PART VI

MULTIMEDIA ANIMATION

PART OVERVIEW

We have now landed on an exciting chapter in our learning journey!

Multimedia animations are undoubtedly the most compelling among all the elements of multimedia. Animation means fun! And computerised animation means creativity unbound! 3D Animation means endless days of excitement!

Traditional hand drawn animations have long been in the race, ever since the advent of Walt Disney cartoons, but it was only after the introduction of computers – that multimedia animation hit the main streets and represents a multi billion-dollar industry today!

In the next few chapters, we will be doing really serious work and understand almost all the basic technologies and concepts associated with animations. Have a cup of tea, before you begin!

Chapter 16

Fundamentals of Computer Animation

CHAPTER OVERVIEW

· This chapter serves as a curtain raiser for this complex technology.

We begin with the most fundamental question: Why do we need a specialized medium called animations in a multimedia project, after all?

A briefing on different types of animations popular in the industry follows these discussions.

It is important to understand and classify different types of animations – based upon technology, media and applications. Later on, this will be of immense use to us – because the strategies used to develop animations are very much influenced by the category to which they belong. The rest of this chapter is devoted to understanding two-dimensional and three-dimensional planes and what sorts of tools are available to develop 2D and 3D animations.

The purpose of this chapter is to wet you into the world of animations and prepare you for more detailed discussions in the later chapters.

16.1 Introduction

Multimedia animations or simply animations represent a series of drawings that are presented one after another to the user's eyes at those speeds that provide an illusion of movement.

Going by their basic concept, animations are not very different from films. The only difference is that while films are video graphed via a video camera or a camcorder, frames that make up the animation are created either with the help of drawings or specialized three-dimensional environments.

Animation, as a technology, was born well over a century before computers. But conventional animations took lot of money, effort and time to develop and were beyond the reach of mainstream entertainment. It was only after the introduction of computers that animation was able to evolve as a multi million-dollar industry and was able to stroll past dizzy technical heights hitherto unknown.

Our focus here is however limited to the fundamentals of computer based animation technology – and with special emphasis on its role, as a facet of multimedia. So, let us keep all other generic discussions aside and get down to business.

16.2 Animations in multimedia projects

Animations were incorporated into multimedia, primarily because of the need for dynamic graphics in real time multimedia applications.

Figure 123: It'll much more fascinating to see these balloons floating - instead of standing still.

For example, let us imagine that we need to show a balloon floating in thin air – in a children's edutainment title.

With graphics imagery, what we can provide, at the best – is a high quality digital photograph of a big balloon. But if we were to use animations for illustrating the same point, then the balloon can be brought to life and may well be floating across the monitor – if not the big blue sky! Imagine how compelling it will be for a six-year-old child, staring at the monitor!

This is the power of animations and hence their respected position in the world of multimedia.

Do you get the point?

16.3   Need for animations in multimedia projects

Animations are engaged in multimedia projects, for one or more of the following reasons:

❑   To explain a concept or illustrate a point, better. Animations are perhaps, the best tools for illustrating what you are really trying to say.
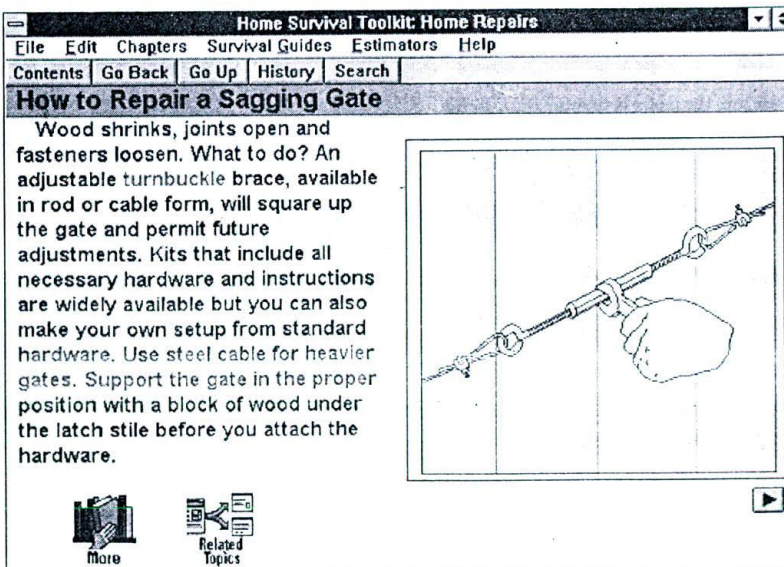

Figure 124: Usage of animations – from "Home survival toolkit" CD-ROM

❑   Look at the example provided from "Home survival toolkit " CD-ROM. This title explains how to use various types of household hardware for domestic purposes, how to do your own repairs within the house etc. Such details can be best explained with the help of computer animations, rather than pages and pages of photographs or texts.

❑   There are situations wherein, a given sequence cannot be photographed or video graphed. For example, in Andromeda interactive "Interactive space encyclopaedia" CD-ROM, various astronomical concepts - like the 'big bang' theory - are clearly illustrated with the help of computer animations. It may not be possible to video graph such a sequence, which is believed to have happened millions of years ago! A static digital photograph will hardly impress upon the viewers! An animated shot is the only viable alternative.

❑   A similar illustration can be provided from Microsoft's Oceans CD-ROM. In the section titled, 'How does a sub dive?' - instead of mincing up with words, the titles throws open a cute little animation, which illustrates the point beyond all conceivable doubts. The background voice over explains what is happening – as the animation proceeds.
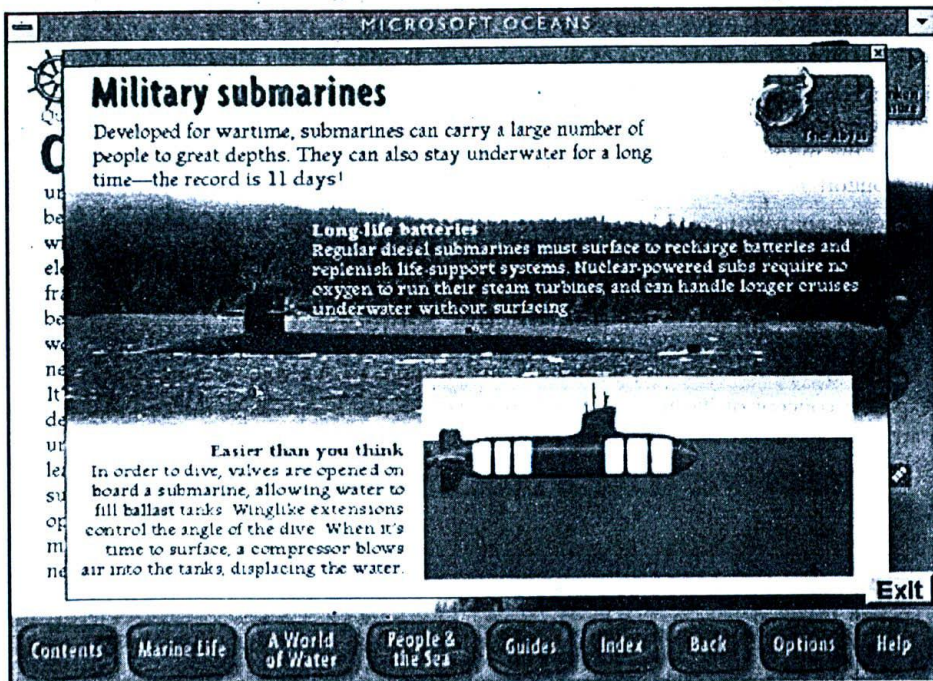

Figure 125: Usage of animations – from Microsoft "Oceans" CD-ROM

❑   Animations are most useful, when you need to illustrate something – step by step. Since animations can be accompanied by voice-over, the sequence can be controlled very well. You can look at all the examples provided above, to appreciate this point. For example, in Oceans CD-ROM, how clear it is to understand the basic principle behind a submarine – when a background voice explains what is happening!

❑   To make the proceedings rich, colourful and compelling, Animating the first few sequences of the title – to keep up the excitement and tempo – has almost become customary with most multimedia titles. Of course, good titles maintain the initial interest generated, throughout the proceedings - with various kinds of animations.

Figure 126: The compelling beginning sequence of Sid Meier's multimedia game 'Civilizations'

In short, animations are not optional elements in multimedia titles – but mandatory.

But the extent, to which animations are deployed - is dictated by the nature of the title under development. In general, children entertainment and edutainment titles and multimedia games make extensive use of animation technology, than other types of multimedia applications.

16.4 Computer animations - classification

The term 'computer animation' encompasses literally any kind of animation created using computers. Multimedia animations are those that are used in multimedia projects.

A simple classification of various types of computerized animations will be of great interest to us, at this stage.

Table 26: Animations - Different classifications

Classification	Based on	Animation
I	The basic philosophy of animation	Cel / Frame animation
		Object animation
II	The number of dimensions involved	Two dimensional animation
		Three dimensional animation
III	The nature of applications	Movie animation
		Television animation
		Multimedia & Games animation
		Net animation and others
IV	The technology used to create animated movements	Animations by programming – including Morphs
		Precompiled animations

Now, let us explore these categories without getting into the details. Those who are interested in specific topics may have to explore other specialized books on the subject.

16.5 Classification I

16.5.1 Cel animation

In cel or frame animation, the entire animation sequence is treated as a collection of independent frames or still images. Each frame differs from the previous one, by minor variations.

When these independent frames are displayed in sequence, they create the illusion of movement. When the images displayed are fast enough to fool the human eye (at around 25 to 30 frames per second) – the result is a very smooth animated movie!

This basic philosophy is not very much different from the technique adopted in cinemas. In cinema theatres, the filmed shots roll past the projector at incredible speeds, creating the illusion of a group dance or fight sequence on the screen.

The only difference between them and cel animation is that the individual frames are video graphed in movies, whereas they are developed using traditional drawings or by other means – in animations.
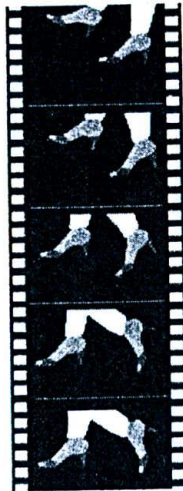
Figure 127: Each frame differs from the previous one by a small variation.
When the frames are flipped at high speeds, the shot gets animated.

16.5.2 Object animation

In object animations, a static backdrop is maintained throughout a sequence – and the object to be animated is moved across the backdrop.

In the example provided, the kite is the object that is being animated.

Take note that I have carefully places only static objects like houses in the background. I'd love to add a tree – but then, during animation, if it remains still and the kite alone is moving – then it might not look natural. After all, when the blow of wind is so good that it lifts a kite, then it would move the tree branches as well!

You can have more than one animated object in the sequence. For example, I can have another animated kite in the same shot or even a bird or two.

One interesting question comes up: Kite is a static object and hence it can be animated here and there. But, how

about birds? Will they not have their own animated movements – flip of wings etc.? I leave this question to you for the moment, with a hint: It has something to do with cyclic animations, covered in a later section.
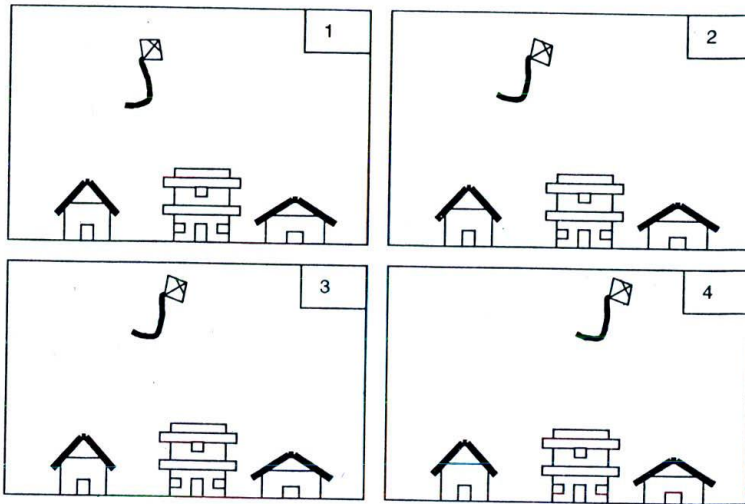
Figure 128: In this sequence, the background houses etc remain static, whereas the kite moves here and there...

Object animations can be created only with the help of software packages that support them. I cannot think of a better example than macromedia flash - for this.

Traditional Indian shadow puppeteers are known to make use of this technique for creating two-dimensional animated movements!

16.6 Classification II

16.6.1 Two-dimensional (2D) animation

Animations created in two-dimensional planes are called 2D animations.
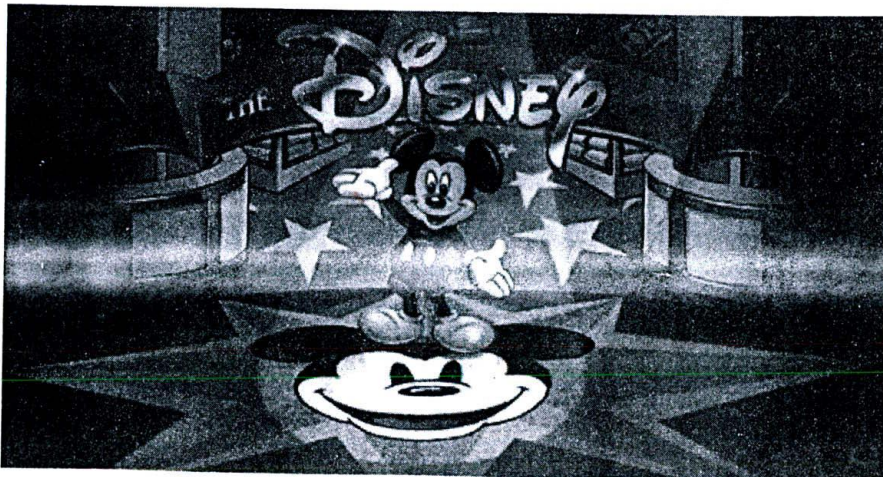
Figure 129: Old Walt Disney films are classic examples of two-dimensional animations

Two-dimensional planes are characterised by two axes – X and Y - that define any point in that plane. A good example for a two-dimensional plane will be this very paper which you are reading.

Classic examples of two-dimensional animations are old Mickey and Donald cartoons of Walt Disney!

16.6.2 Three-dimensional (3D) animations

Animations created in specialized three-dimensional environments are called 3D animations.

These environments allow objects to be created and animated in a virtual three dimensional space -characterized by three planes. We will be learning more about three-dimensional world and moving objects around in virtual space – in the pages that follow.

Feature films like 'Toy story' and 'Finding Nemo' are examples for three-dimensional animations.

We will be exploring 2D and 3D animation concepts further, as we go along.

16.7 Classification III

16.7.1 Animation for movies

Animations we saw in movies like Jurassic park are essentially 3D animations – but are of complex nature.

They are probably the most expensive to produce – among the lot, as they require high-end graphic hardware and software to develop and render decent animations.

16.7.2 Animation for television shows

Conceptually, animations produced for television shows are not different from those developed for movies – but the main difference lies in screen size and the corresponding resolution/ rendering quality.

Whereas movie animations demand resolutions and rendering of the highest quality possible (and hence require expensive hardware / software), those meant for television shows require much lesser resolution (and hence, tolerate mid-end hardware / software).

Note: Terms like rendering may sound foreign to you, at this stage. Don't worry! We will be covering all these fundamentals, in later sections!

It is said that the animation rendering process for movie 'Titanic' was done on roughly 120 machines, simultaneously!

16.7.3 Animations for multimedia applications and games

A wide range of 2D and 3D animations are made use of in multimedia applications and games.

It is difficult to provide any basic grammars for such animations – as the nature of applications are too many.

The specific needs of the application, dictate the quality and complexity of the animation. In the examples we saw earlier in the chapter (Microsoft Oceans and Civilizations CD-ROM), we witnessed the usage of both 2D and 3D animations.

Animations for multimedia projects can be further sub-classified into

❑   Animations for content and

❑   Animations for interface design

Animations for content are those that are used to illustrate a concept or an idea, in the multimedia project. For example, the submarine animation we saw earlier in Microsoft Oceans is an animation meant for content.

There might be situations wherein the interface design may have to feature some minor animations. These are called animations for interface design.

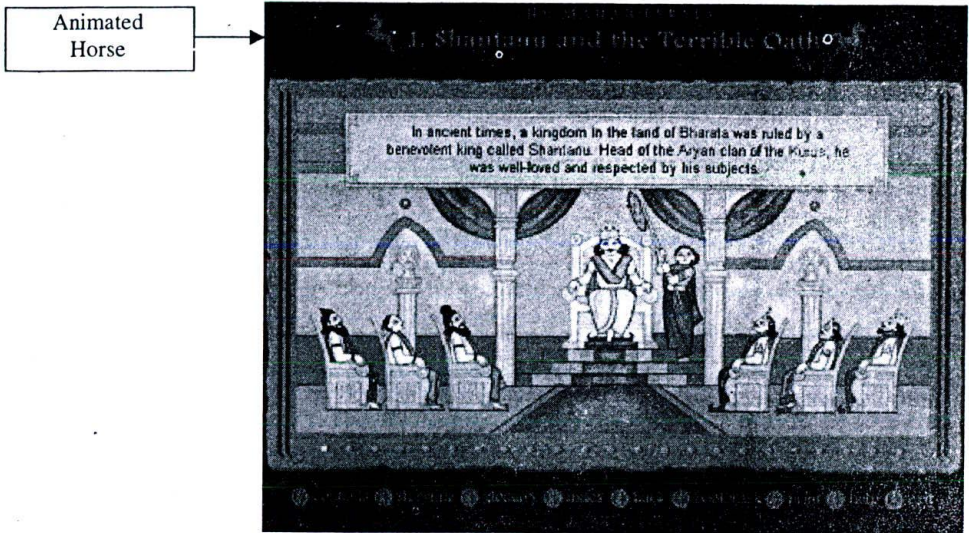As a rule, interface design animations are most simple in nature and in most cases, are 2D animations.

Figure 130: Magic software's Mahabharatha features small animated buttons that add flavour to the interface

16.7.4 Animations for the Internet

The most important characteristic of Internet animations, that set them apart from the rest of the lot – is their size. As a rule, they must be less than 1 MB or, preferably, less than even 500 KB.

Macromedia flash animations are becoming the de-facto standard for animations on the net. We will be learning more about Flash, as we go along.

16.8 Classification - IV

16.8.1 Animation by programming

From the computer's perspective, every animation can be thought of as a series of drawing commands. These commands are executed at such incredible speeds, that they produce the illusion of seamless movement across the screen.
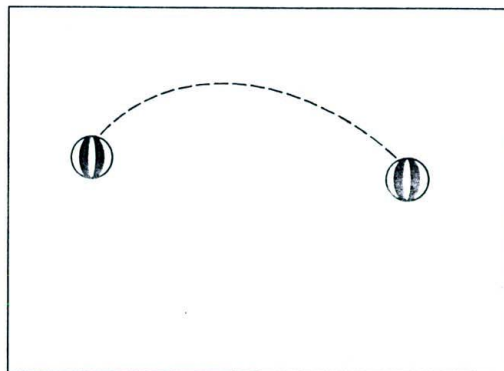

Figure 131: This movement of a ball can be produced, by writing a few lines of software code!

When one can write programs (using software languages like visual basic) that ultimately issue out a series of drawing commands, then that will result in animations – very similar to those produced by a series of images flipped one after another.

Let us say we want to animate the movement of the ball, in a predefined trajectory.

To the eyes of software program, the ball will be an image. You can then write a few lines of code to move the ball image a few pixels away every second – until it reaches the desired destination point. When this program is executed, it looks like an animation.

Animation by programming is very useful for producing bizarre effects with colours and curves. What cannot be achieved with the help of drawing tools can be achieved with the help of programming.
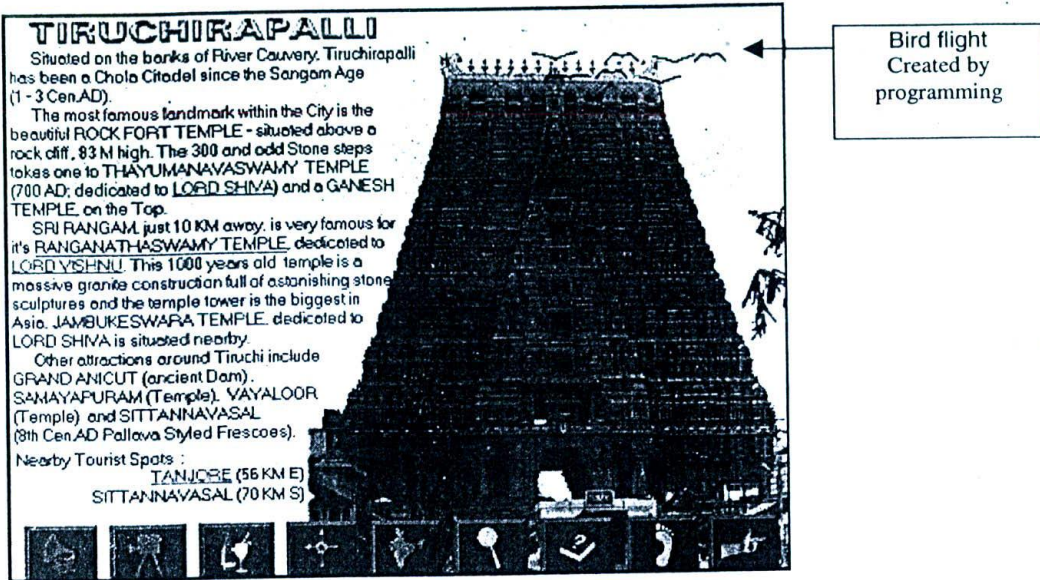
Figure 132: Simple animations like the flight of birds and the flow of flowers were created in 'Tourist's India' CD-ROM – using software coding.

Professional animation designers in reputed special effect studios like ILM (Industrial light and magic) are known for tweaking the software programs (mostly in C++) here and there, whenever they are obstructed by the limitations of the tool they are using.

Different bird flight animations in my CD-ROM 'Tourist's India' were done purely with the help of programming.

16.8.2 Morphing

Morphing can be categorized as a specific variety in programmed animations. It enables seamless transformation of one image to another or one video to another – in the form of a sequential animated movement.

Since its conception, morph is finding its usage in many movies, television shows and other entertainment media.

Probably the best movie I can think of, to illustrate the power of morphs is Terminator II – Judgement Day.

16.8.3 Precompiled animations

In an earlier section on animations by programming, we saw that movements can be created just during runtime – using relevant software codes.

But in most other cases, all movements are pre-drawn, flipped and compiled into specific file formats. These are called precompiled animations.

In real-time multimedia projects, we will mostly be using precompiled animations and only in very rare and exceptional occasions – will we consider animation by programming.

Almost all software tools meant for 2D and 3D animations render their output as precompiled animations – using one file format or other.

16.9   Understanding two-dimensional animation planes

Let us consider this particular page of the book. It possesses certain magnitude of area.

This area can be expressed as the product of length and width.
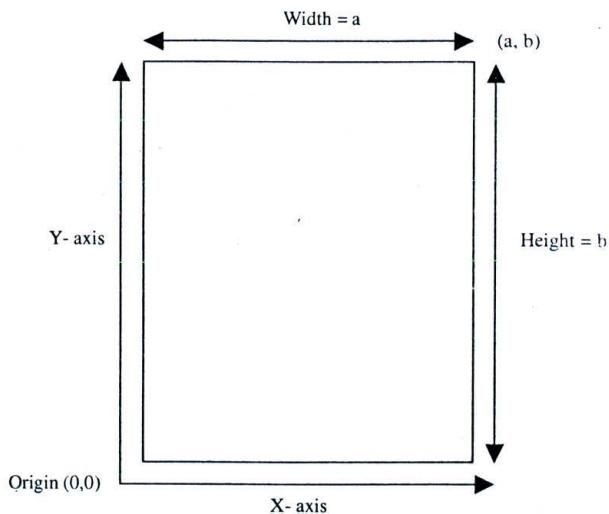
Figure 133: Two dimensional planes consist of X and Y axis

This page can be called as a two dimensional plane, because, any point (i.e. any location) within this page, can be represented using two coordinates - one on the X axis that runs horizontal to the page and the other on the Y axis that runs vertical to the page.

If we can draw, two such imaginary axes in this page, one on the extreme left (Y axis) and one on the bottom most part (X axis), then we can call the whole page as a two axis coordinate system or a 2 dimensional coordinate system.

Now, any point within this plane will have an X coordinate value and a Y coordinate value.

For example, if we assume that the total length of the page, to be 'a' and total width of the page to be 'b', then the top left corner can be represented as (0, a) - meaning that the X Co ordinate value is 0 and Y coordinate value is 'a'. Similarly, the top right corner will be (b, a) bottom left corner will be (0,0), and bottom right corner will be (0,b).

These are extreme points of the page - any other point, will have X and Y values in between a and b.

Any figure, then, can be developed by filling up the points in the plane with the required colour. Consequently, each frame in the animation sequence can be treated as a 2D plane and the sequential movements of the object being animated can be recorded.

Two-dimensional animation files generally record only the deviations of the second frame from the first, and not the colour values of the entire screen used for animating the objects. Apart from saving considerable file space, this technique also helps the system to update the frames quickly, so that the movements appear to be natural.

16.10 Understanding three-dimensional worlds

Now, instead of a page, let us consider the entire book, as an object.

The book possesses not only area - but volume as well, because of its height. This volume can be expressed as the product of length, width and height.
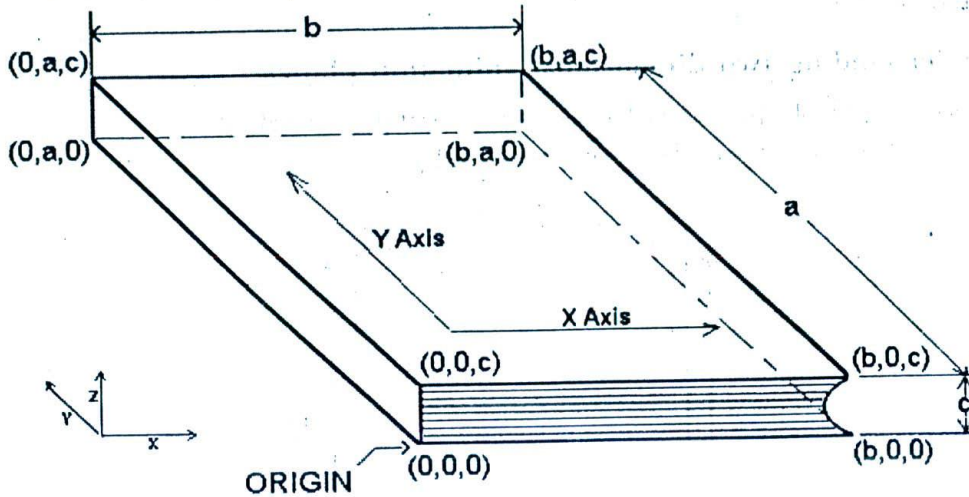

Figure 134: This whole book can be conceived as a three-dimensional object.

We can treat this book as a typical 3D object - because, any location on the book can be represented as a set of three coordinates — running along three different axis X, Y and Z.

X axis that runs horizontal to the book, Y runs vertical to the book and Z runs perpendicular to X and Y.

In three-dimensional coordinate systems, more than one plane comes into the picture.

The whole system has to be perceived as that space intersected by three different two-dimensional planes - the XY plane, the YZ plane and the ZX plane. Have a look at the figure that shows all the three different planes.

Coming back to the book example.

If we could draw three imaginary axes on the corners of the book,

-       One on the extreme left (Y axis),

-       One on the bottom most part (X axis) and

-       One more along the direction perpendicular to X and Y axes (Z axis)

Then we could call the book as a three-axis coordinate system or a three-dimensional coordinate system.

Any point on the book will have an X coordinate value a Y coordinate value and a Z coordinate value.

As in the previous two-dimensional example, if we were to assume that the total length of the book to be 'a', total width to be 'b' and the height of the book to be 'c', then the top left corner on the bottom side of the book   (i.e. at the back cover) can be represented as (0,a, 0) – which means that the X coordinate value is 0, Y coordinate value is 'a' and Z coordinate value to be 0 again.
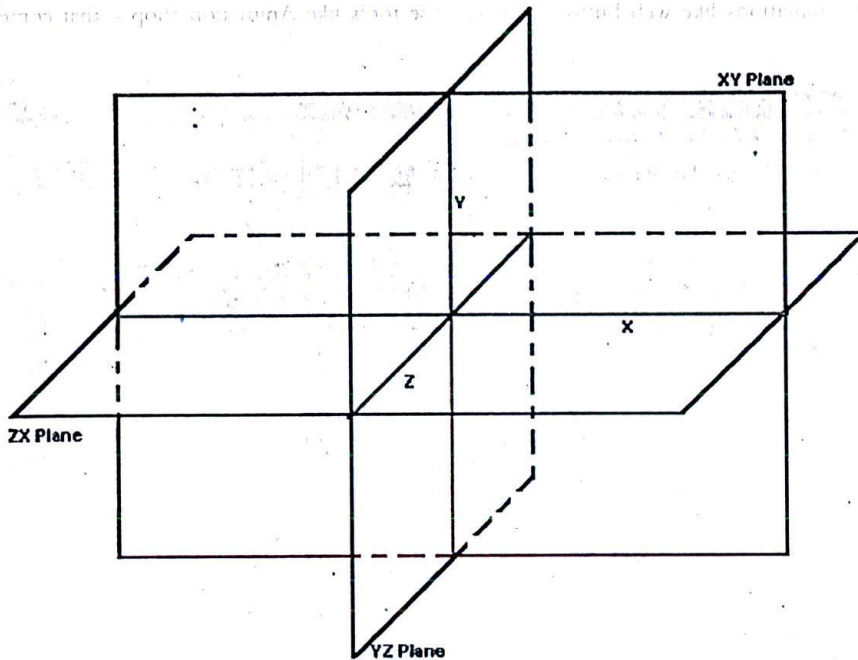
Figure 135: Three planes make up a three-dimensional world.

The very same top left corner, on the front side of the book (i.e. at the front cover) can be represented as (0, a, c) - meaning that the X coordinate value is 0, Y Co ordinate value is 'a' and Z Co ordinate value is 'c'.

On similar grounds, the following can be inferred:

On the front side of the book:

❑ The top right corner will be (b, a, c),

❑ The bottom left corner will be (0, 0, c),

❑ The bottom right corner will be (b, 0, c).

On the back side of the book:

❑ The top right corner will be (b, a, 0),

❑ The bottom left corner will be (0, 0, 0),

❑ The bottom right corner will be (b, 0, 0).

16.11 Animation tools

There are a number of tools available in the market – for designing and developing 2D and 3D animations.

As I had mentioned earlier, animation industry is worth millions of dollars and its potential has not yet been fully realized in countries like India. Hence, it should not surprise you to note that companies across the globe are throwing their money and time behind this lucrative market.

16.11.1 Two-dimensional animation software

Depending upon the project you are working on and its requirements, the tool you select for creating 2D animations could be simple, complex or professional.

To create simple animations like web buttons, one can use tools like Animation shop – that comes bundled with paint shop pro.
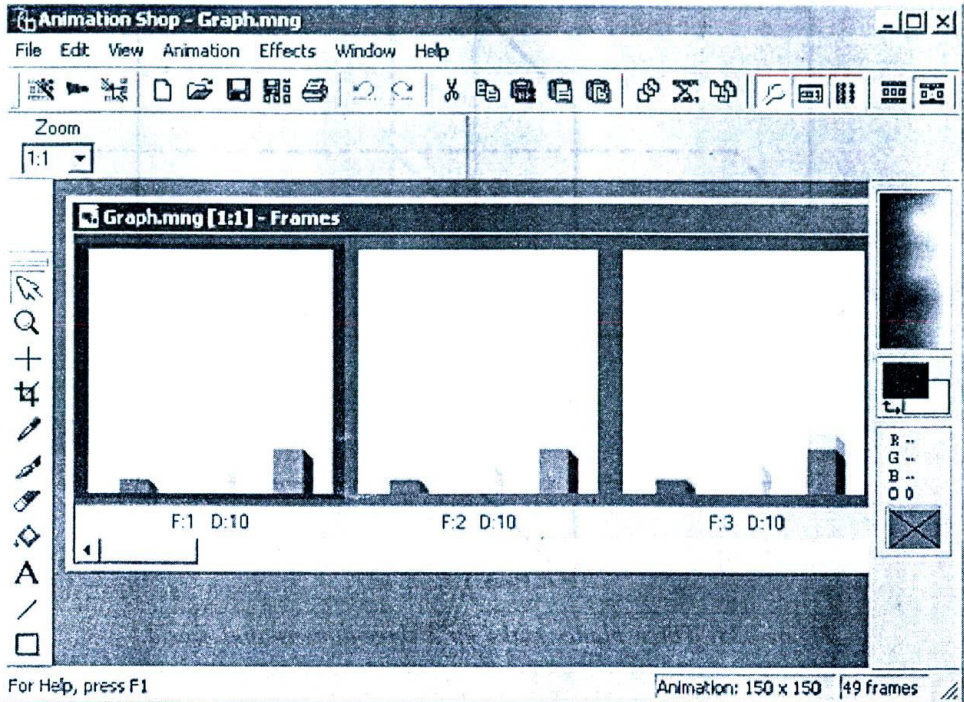

Figure 136: Simple animations can be easily done using Jasc Inc.'s Animation shop

If the animations are slightly complex, it is better to go for professional tools like Macromedia Flash.

If you want to do animation by programming, then you may have to depend on multimedia authoring packages like Macromedia Director and Author ware.

Talking about the fate of 2D in movie industry, we notice that traditional 2D animations are giving way to computer generated 3D animations. If you look at a list of all the animated feature films produced in Hollywood, this trend is evident.

Table 27:Tools for 2D animation

Product	Company	Website
Flash MX	Macromedia	http://www.macromedia.com
US Animation	Toon Boom Technologies	http://www.toonboom.com
RETAS	Celsys	http://www.retas.com
Toonz	Digital video	http://www.divideo.it
Animation shop	Jasc Inc	http://www.jasc.com

First, there were traditional hand-drawn 2D films; and then, there was a transitional period, in which 2D and 3D co-existed and now, we are almost in the third stage – wherein, 3D animations have captured the mantle.

To give you some idea about what sort of tools are available in the market for 2D animation, we've provided a

table. This is just indicative – not exhaustive. Also, professional photo editing tools like Corel Photo paint are capable of editing animations – apart from still images.

The scope of this book limits us from discussing 2D animations any further. In the chapters that follow, we will be looking at Macromedia Flash and how to produce basic animations with that great tool.

16.11.2 Three-dimensional animation software

3D animation is a lucrative field that came into existence only after the intervention of computers in the animation industry.

It's then not very surprising to find a much more variety of tools available in the market, for generating 3D effects and animations. There are specialized packages for modelling, rendering and even for painting over 3D models!!

A brief listing of some of the tools I am aware of is provided below for your reference.

Table 28: Tools for 3D modelling and animations

Product	Company	Website
Maya	Alias systems	http://aliaswavefront.com
SoftImage	Avid Technology Inc	http://www.softimage.com
Light wave 3D	Newtek Inc	http://www.newtek.com
3D Studio Max	Discreet	http://www.discreet.com
Houdini	Side effects software	http://www.sidefx.com
True space	Caligari Corporation	http://www.caligari.com
Bryce	Corel Corporation	http://www.corel.com
Cool 3D	Ulead	http://www.ulead.com
Deep Paint 3D	Right Hemisphere	http://www.deeppaint.com
Poser	Curious labs	http://www.curiouslabs.com
Photo realistic	Render man	Pixar http://www.pixar.com
Rhino 3D	Robert McNeil & associates	http://www.rhino3d.com

Once again, the scope of this book and the chapter limits us from detailed discussions on the concept of 3D. There is one dedicated chapter on 3D software later in this part – which will introduce you to many basic concepts.

However, you should remember that 3D animation technology is an ocean by itself! Once you are into it, there is no way out!

Its fascinating swirls and depths will absorb you for the rest of your life!

16.12 Summary

Animations are artificial movements created by flipping a series of images at specific speeds. The need for animation as a media arises mainly because of the limitations of conventional videography. Computer generated animations can animate even those things that do not exist – in a virtual world.

Animations can be classified as 2D and 3D animations, cel and object animations, programmed and compiled animations and so on. Two-dimensional animations are developed on 2D planes and three dimensional animations are developed on 3D virtual worlds.

Many software tools are available in the market – for developing 2D and 3D animations. The number of tools available in the 3D category is much more that for 2D.

16.13 Keywords

❏ **Cel or frame animation:** Animation sequence produced by displaying different Frames of movements, one after another, rapidly.

❏ **Object animation:** Animation sequence produced by, movement of an object over a general picture that's maintained as a backdrop.

❏ **Two-dimensional animations:** Animation sequence created in two-dimensional planes.

❏ **Three-dimensional animations:** Animations created in three-dimensional environments.

Chapter 17

Developing Animations for Multimedia Projects

CHAPTER OVERVIEW

This second chapter on multimedia animation technology provides a very reliable grounding for all enthusiastic and budding 'would be' animators, to really put their hands on to the very heart of core animation techniques and tools.

Fundamental concepts have been carefully discussed so that they are not limited to specific animation package, but applicable to most industry recognized professional animation environments. Some expert advice, programming tips and decision issues on choosing between two-dimensional and three-dimensional software have been pepped along the way.

17.1 Introduction

Our previous chapter was an introduction to this interesting world of animations – we understood some basic terminologies like 2D and 3D and wetted our hands with different kinds of animations.

In the current chapter, we will be getting down to more serious business and start discussing what are all the different stages of planning and execution – in developing an animation sequence for a project. These different steps detailed may not be followed word-by-word – but an understating of the overall workflow is required for any budding animator.

An important question to be answered, as a part of the planning process: Should we go for 2D animation... or 3D?

17.2 Animation process workflow

Professional animation development is a sequential and well-defined process.

In some cases, a step or two may overlap or be neglected altogether, but the general workflow is almost consistent between different development environments. The process we have detailed here is flexible enough to accommodate even very large animation projects like 3D movies.

We will address the topic in three different phases, for the sake of convenience.

❏　The first phase, which is the planning stage for the animation sequence to be developed

❏　The second phase, wherein we make a choice between 2D and 3D

❏　The third phase, which is the execution phase – wherein the animation sequence is developed using relevant software tools

Look at the project flow diagram provided – and do not be disheartened by the complexity of the diagram! As we proceed from stage to stage, you will realize why we need such a streamlined flow of work. Teams, which do not bother to do proper planning and desperately begin their work in great urgency – are brutally punished by rework, as things mature! Remember that animation is world of imagination and what is in your mind may be strikingly different from what the team leader expects in the sequence!

For the sake of simplicity, we take up a single example as our illustration, throughout the proceedings. And it is this:

We are in the process of developing a multimedia animation for an edutainment title on chemistry. A simple chemical reaction viz. the formation of water compound from hydrogen and oxygen – needs to be illustrated by means an animation sequence.

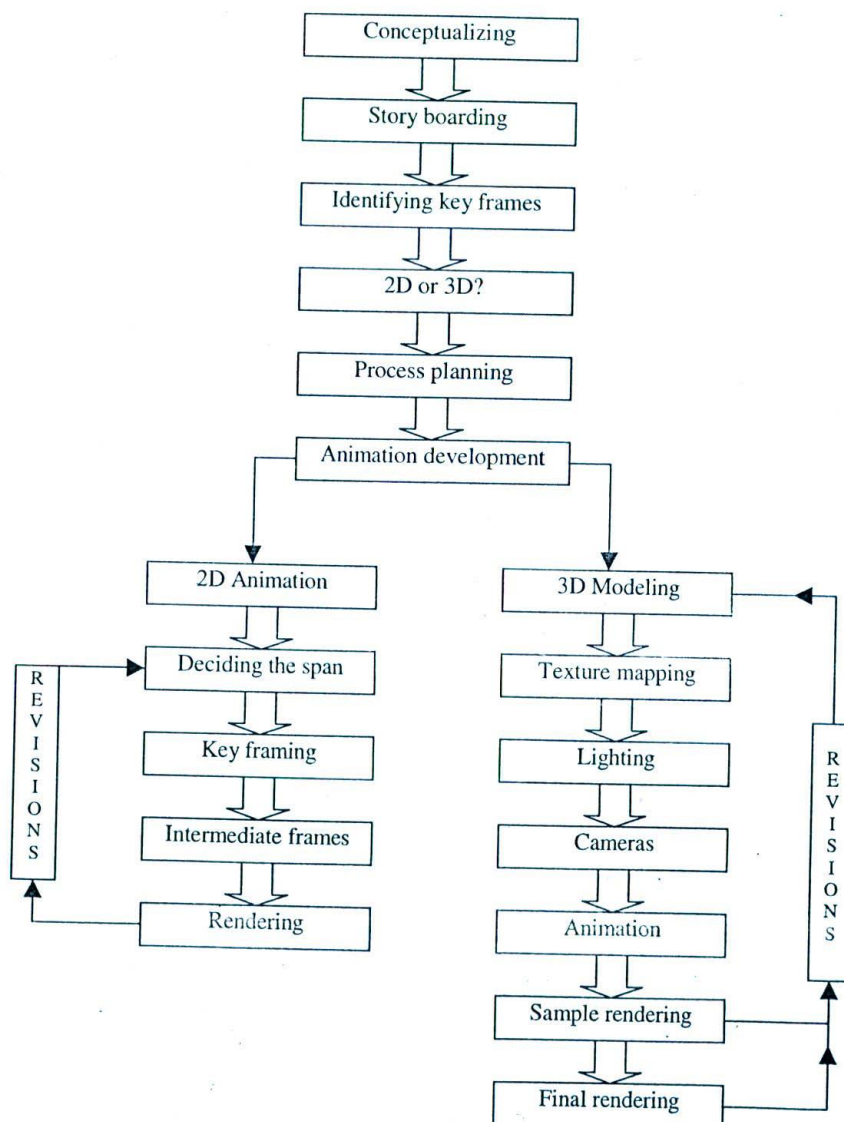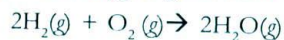Hydrogen and oxygen gases react in the ration 2:1, to produce water.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Figure 137: Animation development – process workflow

17.3 Conceptualizing

The given scenario, which has to be expressed as an animation sequence, has to be first conceived as an animation concept. By animation concept, we mean an approximate imagination of the actual animation sequence that's going to be developed.

All sorts of wild and strange imaginations cannot be translated into animations! Also, if you are working as a team, each team member will have their own imagination about the sequence!

The process of conceptualising is to put down all ideas in paper and to decide upon those themes that seem to satisfy the requirements of the project. Typically it begins with a brainstorming session with the team involved and the project manager should be the one to decide what should go into the concept.

For smaller projects, this session may well happen within the minds of the animators before the work is actually begun.

Talking about major animation projects like 3D films, this process of conceptualising is much more complex – since strategies and themes have to be evolved, both for the overall picture under production as well as the individual sequences that make up the movie.

Since we have kept our sample scenario pretty simple, we can easily evolve the animation concept as follows:

'Oxygen and hydrogen elements will be represented in the form of circles /spheres. Two hydrogen elements from each direction cross oxygen and get attracted to it as the cross. May be the attraction can be represented by love hearts. They come together and result in water.'

Note that we are trying to add some amount of creativity and drama so that even a chemical reaction looks vibrant – when animated! You will understand this better, as we go along.

17.4 Story boarding

Story boarding is a simple and yet, intuitive technique - which, when put to proper use - will result in increased productivity and shortened development time.

It is the process of visualising all the important shots (or 'frames') in an animation sequence and putting them down as rough sketches on paper.

Thinking about our sample scenario, we know that we have to illustrate the important happenings like

❑　　　　How oxygen element needs to be displayed?

❑　　　　How hydrogen elements approach oxygen?

❑　　　　How they combine together?
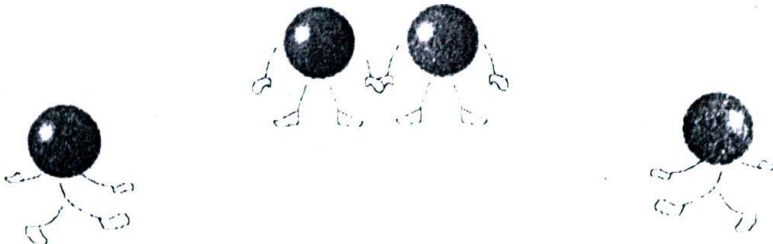
❑　　　　What is the resulting compound?

Figure 138: Imaginations can be different – but this is how we perceive the sample scenario.

Now, our storyboard will decide which element has to come first and from where, which element comes next and how they all combine and form the compound.

For the sequence at hand, we will dramatize the situation as follows:

❑   The beginning shot in which the Oxygen element waits in the centre – not knowing what to do

❑   One hydrogen element makes an entry from the left hand side and moves across the screen with small jumps – oxygen looks at it

❑   Another hydrogen element enters from the right hand side – oxygen looks at it as well

❑   ˙ Both hydrogen elements stop slightly after crossing oxygen

❑   "Love" waves

❑   Hydrogen mixes with oxygen

❑   Water!

Along with this, we may also have to think about other details like background colour system, camera angles etc. and try to note them down on the storyboard paper. These details will help the animators understand our overall expectations from the sequence – better.

Once the storyboard is ready, multimedia animation sequence is all set to progress to the next ·stage!

17.5 Identifying key frames

Key frames in an animation sequence can be defined as those important frames in which the movements of objects mature from one stage to another.

Identification of key frames helps animators to proceed with the sequence development in a very methodical manner. It also enables smoother integration of various parts of an animation sequence.

The animated portions in between the key frames are called 'slots'. These slots can be of varying lengths, depending upon the movements of the objects under animation.

Certain animation tools provide the flexibility of automating the movements within the slots. For example, in Macromedia Flash, you can specify an object's starting point in the first key frame and its end point in another key frame and the movements in between these two frames will be automatically generated by Flash.

In our example, some of the key frames will be...

❑   The frame in which oxygen waits for the hydrogen elements

❑   Entry point of first hydrogen element

❑   Different movement points of this element (may be many key frames)

❑   Entry point of second hydrogen element

❑   Different movement points of this element

❑   Stopping and looking at oxygen

❑   Combining with oxygen

❑   Water formation etc.

17.6   Decision between two dimensional and three dimensional animations

After deciding upon the key frames, we are stuck with a rather serious question: Are we to develop this sequence as a 2D or 3D animation?

We need to consider the following points, before deciding our choice.

· 17.6.1 3D may sometimes be a simpler option!

On the outset, 2D animations seem to be relatively simple and 3D, all complex.

Unfortunately, this is not entirely true.

There are many situations wherein, the required 3D models (i.e. three dimensional wire-frame structures) are readily available or can be developed easily. In such cases, it may be much easier to develop the animation sequence in 3D instead of 2D.

For example, if you want a ball or box or any other regular geometric shapes to be animated, then it is lot easier to work with 3D than 2D. By applying techniques like texture mapping, that are peculiar to 3D environments, striking results can be obtained with ease.

Thousands of ready-made 3D wire frame models are available on the market and the web. And most 3D software tools also pre-package a wide variety for models within their core distribution package. For example, Newtek's Light wave 3D ships with hundreds of ready-to-use wire frame models that can be used in a wide variety of scenarios.
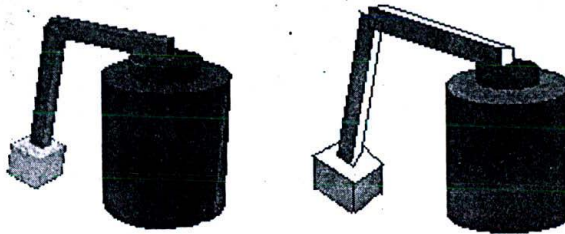
Figure 139: Look at these objects. The one on the left is 3D and the other is 2D. I took more time to draw the 2D model than develop the 3D; and if I were to animate the lever above cylinder, 3D may take a lot less time than 2D!

17.6.2 Character animation is a complex business in 3D!

It's rather difficult to model and animate live characters like human and animals and plants in 3D environments, as compared to 2D.
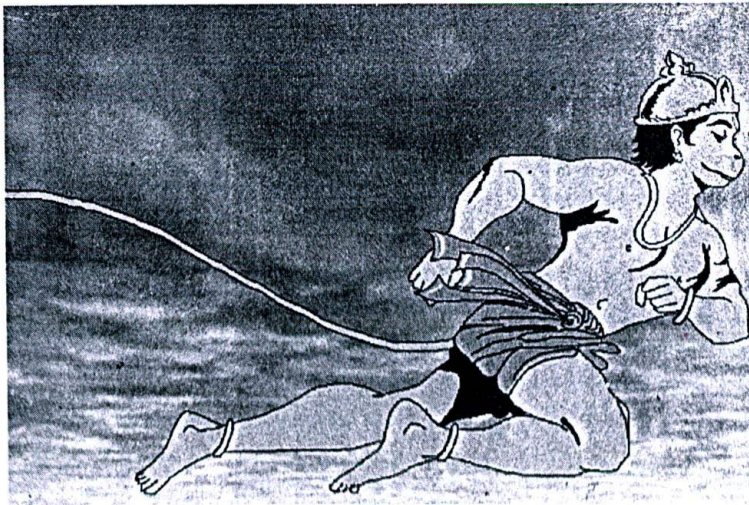

Figure 140: 2D character 'Hanuman' looks pretty dynamic in 'Tales from Indian Mythology' project CD-ROM, published by cybervalley systems.

Even 2D character animations are difficult - but can reasonably manage to bring out acceptable results with experienced animators on the job.

17.6.3 3D effects with 2D tools

Sometimes, the desired 3D effect can be achieved with the help of few intelligent digital brush strokes, within the 2D animation or painting tool! For example, the characteristics shades of light behaviour over the object can be brought out over 2D objects with advanced painting tools.
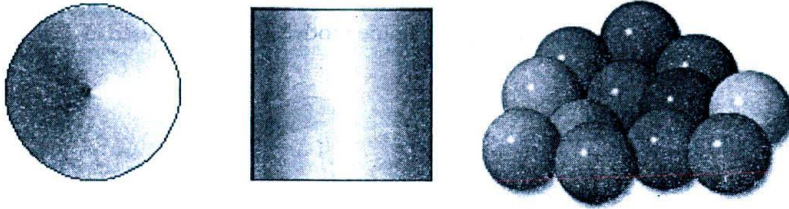

Figure 141: Digital painting tools enable creation of 3D.objects to some extent.
The group of balls on the extreme right was created using paint shop pro's picture tubes.

In such cases, instead of going 3D, we can consider 2D with advanced painting options. On the flip side, this may demand experienced animators and their patient effort.

17.6.4 Consider the relevance of the situation

Creating certain kinds of animations is simply not possible in 2D.

For example, consider an architectural walkthrough animation in which the entire building has to be animated in different angles. It is rather impossible to think of 2D for such cases.
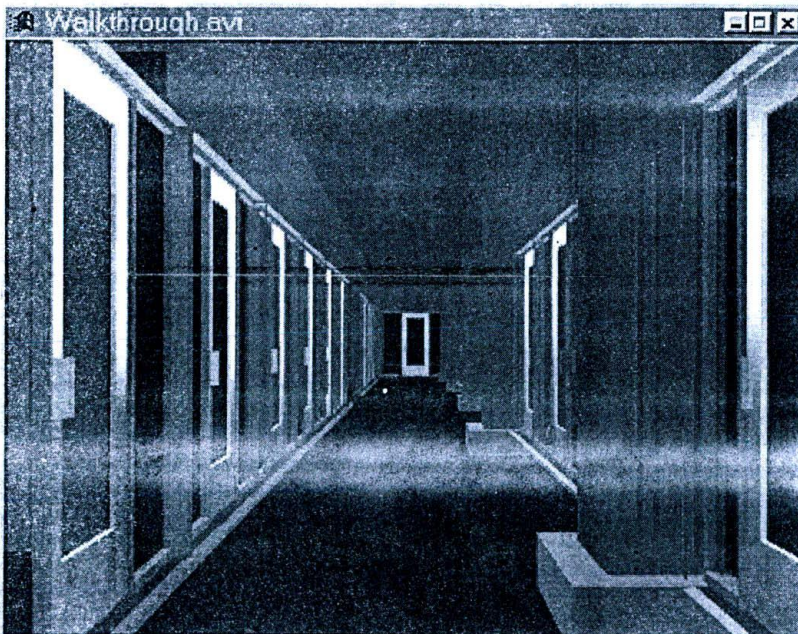
Figure 142: Building walkthroughs like this can be done only with the help of 3D tools

17.7 Process planning

In case extensive animations are involved in a particular project, it's important to plan the entire animation development process.

In typical multimedia projects, critical paths (i.e. those activities, which, when delayed – will result in the total delay of the very project) are recognised well before the production of the title - because of the complexity involved in making various kinds of media ready, and integrating them into meaningful forms.

17.8 Animation development

When we reach this state, it means we have gone through the pain of proper planning procedures and are all set to take the graphic tablet on our laps and really 'start doing something'. The process of developing 2D and 3D animations are so different from each other, that they necessitate different treatments.

17.9 2D Animation development

❏ First, decide the total number of frames to be engaged for the particular animation sequence. This is what is called the span of the animation. The more the number of frames, the better - because, with gradual transition, the movements of the objects tend to be natural and smooth. On the flip side, this also means that we have to develop more number of frames!

❏ Tools like Flash provide flexibility to the users, to increase or decrease the number of frames between the key frames. However, it is better to plan as much as possible in the beginning rather than doing alterations during development. A proper projection on the number of frames required for a given sequence comes only with experience!

❏ It is better to plan for lengthier animations and then reduce the frames as we go along.

❏ Since we have already identified which are all the important key frames in which critical transitions are going to occur, we need to divide the span across the key frames. For example, if we are planning an animation with a span of 70 frames and if we have 7 key frames – then we may plan to distribute 10 frames between each key frame.

❏ The movement of the object(s) between two key frames dictate the number of frames to be inserted between them. If the movements are long, more frames are to be allocated in-between key frames.

❏ Develop the key frames. For the very first key frame, you may have to draw the objects to be animated or import them from files. But for subsequent key frames, it is enough if you show the relative movement of the object with respect to the present.

❏ First key frame development involves drawing the actual figures over the frame, using one or more drawing tools available with the environment. Sometimes, it may be felt that the drawing tools supported by the animation environment are simply not enough...in such cases, the frames have to be stored as individual bitmaps and manipulated using any of the advanced image editing software - till the desired results are obtained. This is a cumbersome process.

❏ In professional animation studios, it is customary to leave the key frames to be developed by experienced animators and leave the frames in-between to budding professionals.

❏ Once the key frames are done, the frames in-between can either be automatically generated or hand drawn using relevant tools. The nature of transformation or movement determines the choice.
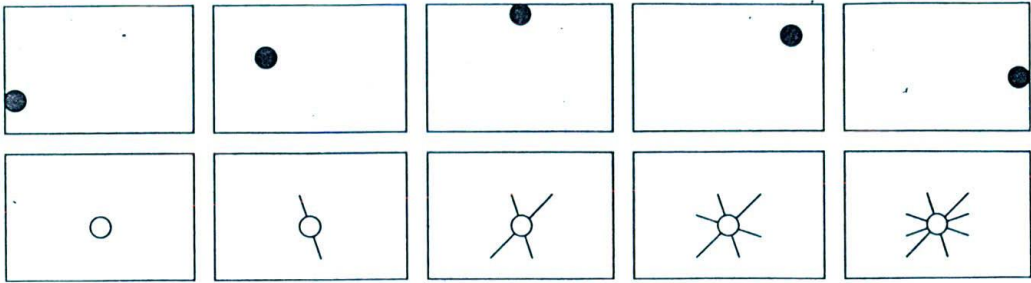
Figure 143: Two types of simple animations are provided as examples here. Which one, do you think – can accommodate automatic generation of frames in between key frames? And for which one, should we draw all the frames in-between key frames?

❏   Tools like Macromedia Flash have extensive capabilities for transforming objects across the frames, provided the objects are vectors.

❏   The speed at which the transformation between key frames occur, determines the number of frames. This speed can be easily controlled in tools like Flash. We will be seeing some of these capabilities in the next chapter – so, don't worry much about Flash for the moment.

❏   Once the frames are completed, they can be played back using the playback feature.

❏   When all the slots in between the animation have been completed, then they have to be linked and rendered together.

❏   At this stage, you may have to go back to some of the previous key frames and do the required editing – so that the overall animation looks like one seamless flow of movements instead of a chain of animations linked together!

❏   The final stage of animation development process is to plug-in the animation thus developed into the project slot. We need to ensure that the animation developed integrates well with the project and serves the purpose. If you have gone through the pain of proper planning which was detailed elaborately in the earlier pages – you will have little to change at this stage!

❏   There are two ways of plugging in the animation into the project slot – they are linking and embedding.

❏   Linking is the process of maintaining the animation file outside the multimedia core program and making relevant calls to the animation media file for playback - whenever required. This is the most preferred means of plugging-in animations into the project. The only flip side is that the animations can be seen by the users outside the program and may even be copied and reused!!

❏   Embedding is - 'literally' - the process of bundling the animation as a part of core multimedia project file. Professional multimedia authoring programs have something called resources – and once you specify all the sounds, videos and animations as resources, they automatically manage them and make them available to the executable program during runtime.

So THAT was two-dimensional animation!

In the next chapter, we will be looking at Macromedia Flash very deeply, which will help you to translate all these ideas to real-time action!

17.10 3D animation development

When it comes to 3D, the development process is almost completely different from 2D! And much more exciting too...

This process consists of several steps, which are sequentially detailed below.

17.10.1 Modelling

Modelling is the very first step in 3D animation development.

Models are wire frames that represent certain 3D shapes in the virtual world. Even simple objects like spheres and cylinders look pretty scary as 3D wire frames.
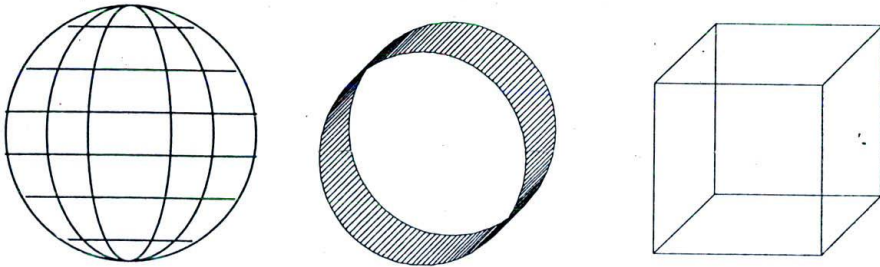
Figure 144: Even simple objects do not look that simple, when you look at their 3D wire frame models! Each model is made up of a number of lines and curves.

The reason is that 3D wire frame models are actually mathematical curves, which construct the 3D models in a virtual 3D space. Models of objects like plants, animals, mountains and landscapes are made up of much more complicated curves and are scarier than spheres - to look at.

Since simple mathematical curves cannot define such complex contours, 3D software programs make use of curve equations called splines. When several splines are put together in a three-dimensional co-ordinate system, complex surfaces can be created.

There are several varieties of splines in use – these include linear spines, cardinal spines, bezier spines and b-spines. One of the most complex objects to model viz. the human face - is defined using a special breed of splines called Non-uniform rational B splines (or NURBS!). When you are buying new 3D software programs for yourself or for your company, you should ensure that the software supports NURBS.

All the objects required for the animation sequence have to be modelled – either using the tools that come bundled with the 3D software or using specialized modelling tools. All basic geometric shapes like sphere, cylinder, box, tarsus and cone can be readily generated to required sizes - with most 3D tools. Some tools also support Boolean operations like add and subtract – with the help of which, two or more geometric shapes can be combined together and new shapes can be evolved.

For very complex models (like dragons!) 3D modellers resort to 3D laser probes, which, by making use of laser sensors arranged in all the 3 axes, capture the 3 dimensional data that make up the object. However, for this method to work, a physical model of the object needs to be created (in wood or plaster-of-paris) – over which the 3D probe can pass through!

Considering all these troubles, it is worthwhile to look at the 3D models and model libraries that are available in the market. Type "3D model libraries" in www.google.com and look out for the appropriate companies that sell the model you are looking for. To my knowledge, the digimation collection (http://www.digimation.com) is well worth a visit.

It is rather astonishing and even humiliating to realize that the creatures of Jurassic age that terrorized the explorers and movie fans alike – as actually complex mathematical equations!
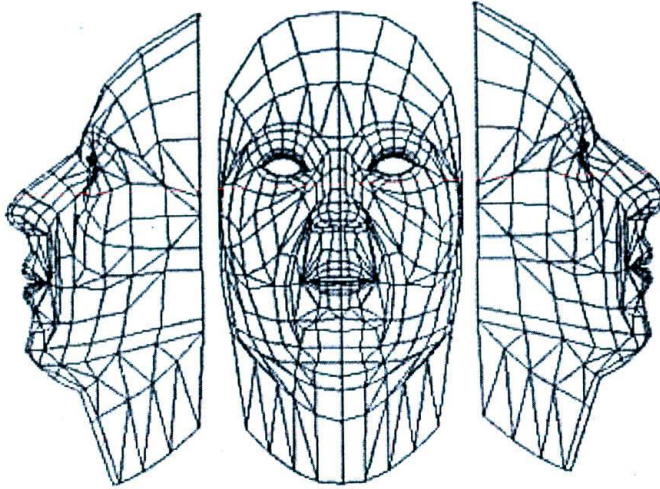
Figure 145: NURBS modelling is used to define the complex contour of a human face!

Modelling is the most important step in 3D animation sequence development.

17.10.2 Materials and texture mapping

Professional 3D software allows different kinds of material attributes to be applied to 3D wire frames. For example, one can 'apply' gold's properties to a model, so that it behaves like a gold, during rendering. Explicit characteristics of gold like shininess, reflectivity and refractivity, can be controlled so that when lights fall on the model, they behave accordingly. This gives a more realistic and natural look to the models, when rendered.

Texture mapping is even more interesting: It is the process of wrapping 3D wire frame models with 'textures' – which are nothing but 2D bitmaps. For example, the texture of, say mosaic, can be wrapped over a 3D floor in a virtual house – so that it looks very natural! Some 3D software allows even 3D projections or 'bumps' to be present over the wire frames, so that the looks are even more astonishing!
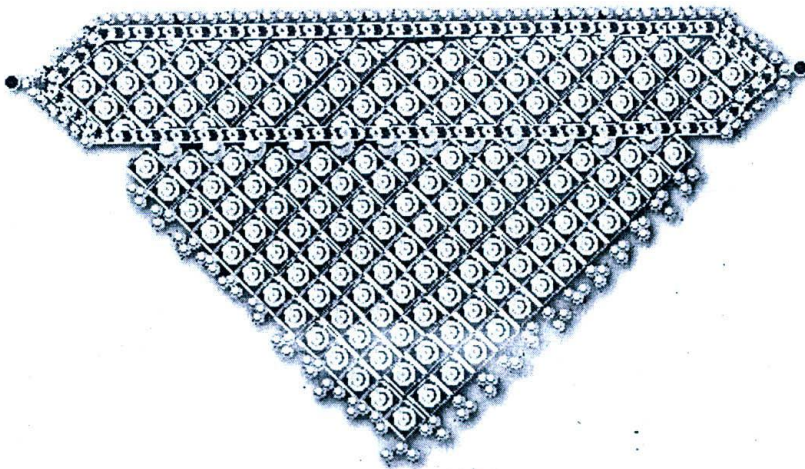
Figure 146: For a jewellery design project, I crafted this choker almost entirely with 3D!
In full colour rendering, it is indistinguishable from a photograph – thanks to materials!

Figure 147: This was one of the surrealistic environments created for the CD-ROM "Tales from Indian Mythology". Look at the bumps visible on the floor and on the rocks.

17.10.3 Lighting

Once we have modelled the required wire frames and applied material and texture over them, we need to 'illuminate' our world with proper lights!

As you begin working on a project, there is a default lighting mode that is already available – but this will illuminate all objects with even lighting. You can override this behaviour by adding spotlights, ambient lights and other kinds of lights - within the 3D universe.

The luminescence, colour and various other characteristics of light, are controllable. There can be more than one light, in any scene. And with some advanced software, the light intensities can even be of negative value, so that they actually 'absorb' light that is already present!
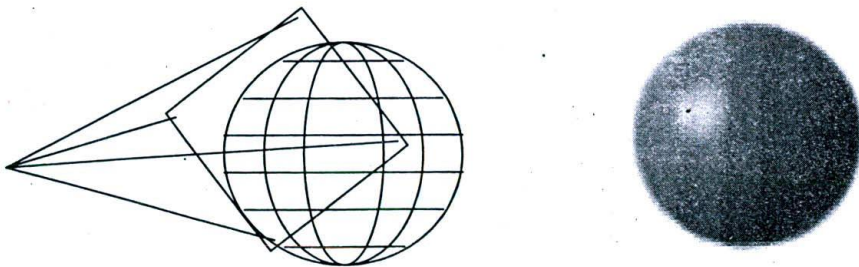
Figure 148: Application of light over the sphere in a virtual 3D world – and its ultimate behaviour during rendering.

Your lighting arrangement and the reflectivity /shininess of the material you are using, will ultimately determine the look and feel of the 3D objects – during rendering.

17.10.4 Cameras

Cameras, in a 3D environment are used to 'view' the objects that are placed in the 3D world. You can also view the objects without cameras – but you may not have much flexibility in viewing. Moreover, if you are going to move around the object and see different portions, then cameras become inevitable.

Note: Please understand that the camera movements are different from the object movements. For example, when a 3D ball is animated from one end to another, then that is the movement of the object. You may either stand still and watch this movement or move along in certain other direction! This movement of your viewpoint is what is called the camera movement. I have tried to give an example to illustrate this idea – but the best place to know the better is a professional 3D tool!
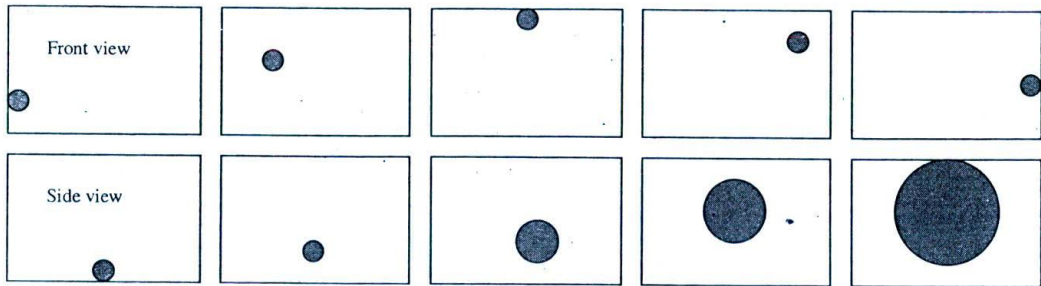

Figure 149: The front view and the side view illustrated.

Look at the example. In the first case (front view), you are a mere observer, just observing the ball going from one end to the other. In the second case (side view), you are standing right in front of the ball and the ball is actually coming towards you! These two examples illustrate two different viewpoints a camera can take – while observing the object movements. If you want you can also move the camera you are holding on your hand – and traverse along with the ball.

Cameras can be used to 'walk through' a 3D model of the building, to generate an illusion that the viewer is actually taking a walk inside the building – room by room!

When an object has to be viewed at several angles, one can make use of the cameras. Instead of rotating the object, it's much easier to rotate the camera at desired angles and take 'snapshots'.

Cameras, like lights, do possess several attributes like the field of view and focus that decide the ultimate behaviour of the camera. There can be more than one camera, in any given scene.
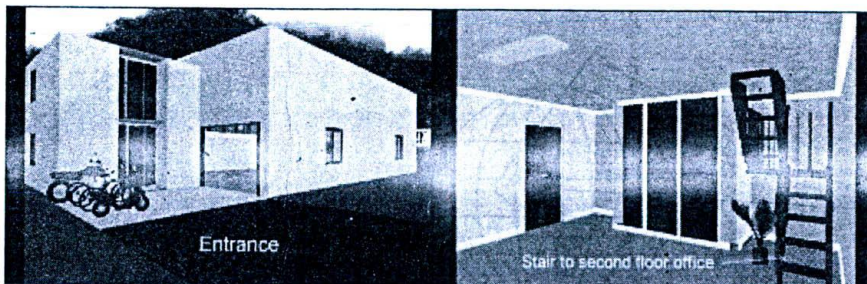

Figure 150: These two shots illustrate two different sequences from an architectural walk through done by 3D experts at cybervalley systems. A singe camera was allowed to wander all along the corridors of a virtual factory that was going to be built by the clients.

17.10.5 Key framing and animation

One of the significant advantages of 3D software is their ability to generate frames in-between key frames automatically. Once the key frames are defined in the timeline, the software automatically generates the intervening movements. .

To give even more flexibility in movement of objects, 3D software allow the models to traverse along a trajectory or 'path' – during animation. For example, in the throw ball animation we illustrated earlier, it is possible to define a path for the movement of the ball and allow the object to traverse along that path – for the required amount of time.
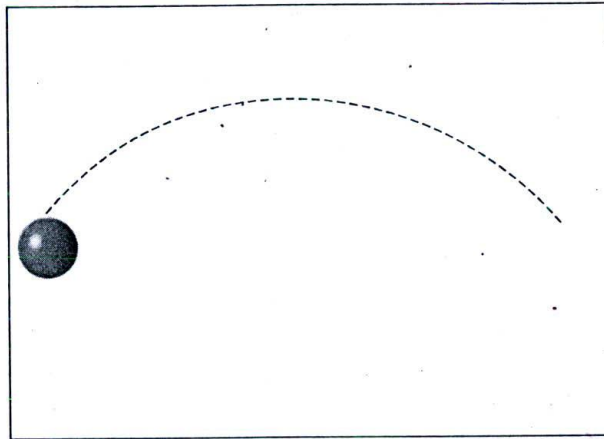
Figure 151: 3D models can follow a 'path' or trajectory, while moving in the virtual 3D world.

This path need not be just a simple curve – it can be any spline that can be defined on a 3D space! This gives immense flexibility to the animators to make the models traverse the way they want. One of the initial movements to be tried is spiral – it is wonderful even to see a simple object like ball rolling along a spiral curve with smooth flow!

Many 3D software tools have advanced motion control capabilities like inverse kinematics and bi-pedalling, with the help of which, it is possible to generate realistic walking and even dance movements. For example, inverse kinematics allows you to 'connect' various polygons- say, the limbs of a man; when the developer 'pulls' the hand, the rest of the body responds naturally, so that he need not bother about animation each and every part of the model!

For more complex movements, it is also possible to capture the movements of a live human using electronic circuitry and apply the same over a 3D model. This technique is frequently used in many feature films and is called 'motion capture'.

17.10.6 Rendering

Rendering is the last and final step to be completed, before we can actually see the wonderful movements we created . in 3D environments. It is the process of applying lights, materials, textures, camera and animations to the given 3D scene - frame by frame - and capturing the output as individual images.

During rendering, all the relevant colours and shades are applied over the model – based on our lighting, texture arrangement and other necessary details. Internally, these are nothing but mathematical calculations. Since all these computations need to be done frame-by-frame, rendering process takes considerable time to complete.

The time required for rendering a particular sequence is governed by factors like

❑   Complexity of the scene (textures, lighting etc)

❑   Computational power of the machine(s)

❑   Resources available (RAM etc.)

For this reasons, it is best to start the rendering process (after sufficient back up and UPS arrangements) at nights and leave the system open for computations over the night. To save power, you can just switch off the monitors.
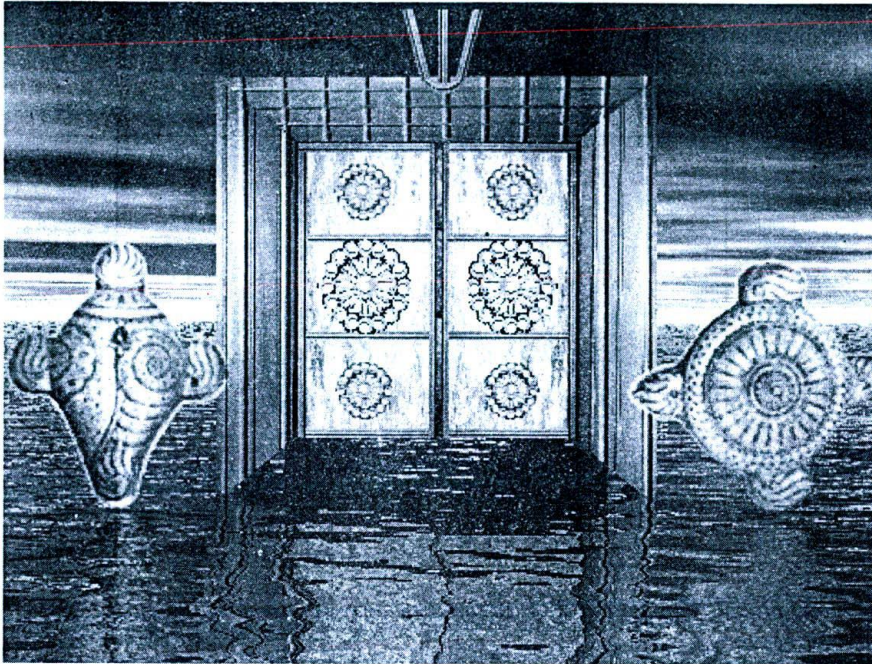
Figure 152: For rendering this scene titled 'Vaikuntha' for 'Tales from Indian Mythology' CD-ROM, we spent nearly 3 hours for each frame on a Pentium 1GHz machine with very decent RAM and swap space! The results speak for themselves.

In highly complex projects like 3D animations for movies, rendering becomes increasingly complex and we may have to go for network rendering! Network rendering is the process of rendering a single 3D sequence in a network of computers – in which each frame can be rendered in a different machine. The software co-ordinates rendering tasks across the machines – based on their capacity and availability.

Network rendering is supported by most professional 3D software today.

Note: It is said that – for rendering the sequences of movie 'Titanic', roughly 120 Linux servers were networked on a huge framework – often called the 'network farm' or render farm!

There are several algorithms available for rendering – like gouraud shading, phong shading and ray-tracing. Ray tracing offers good results but it is also the most time consuming, among the three. Hence 3D tools make use of phong shading for previews and ray-tracing for final rendering process. If you are buying a 3D package for yourself or for your school/college, make sure that it supports ray tracing!

Radiosity is an advanced form of rendering which can produce stunningly realistic images. But the concept and algorithm are pretty complex to understand and not many tools in the market, can boast about this capability.
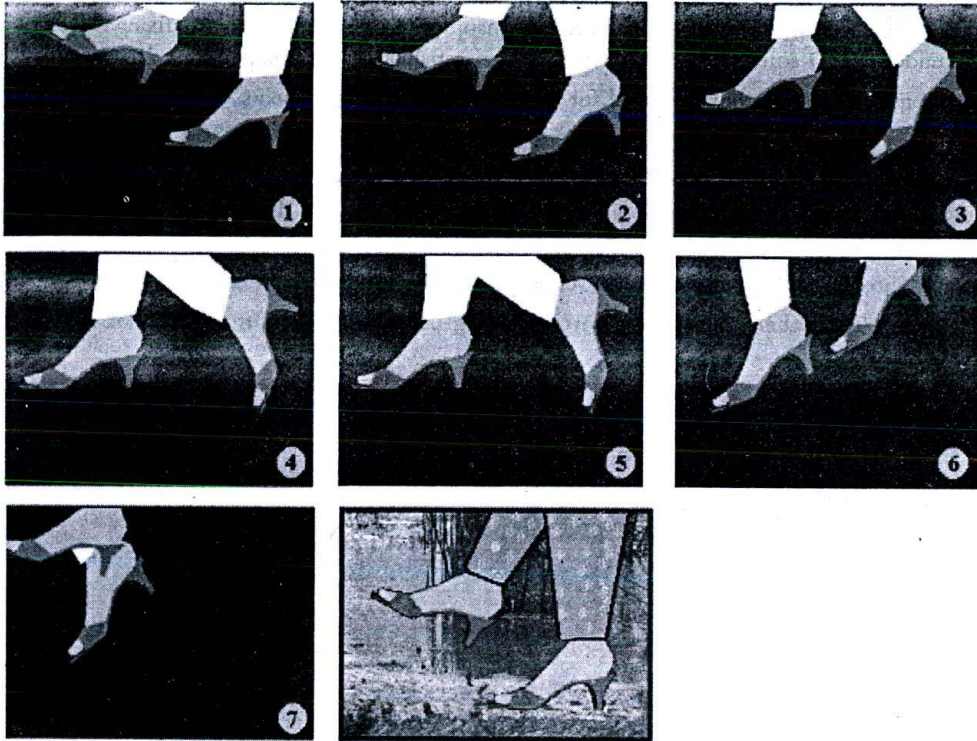
17.11 Cyclic animations

Cyclic animation is a very simple animation technique, capable of producing stunning results.

In a cyclic animation, the frames are looped - so that, after the last frame, the first frame follows once again and the process continues till the user deliberately stops it.

The serious limitation of cyclic animation is that it cannot be applied to all the sequences and can be adapted only to those object movements, which are repetitive in nature. For example, let us consider that the required animation sequence is that a girl is walking down the lane. Now, her leg movements, after all, are repetitive in nature - as far as the animator is concerned...so, he just limits himself to seven frames of animation, and still manages to make her walk, over and over again!

Figure 153: Cyclic animations can be used for movements that are repetitive in nature.

Look at the example. All the seven frames required for the animation have been displayed. Note that the last frame of the sequence has carefully been designed, so as to blend seamlessly with the first frame, which will follow - when looped.

The playback speed for this particular animation is 8 frames per second.

Pretty good 'cat walk'...isn't it?

Certain other scenarios in which cyclic animations can be put to use:

❑ Movement of fire flames

❑ Movement of birds

❑ Movement of clouds etc

❑ Character movements like walking and running

❑ Eye lid movements

17.12 Summary

Animation development is a seamless workflow that has definite number of steps – right from planning to execution. Planning phase includes conceptualising, story boarding, key frame identification, 2D / 3D decision-making and process planning. Execution phase includes 2D or 3D animation development and linking / embedding.

2D animation development process is almost completely different from 3D animation. For 2D, we need to fix up the total span of animation, define the key frames and develop them, fill the in-between frames with appropriate movements – either automatically or manually and finally render the animation.

For 3D, one needs to do modelling, material and texture mapping, lighting, camera setting, fixing key frames, animating and finally rendering. 3D software tools posses advanced capabilities – as compared to 2D packages.

Cyclic animation is a simple technique useful for animating repetitive movements.

17.13 Keywords .

Story boarding: The concept of visualising the animation sequence to be developed - as a series of frames, and exhibiting the same, roughly in paper.

Key framing: Those frames in which, the movements of objects mature from one stage to another.

Texture mapping The technique of applying (or wrapping) 2D images (called maps) over 3D wire frame models.