI, and immersive media. These developments are transforming the way digital content is created, animated, and experienced. Some of the major future trends in 3D modelling are discussed below:

(i) Artificial Intelligence in 3D Modelling: Artificial Intelligence is expected to significantly transform the 3D modelling industry by automating repetitive and time-consuming tasks. AI-powered tools can assist artists in generating textures, creating realistic facial expressions, improving character animations, and automatically generating 3D objects and environments. These capabilities can reduce production time, enhance creativity, and allow artists to focus on more complex aspects of design and storytelling.

(ii) Growth of Virtual Reality and Augmented Reality: Virtual Reality and Augmented Reality technologies are expanding rapidly across sectors such as gaming, education, healthcare, architecture, engineering, and entertainment. These technologies depend heavily on detailed and realistic 3D models to create immersive experiences. As VR and AR applications become more widespread, the demand for high-quality 3D assets and interactive environments will continue to increase.

(iii) Real-Time Rendering and Virtual Production: Real-time rendering technology enables artists, animators, and filmmakers to view and modify scenes instantly without waiting for lengthy rendering processes. Modern game engines, such as Unreal Engine and Unity, are increasingly being used in film, television, and animation production. This trend supports virtual production workflows, allowing creators to visualize and adjust scenes in real time, improving efficiency and creative decision-making.

(iv) Development of the Metaverse and Digital World: The emergence of the metaverse is creating a growing need for realistic 3D environments, digital avatars, virtual assets, and interactive spaces. 3D modelling plays a crucial role in building immersive virtual communities where users can work, socialize, learn, and engage in entertainment activities. As digital worlds continue to evolve, the demand for skilled 3D artists and designers is expected to rise.

(v) Improved Realism and Advanced Simulation: Future developments in 3D modelling will focus on achieving greater realism in visual appearance, lighting, textures, physics simulations, and character movements. Advanced technologies will enable more accurate simulations of natural phenomena such as water, fire, cloth, hair, and human motion. These improvements will make digital content increasingly realistic and difficult to distinguish from real-world imagery.

(vi) Cloud-Based Collaboration and Online Production; Cloud computing is changing the way creative teams collaborate on projects. Cloud-based platforms allow artists, designers, and animators to work together in real time from different locations around the world. These technologies facilitate asset sharing, project management, cloud rendering, and version control, leading to greater productivity and flexibility in animation and media production.

(vii) Increased Accessibility of 3D Modelling Tools: Advancements in software development are making 3D modelling tools more accessible to beginners, students, educators, and independent creators. Modern applications offer user-friendly interfaces, automated features, and affordable subscription models, enabling a wider range of users to learn and create professional-quality 3D content. This increased accessibility is expected to encourage innovation and expand participation in the digital media industry.

Practical Exercise

Activity 1: Exploring applications and future trends of 3D modelling.

Materials Required:

1. Notebook and pen/pencil
2. Chart paper or poster sheets
3. Sketch pens, markers, and coloured pencils
4. Ruler and eraser
5. Computer or laptop with internet access
6. Reference books, magazines, or articles on 3D modelling
7. Printed images or examples of 3D applications
8. Presentation materials (slides, charts, or handouts)

Procedure:

Step 1: Introduction and Discussion

Begin the activity by asking students the following questions:

- Have you seen 3D animation in films, television shows, or video games?
- Which animated movie or video game do you like the most, and why?
- Where do you think 3D modelling is used in everyday life?

Step 2: Group Formation and Topic Allocation

Divide the class into small groups and assign each group one of the following topics:

a) Animated Films and Movies
b) Video Game Development
c) Visual Effects (VFX)
d) Television and Web Series
e) Advertising and Product Promotion
f) Virtual Reality and Augmented Reality
g) Motion Graphics and Digital Media
h) Architectural and Interior Visualization
i) Future Trends of 3D Modelling

Step 3: Research and Discussion

Ask each group to:

a) Discuss the assigned topic.
b) Identify real-world applications and examples of 3D modelling.
c) List the advantages of using 3D modelling in that field.
d) Explain how emerging technologies and future developments may improve the industry.

Step 4: Preparation of Presentation Materials

Each group should prepare:

a) A short presentation, chart, or poster.
b) Drawings, diagrams, or visual examples related to their topic.
c) A list of current applications and future possibilities of 3D modelling.
d) Key points highlighting the importance of 3D technology in their assigned field.

Step 5: Group Presentations

Allow each group to present their findings before the class. During the presentation, students should explain:

a) How 3D modelling is used in their assigned field.
b) The advantages and benefits of 3D modelling in media and animation.
c) Examples of successful applications.
d) Future developments and technologies that may influence the field.

Summarize the key points discussed and highlight the growing importance of 3D modelling in today's digital world.

Check your progress

A. Fill in the Blanks

1. 3D modelling is widely used in films, games, and _____ reality.
2. In video games, 3D models are used to create interactive _____.
3. _____ technology allows users to interact with virtual environments in real time.
4. AI-powered tools help automate _____ and animation tasks.
5. Motion graphics designers use 3D modelling to create animated _____ and text.

B. Multiple Choice Questions

1. Which industry heavily uses 3D modelling for interactive environments?
   a) Agriculture
   b) Gaming
   c) Banking
   d) Tourism

2. Which of the following is used for real-time rendering and virtual production?
   a) MS Paint
   b) Unreal Engine
   c) Calculator
   d) Notepad

3. What is one major advantage of 3D modelling?
   a) Reduces creativity
   b) Creates realistic visuals
   c) Removes animations
   d) Increases manual work

4. Which technology creates immersive digital environments?
   a) VR and AR
   b) Word Processing
   c) Spreadsheet Software
   d) Email Systems

5. Which field uses 3D modelling for building visualization and walkthroughs?
   a) Medicine
   b) Architecture
   c) Agriculture
   d) Accounting

C. State whether the following statements are True or False

1. 3D modelling is used only in animated films.
2. Visual effects artists use 3D models to create fantasy creatures and simulations.
3. AI can help automate tasks in 3D modelling.
4. Motion graphics use 3D modelling for animated logos and effects.
5. Virtual Reality and Augmented Reality depend on realistic 3D models.

D. Subjective Questions

1. Explain the applications of 3D modelling in animation and media industries.
2. Describe the role of 3D modelling in video game development.
3. Explain the advantages of 3D modelling in animation and media.
4. Discuss the future trends of 3D modelling in animation and media.
5. Explain how AI, VR, and AR are transforming the future of 3D modelling.

What you have learned?

After completing this session, you will be able to:

- apply 3D modelling techniques in animation, digital media, and content creation projects;
- describe the advantages and applications of 3D modelling across various industries;
- explore emerging technologies such as AI, VR, AR, and the Metaverse in relation to 3D modelling;
- enhance teamwork, communication, collaboration, and presentation skills through project-based activities;
- develop awareness of current trends and advancements in modern digital media technologies; and
- recognize the role of 3D modelling in creating realistic, interactive, and immersive digital experiences.

ANSWER KEY

UNIT 1: INTRODUCTION TO ANIMATION

SESSION 1: FUNDAMENTALS OF ANIMATION

A. Fill in the Blanks

1. Movement
2. The growth of a pea plant
3. The pea brothers
4. The banayan deer
5. *Chhota Bheem*

B. Multiple Choice Questions

1. b
2. b
3. c
4. c
5. c

C. State whether the following statements are True or False

1. True
2. True
3. False
4. True
5. False

SESSION 2: TECHNIQUES OF ANIMATION

A. Fill in the Blanks

1. Two-dimensional
2. Range
3. 3D
4. Editing
5. 2D

B. Multiple Choice Questions

1. a
2. a
3. a
4. b
5. c

C. State whether the following statements are True or False

1. True
2. False
3. True
4. True
5. True

SESSION 3: TYPES OF ANIMATION

A. Fill in the Blanks

1. Traditional
2. Graphics
3. Computer Generated Imagery
4. cut-out
5. Sequence of drawings

B. Multiple Choice Questions

1. c
2. a
3. d
4. c
5. a

C. State whether the following statements are True or False

1. True
2. True
3. False
4. True
5. False

UNIT 2: ESSENTIALS OF ANIMATION

SESSION 1: PRINCIPLES OF VISUAL STORYTELLING

A. Fill in the Blanks

1. Narrative
2. Symbols
3. Visuals
4. Memorable
5. Visual

B. Multiple Choice Questions

1. c
2. a
3. c
4. a
5. a

C. State whether the following statements are True or False

1. False
2. True
3. True
4. False
5. True

SESSION 2: PRINCIPLES OF ANIMATION

A. Fill in the Blanks

1. Charisma
2. Action
3. Principle
4. Movement
5. Believable

B. Multiple Choice Questions

1. c
2. b
3. b
4. a

C. State whether the following statements are True or False

1. False
2. True
3. True
4. False
5. False

SESSION 3: BASICS OF PRODUCTION PIPELINE

A. Fill in the Blanks

1. Modelling
2. Compositing
3. VFX
4. Layout tools

5. Matte painting

B. Multiple Choice Questions

1. b
2. c
3. b
4. c
5. c

C. State whether the following statements are True or False

1. False
2. True
3. False
4. True
5. True

UNIT 3: DIGITAL 2D ANIMATION

SESSION 1: CONCEPT OF 2D ANIMATION

A. Fill in the Blanks

1. Two-dimensional
2. Rough sketch
3. Storyboard
4. Individual
5. Multiple

B. Multiple Choice Questions

1. c
2. c
3. c
4. a
5. a

C. State whether the following statements are True or False

1. True
2. False
3. True
4. False
5. True

SESSION 2: TYPES OF 2D ANIMATION

B. Fill in the Blanks

1. Frame-by-frame
2. Directly
3. Celluloid

B. Multiple Choice Questions

1. a
2. b
3. b
4. a
5. a

C. State whether the following statements are True or False

1. False
2. True
3. True
4. False
5. True

SESSION 3: APPLICATIONS OF 2D ANIMATION IN ANIMATION AND MEDIA

A. Fill in the Blanks

1. 2D animation
2. Between key frames
3. Adobe Animate
4. Depth
5. Free animation programme

B. Multiple Choice Questions

1. a
2. a
3. d
4. c
5. c

C. State whether the following statements are True or False

1. True
2. False
3. True
4. True
5. False

UNIT 4: INTRODUCTION TO 3D MODELLING

SESSION 1: FUNDAMENTALS OF 3D MODELLING

A. Fill in the Blanks Answers

1. Depth
2. Edge
3. Polygonal modelling
4. Mesh
5. Slime

B. Multiple Choice Questions

1. a
2. d
3. d
4. c
5. c

C. State whether the following statements are True or False

1. False
2. True
3. True
4. True
5. True

SESSION 2: CREATING AND EDITING 3D MODELS

A. Fill in the Blanks

1. X and Y
2. Z
3. Two-dimensional
4. Skinning
5. Tweens

B. Multiple Choice Questions

1. b
2. c
3. c
4. c
5. b

C. State whether the following statements are True or False

1. True
2. False

3. True
4. False
5. True

SESSION 3: APPLICATIONS OF 3D MODELLING IN ANIMATION AND MEDIA

B. Fill in the Blanks

1. Virtual
2. Environments
3. Virtual reality
4. Modelling
5. Logos

B. Multiple Choice Questions

1. b
2. b
3. b
4. a
5. b

C. State whether the following statements are True or False

1. False
2. True
3. True
4. True
5. True

GLOSSARY

2D Animation: A form of animation created on a flat, two-dimensional plane, using only the X and Y axes. Movements are drawn frame-by-frame or created digitally using software.

3D Animation: Animation that includes depth using the X, Y, and Z axes. 3D models are built, textured, rigged, and animated to create realistic movement and environments.

Anticipation: A principle of animation where small preparatory actions are added before the main action to make movements look natural and predictable.

Contact Point: A key pose in a walk cycle where the character's foot first touches the ground during a step.

Cut-out Animation: A technique that uses flat shapes, characters, or pieces moved frame-by-frame, traditionally made from paper but now often created using digital tools.

Frame: A single static image in a sequence of images. When played rapidly, frames create the illusion of motion.

Inbetweening (Tweening): The process of creating frames between key poses to produce smooth motion. Digital software can automate this process.

Keyframe: A major pose or position in an animation that defines starting and ending points of movement.

Looping: Repeating a sequence of frames continuously, often used in walk cycles to avoid redrawing steps repeatedly.

Modelling (3D): The process of creating digital 3D objects or characters by shaping vertices, edges, and faces using 3D software.

Motion Tween: A type of tween in animation software where a symbol moves between two keyframes automatically.

Passing Pose: A keyframe in a walk cycle where the legs pass each other and the body is at its highest position.

Pixel Art Animation: A style of animation created using pixel-based graphics, often used in retro games.

Polygon: A flat geometric shape used in 3D modelling. Many polygons combined form a 3D object.

Pose-to-Pose Animation: A technique where animators create key poses first, and then fill in the in-between frames.

Principles of Animation: A set of twelve foundational rules developed to make animations appear natural, including squash and stretch, anticipation, timing, and exaggeration.

Production Pipeline: The step-by-step workflow followed in animation production, generally including pre-production, production, and post-production.

Rendering: The process of generating the final image or video from a 3D scene with lighting, shading, textures, and effects.

Rotoscoping: An animation method where frames are traced over live-action footage to create realistic movements.

Shape Tween: A tween used to transform one non-symbol shape into another, creating a morphing effect.

Storyboard: A sequence of drawings representing the shots planned for a film or animation. It helps visualize timing, camera angles, and storytelling.

Squash and Stretch: A principle of animation that exaggerates the shape of an object to show weight, energy, and flexibility.

Texturing: Adding colours, patterns, and surface details to 3D models to make them look realistic or stylized.

Timing: A principle that determines how long an action takes in animation, affecting the weight and speed of movement.

Walk Cycle: A series of frames or drawings that animate a character walking in a looping sequence.

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