Akanksha |16U130014 | Under the guidance of Prof. Phani Tetali

An Informative Summary -

Timing for Animation

A book by Harold Whitaker and John Halas, Updated by Tom Sito
(Second edition, 2009)

Abstract

As animation is time consuming and requires immense efforts, it is uneconomic to edit out motions later. The behaviour of an object and the effect of weight seen on the screen, relies exclusively on the spacing between the drawings and not the drawing itself. Therefore, the director is required to perfectly plan and time the animationand notdepend on the quality of thedrawings in their static sense.

"Movement is, in effect, a signal to attract attention."

For good 'readability ' of animation there should be enough time for preparing the audience for an action rather than the time of the action itself. When creating moods like frantic chase or melodious romance, one needs to remember that all the timing calculations must be based on a constant frame rate. One can draw a circle, the audience will understand whether it is a cannon ball or a soap bubble only when the timing for its animation says so.

In animation, a movement is a set of drawings that have neither weight nor any forces acting on them; hence it necessitates the backing of Newton's Laws of Motion. An animation's success is defined on how well the animator answers the fundamental question: What will happen to this object when a force acts upon it? Cartoon as a medium exist by means of caricature, where proportions and motions are exaggerated.Therefore, a cartoon character is not expected to behave exactly like a human.

In this book, divided into 5 chapters, the author articulates the nature of movements taking into account the widely practiced rules for timing and the fundamental laws of physics. He further explains what do movements mean in terms of animations and good timing. He says, animation is a medium of exaggeration and further explains the use of timing to characterize the movement, give the feeling of weight, the impression of force and efforts. He also illustrates the ways to animate atmospheric effects, to enhance of mood of the animation. The meaning and importance of anticipation, follow through, overlap actions and other animation essentials is also brought to light.

"What we are doing on screen is in fact acting, except we use our drawn characters."

Often he uses the reference of live action film processes to undeline the benefits and drawbacks of animated films. He also describes the traditional methods as well as digital methods in the respective timing, planning, editing, etc. sections.

This paper illustrates the highlights of every topic and gives a detailed summary of the book 'Timing for animation' by Harold Whitaker and John Halas, Updated by Tom Sito (Second edition, 2009), with the images used from the book,

Keywords
Animation, Feature films, Traditional, Digital, 2-Dimensional, 3-Dimensional, Director.

Introduction

Animation is used widely, from recreation to education, from promotional to economical purposes, from short to full feature length films. Even live action films contain animation and interactive games and websites are no exceptions. And these different animations require to be approached differently. As animation is time consuming and requires immense efforts, it is uneconomic to edit out motions later. The director is required to perfectly plan and time the animation so that minimum time is spent in drawing the unnecessary.

1.1 General Principles of Timing

For good 'readability ' of animation, two factors need to be taken care of: 1. Good staging and layout and 2. Good timing. By which the author meant that there should be enough time for preparing the audience for an action rather than the time of the action itself. The audience's attention will wander if the timing is too slow or the audience might not catch it if insufficient time is given.

Since different audiences will react in different ways, films have to be timed differently. An entertainment film made for will be timed at a faster pace than an educational film for children.

1.1.1 Timing for Limited Animtion

Animation for TV is carefully planned with its economic value in mind. This approach being called 'limited animation' uses as many repeats and longer holds to reduce the effort in drawing. Generally, about 6 drawings or less are produced.

1.1.2 Timing for Full Animation

This type of animation requires a large number of drawings per second, sometimes all 24 frames. There are limitations neither on the time nor the capital and so this can be afforded only by TV advertisements and feature-length films.

1.1.3 Timing in General

The author says that it is dangerous to try and formulate time as something that works well in one situation or mood most probably may not in another situation.

What is Good Timing?

"Timing is the part of animation which gives *meaning* to movement."

One can draw a circle, the audience will understand whether it is a cannon ball or a soap bubble only when the timing for its animation says so.

1.2 The Storyboard

Major decisions concerning a film's content are taken while making the storyboard which then serves as a blueprint. Any creative problems that might arise during the film's production are to be considered during this stage itself.

Aa general rule, only after a satisfactory storyboard is achieved, any production is allowed to proceed.

1.2.1 Traditional Storyboards

Originally, in 1920s, artists pinned up their 'gag ideas' on cork board wall giving rise to a 'gag-man' or a 'storyboard artist'. These drawings were then photographed by a camera-person and fit to soundtrack by an editor. This process took several days and a rough video was created, called a workreel or an animatic or a storyreel or Leica reel.

1.2.2 Digital Storyboards

Computers became a part of animation since 1990s providing the storyboard artist, itself, the ability to create animatics. Though this unlocked new possibilities, it also increased the job of a storyboard artist. Many jobs, like that of quality control person who double checks the the frames for error or sequence, became unnecessary.

There are many digital software available which can be classified into two — 2D programs like Toon Boom and Flash and 3D programs like Maya.

1.2.3 Additional Storyboard Effects

While in the past, simple roughly drawn sketches would be enough to convey the story, now the storyartists habitually use temporary music, red boxes to indicate camera movements, etc.

Further practice of additional tricks is enabled by software like Adobe After Effects. For similar effects, the Walt Disney Studio had developed a complex apparatus called the 'multiple camera'.

1.3 Responsibility of the Director

The author divides the responsibilities into two, one for the director and other for the animator.

The overall planning and the pacing of the whole story depends on the director along with organising its sequences into scenes. The major difficulty that a director has to undergo is accommodating an action into the time available. As the production progresses, he should keep constant checks on how well the timing is followed.

The smallest units — individual drawings and frames — are entirely the animator's responsibility. An animator should also plan in detail the ways in which each action happens.

1.4 The Basic Unit of Time in Animation

For film and video animations, the basis of timing is considered to be 24 frames per second (fps) as a fixed projection speed. Although different projection speeds have been used in history, 24 fps is the standard rate for all film formats viz. 16 mm, 35 mm and 70 mm. But for television and video, the standard is 25 fps (PAL) or 30 fps (NTSC).

The basic unit of time is { 1/24 } sec, { 1/25 } sec or { 1/30 } sec depending on these formats. An animator is expected to learn the multiples of this unit — 3 frames, 8 frames, 12 frames, and so on.

When a drawing is drawn on each frame i.e. animating on singles, 24 drawings need to be done for each second. If the same is animated on twos, each second consists of 12 drawings. More on this in the subsequent chapter.

"The projector continues to hammer away at its constant projection rate."

When creating moods like frantic chase or melodious romance, one needs to remember that all the timing calculations must be based on a constant frame rate.

1.5 Timing for Television vs. Timing for Feature Films

When an animated film is to compete with a live-action blockbuster and audiences' ever-increasing cinematic expectations, no expense can be spared over its story and visuals.

Whereas animation for television (or the web or other smaller platforms) has many limitations over time and budget. Constraints over the production hours lead to alterations in their creative strategies. For instance, an increase in emphasis over dialogues since it is easier to create and recreate voiceovers than an animated action.

"The audience is more tolerant of the simplicity of its movement, rather than a very realistic design that does not seem to move enough."

1.6 Slugging

In television productions, it is essential to deliver the exact length required. For this, the script was read and recorded in a 'railroad style'.

After editing this soundtrack, the 'slugs' — time required for pauses were marked accordingly on the storyboard. This system was called 'slugging'. At the Walt Disney Studio these pauses were called 'the greys'.

1.7 Bar Sheets

After the called-for slugs have been timed into the soundtrack, it is followed by fine-tuning the director's timing instructions on bar sheets. Next step, the actions and exact scene lengths are decided. Then the usage of tracks, pans, mixes, etc are next after planning the pace of storytelling. These steps, also referred to as 'continuity' of the film, are marked on the bar sheets which then serve as the main reference when the final editing and assembly is done.

1.8.1 Timing for Traditional Animation: Exposure Charts or Exposure Sheets

After the timing notes are completed on the bar sheets, it is then split up scene-by-scene and transferred to printed 'dope sheets' also known as 'exposure sheets' or 'X sheets'. One important factor is to imagine how the effect will be on the audience who sees the film for the first time and only once.

The left column of these charts is used to indicate the animation timing set by the director, and the other columns are left for the animators to work out the number of drawings for each action.

People have their set of symbols and codes, but generally, an action is represented as a curved line while a hold is denoted by a horizontal line, repeating actions are signified by wavy lines and an anticipation is shown by means of loops. Actions like cutting a tree or a blast that need to happen at the exact time are marked with crosses on the required frames. Along with this, relevant information and instructions are also written out on the sheets.

When the director establishes the ideas in these sheets, he/she has already animated the whole film in their heads.

1.8.2 Timing for an Overseas Production

This case necessitates the details on the dope/ exposure sheets to be jotted more painstakingly precise and clear without any use of local phrases.

'Magician's arm anticipates back - 8 frames, thrusts into hat - 4 frames, hold - 12 frames, pull out rabbit - 6 frames, hold and react - 72 frames, etc.

The overseas artists are to be paid not for the quality of the output but its quantity. In case of additional poses, the director must suggest so in the exposure sheets.

1.8.3 Timing for a 2D Digital Production

A director can easily mark timings on the exposure sheets in a digital software using a stylus and tablet. This has also made possible to create extra columns or to make notes directly on the sketches.

1.8.4 Timing for a 3D Digital Production

For 3D animation software, most times the animator requires detailed storyreels with specific poses explained in person.

In digital softwares, the characters can be controlled by 'rigs'— in built bone structures, and the speed of each movement can be controlled by spacing bars or splines.

1.8.5 Timing for an Actor-Based Program (Performance or Motion Capture)

A recent and popular technique in animation is motion capture. With the use of special sensors mapped over an actor, the motions are visualised on a computer and recorded in real time.

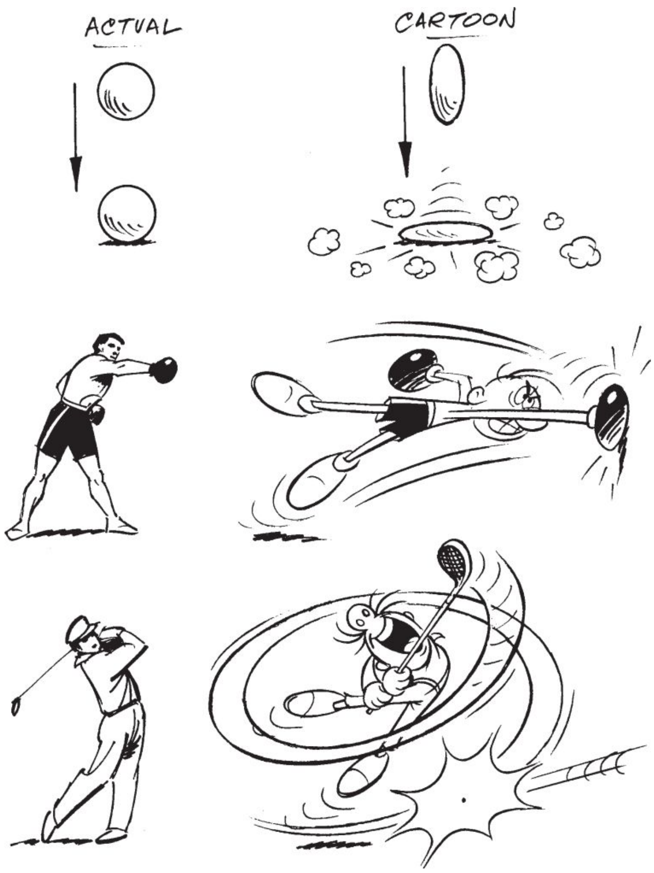
The camera angles and movements can be added later. Also, the animator must edit and flesh out futher to add the animation subtleties.

1.9 Animation and Properties of Matter

An animation's success is defined on how well the animator answers the fundamental question: What will happen to this object when a force acts upon it?

In nature, objects have their own weight, basic structure, degree of flexibility and they exhibit behaviour when a force affects it. In animation, a movement is a set of drawings that have neither weight nor any forces acting on them; hence it necessitates the backing of Newton's Laws of Motion (which we shall examine distinctly in the following chapter).

The timing of a motion in an animated scene can be divided into: i. The timing of inanimate objects,
ii. The timing of the movement of a living character. The prior requires consideration of fundamental straightforward dynamics while the latter requires, in addition, the timing for mental operations and realisations for him to act alive on screen.



2.1 Movement and Caricature

Cartoon as a medium exist by means of caricature, where proportions and motions are exaggerated. Here, the subjects are to be considered as caricatured matter upon which caricatured forces act. Just like natural matter, caricatured matters should exhibit the same properties but in simply surplus levels.

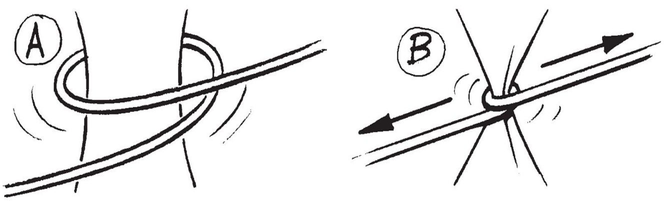
"The facial expression must be emphasized with adequate exaggeration, particularly of the eyes and mouth."

The main job of the animator is to synthesize the natural motions and timings with the exact amount of exaggeration to make it look cartoon but not unnatural.

2.2 Cause and Effect

When an object more or less flexible is acted upon by a force, a chain of cause and effect runs through it, which is the measure for a good movement in animation.

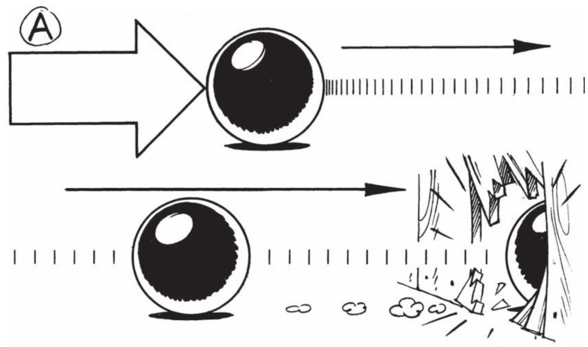
For instance, consider the cord wrapped around something being pulled tight. The two factors of the cause and effect chain are i. the strength of the pulling forces (intensity of the cause) and ii. The flexibility or rigidity of the object being squeezed (intensity of the effect). Exaggerate these intensities.

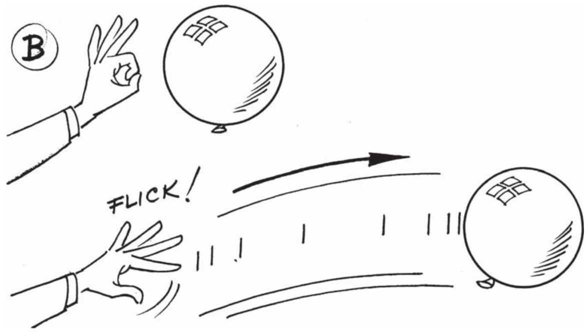


2.3 Newton's Laws of Motion

An object which is at rest shall remain so until a force moves it. And once it's moving it tends to continue in a straight line unless another force brings it to a halt.

Since a heavy object (greater mass) has more inertia and momentum than a light object, it will require more amount of force to change its motion. When animating heavy objects, therefore, extra time must be allowed for the such motions. Lighter objects having lesser resistance will behave differently. A toy balloon needs less time to start moving. While to move a heavy cannonball more force and longer timing is required.



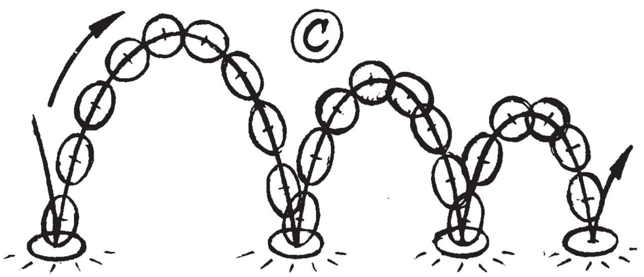


The behaviour of an object and the effect of weight seen on the screen, relies exclusively on the spacing between the drawings and not the drawing itself. Hence, how appealing the sketch of the cannonball is in its static sense will not matter if it does not behave like a cannonball.

2.4 Objects Thrown Through the Air

The speed of an object thrown vertically in air will gradually reduce to zero after which it starts to accelerate downwards. The rate of acceleration is the exact opposite of deceleration. Therefore, the same scale can be used for both.

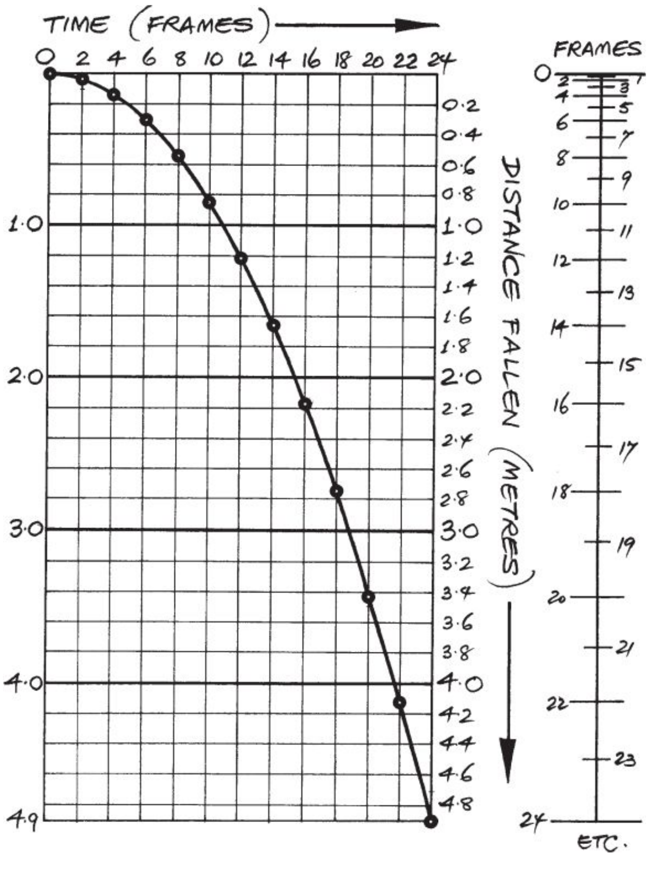
When not thrown vertically upwards, a ball's path can be traced as a parabola. Similarly for bouncing balls, each curve between two bounces is again a parabola. But here the parabola's heights reduces with each bounce.



After timing an object at the required speed, if there remain gaps larger than the object's height (ball's diameter) between two drawings, then stretching the object in direction of it's travel may help to reduce optical confusion. To smooth out the motion even further, speed lines (about which we shall study in chapter 4) can be added

2.5 Timing of Inanimate Objects

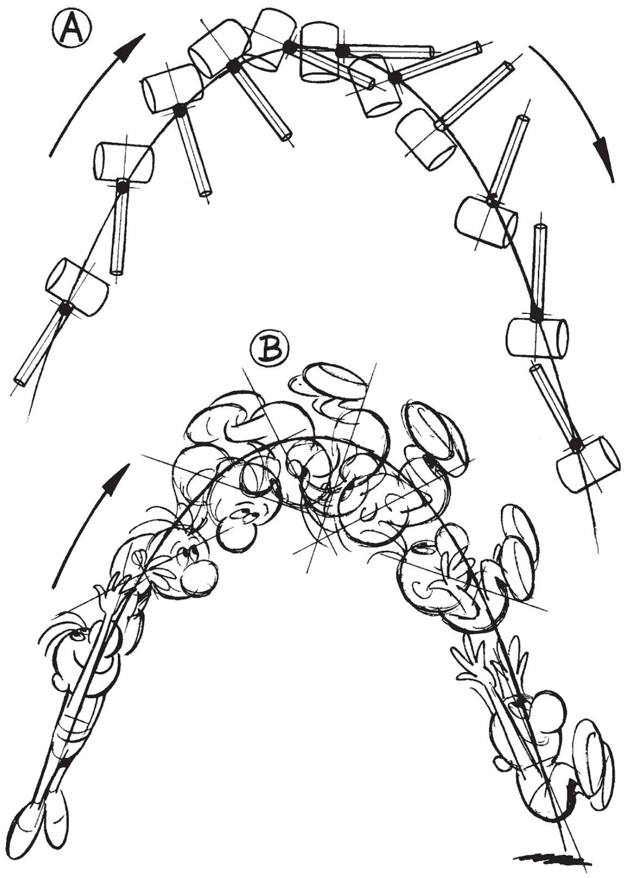
Here, the author mathematically works out a movement of the bouncing ball falling down from its rest position and plots a graph with the x axis as time (in frames) against the distance it is falling (in meters) on y axis, to demonstrate that it gives a parabola.



He further says that in animation, it is usually not necessary to work out a movement mathematically. It is all good if it looks good and is based on what actually happens in nature, but simplified and exaggerated when necessary.

2.6 Rotating Objects

When dealing with a rotating body, it is necessary to remember that its mass should seem as though concentrated at its center of gravity. Center of gravity is the point on the body where the gravity appears to act.



2.6.1 Irregular Inanimate Objects

Most irregular shaped objects tend to rotate when flying through the air with their center of gravity travelling along the parabola. For example, a hammer whose most weight is in the metal head also has the center of gravity close to this end and therefore, this end travels along the parabola while the other end revolves around it.

For high speed rotation, the changes in the perspective of an object aren't visible. Hence the author advises to draw only one drawing and then trace the same in next successive frames after turning it at the required angle, and with its center of gravity over the required point.

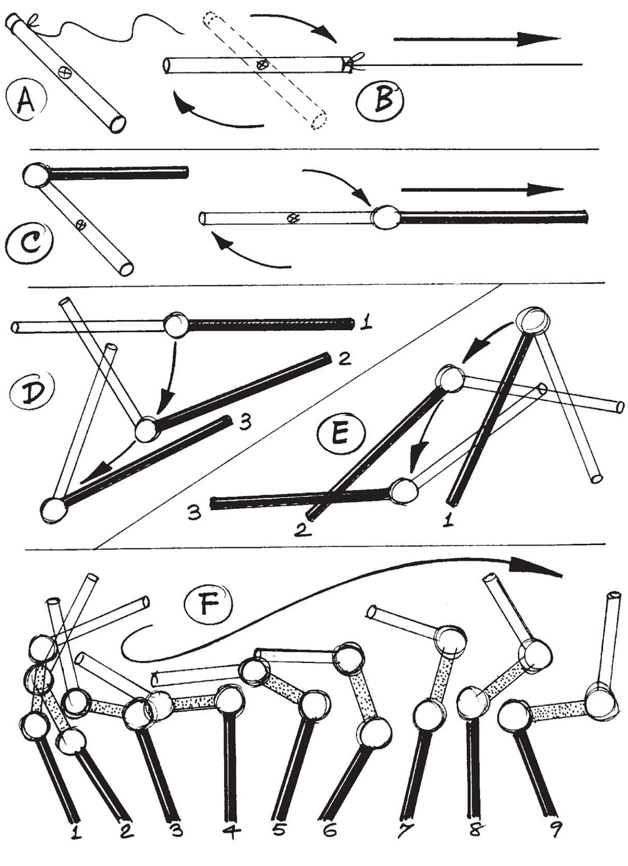
2.6.2 Animate Objects — Characters

"The legs, arms, hands, the position of the body — all must contribute to a reaction."

For the objects whose shapes won't remain constant, like that of a character, the position of the center of gravity on its body will also be variable. Hence its becomes necessary to roughly work out the center of gravity and move the body accordingly so that the center of gravity coincides with the path.

2.7 Force Transmitted Through a Flexible Joint

In this section the author explains the motions of three examples: i. wood with string attached to one end of it, ii. another rod is flexibly jointed to the first and iii. three rods flexibly jointed together.



The fundamental aspect of these actions is that when the primary object's speed is increased or direction is changed, the secondary object, joint loosely, does not move but rotates until it's center of gravity is in line of the path. In the successive frames, it's motion overlaps that of the primary as it rotates.

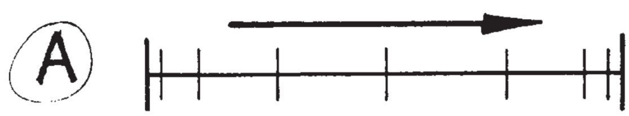
In the above image, the white rods tend to rotate around their centers of gravity when there is change in direction. It's necessary to understand these tendencies as oftentimes force is transmitted through flexible joints in character animation.

2.8 Force Transmitted Through Jointed Limbs

A character can be thought of as a sequence of somewhat loosely connected segments which will behave similar to the rods in the earlier section. If shoulders are pulled backwards, hands tend to follow only after the arms are dragged into the path. The behavior of an object held loosely in the fingers will be similar when the hand is moved around suddenly.

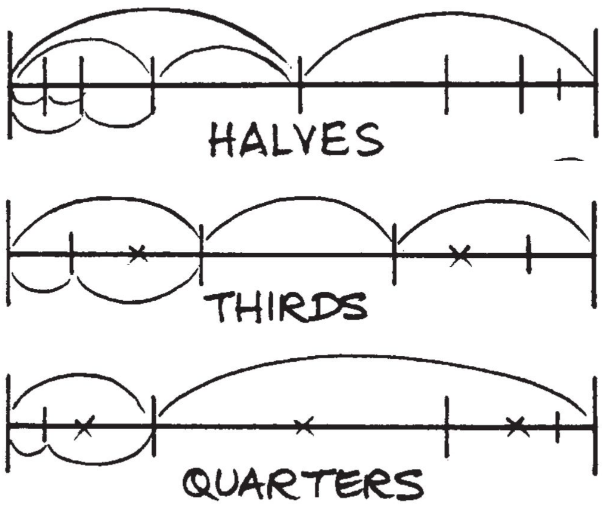
2.9 Spacing of Drawings

While moving from one rest point to another, the general tendency of an object, as observed in nature, is to accelerate to it's maximum speed in the middle of this movement.



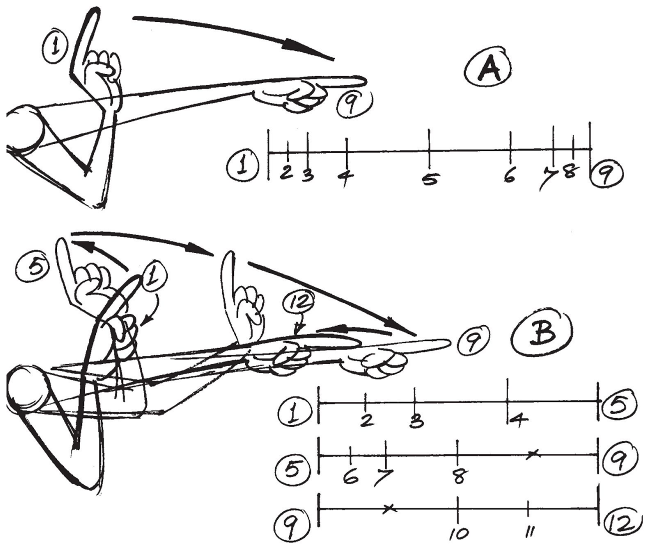
Same applies to a carpenter moving to and fro. For instance, if sawing a log of wood, the body weight moves forward, slows down, changes its direction to backward, slows down and repeats.

If it is difficult to determine the space between the drawings, it is advisable to approximate the distances by halving and re-halving according to the time. In certain cases, distances can be split in thirds or even quarters based on one's convenience and the feel of the motion.



So, in animation, timing an action is the same as determining the spacing between the key poses of the action.

Fig A. A simple movement of a hand pointing its finger, accelerating and decelerating at the two ends. Fig B. An exaggerated movement, initially the arm anticipates in drawings 1-5 after which it shoots out, a bit farther on 6-9 to return back to the final position on 10-12.



2.10 Timing a Slow Action

The slower the movement, lesser the spacing between its drawing; while faster the pace, farther the drawing from each other.

Very nearly placed drawings seem to jitter if they aren't drawn with tremendous precision. Hence, at times it is advisable to advance the movement with digital motion blurs or with short camera dissolve transitions rather than laboriously drawing the in-betweens.

2.11 Timing a Fast Action

One of the basic rules of animation is — quicker an action, bigger its exaggeration.

Unlike live-action films, it's easier to create fast action in animation than a slow action. But it necessitates ensuring the audiences' eyes are able follow the action. Here, the usage of anticipation becomes essential as it ascertains that the audience stays prepared to follow the quick movement when it arrives.

2.12 Getting Into and Out of Holds

Naturally, all parts of a figure do not come to a halt at the same moment. For instance, if a character is to jump, his arms will continue to move for a few frames after he has stopped moving.

This is a combination of certain movements — 'easy-in and easy-out', 'follow through' and 'overlapping action'. We shall see each of these in depth in the following sections. Some animation studios call this combination 'cushioning an action', where moving out of a hold would be 'cushioning out'.

2.13 Single Frames or Double Frames?

Most animations seem sufficiently well on double frames i.e. on 'twos'. But camera movements like pan, zoom, etc. require smoothness hence are usually done on single frames i.e. on 'ones'. Also, the animation to be combined into live-action footage should be animated on ones. And so should be very fast runs and certain oscillating movements. If necessary, these actions may even need speed lines or motion blur to make it work. It is important to avoid combining ones and twos as the result may seem jittery.

2.14 How Long to Hold?

This question further subdivides into two: i. For how long is it possible for the subject to hold? ii. For how long is it necessary to hold to achieve the dramatic effect? A standing figure shifts weight from one foot to another and blinks every 3-5 seconds.

In a held drawing, even though the subject is either intensely tensioned or extremely relaxed, the frame has a balanced look. It can be extracted, framed and hung on the wall unlike most animation drawings that work as a part of a series.

In the Fig., For 32 frames the plug is held (with gurgling sounds). Then the man stands up quickly and his body is held for 8 frames.

2.15 Anticipation

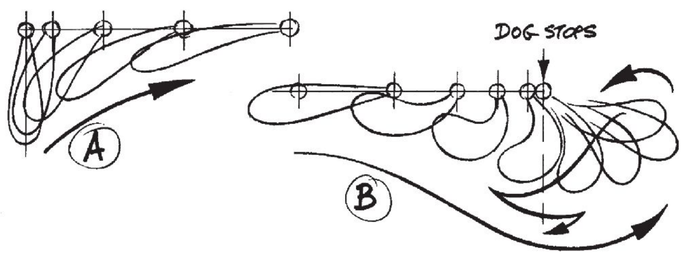
Anticipation is essential to attract a viewer's eye to the right moment and prevent the audience from missing some vital part of the story. Generally go to any moving object about 1/5th second later than the start of an action.

The time required for the main action depends on the quantity of anticipation used. If there's enough anticipation used, the main action can happen very fast; or in an extreme case, not happen at all. For instance, if a figure is too run off the screen, it is enough if he draws back getting ready with only one or two drawings indicating the forward movement, with addition of speed lines and/or puff of dust that disperses slowly, as author suggests, in not less than 12 frames.

2.16 Follow Through

The extremities trail behind during the main motion and hence keep moving little further after the halt before settling back. Similarly, when a body starts to move out of rest, extremities hang back until they are pulled along by the figure.

The author states that the motion of any extremity relies on: i. Character's main action, ii. Weight and flexibility of the extremity and iii. Air resistance.



To retain the fluidity in animation, the accessories should be treated separately from weight of the body. For instance, when a dog accelerates, his floppy ears tend to stay behind before trailing with it. When it slows down, the ears stretch forward before flapping backwards and finally getting to a slow halt.

2.17 Overlapping Action

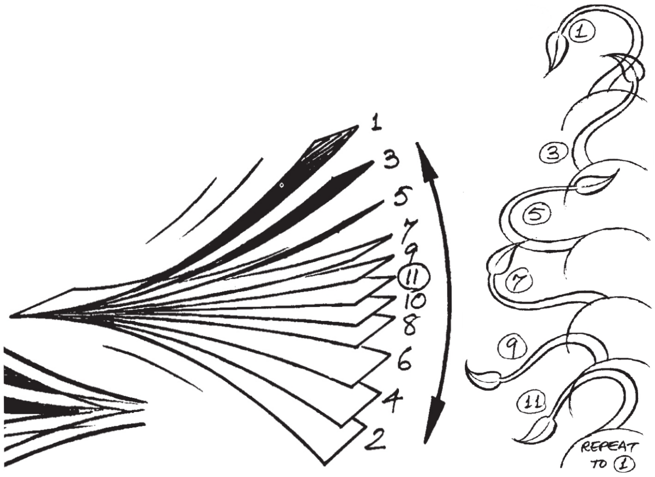
In animation, having a short time lag between motions of different parts of an object is called an overlapping action. If avoided, the character might seem mechanical and unnatural. These actions are an essential part of natural behaviour, but like all actions, the natural tendencies need to be exaggerated for good animation.

Overlapping actions are principally based on the idea of flexible joints (discussed earlier) backed with inertia and basic physics.

If a running dog comes to a halt, his front feet will probably stop first while his back legs and tail are still arriving behind.

3.1 Timing an Oscillating Movement

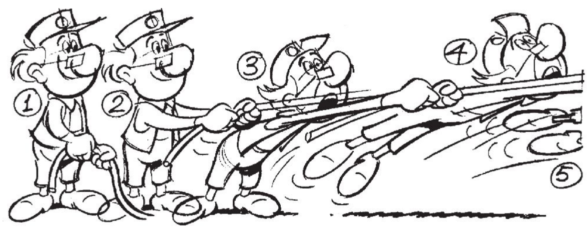
A rapid vibrating motion, such as that of a spring can be animated as shown in Fig. A. The in between movement is so fast that no drawings between the extremes are required. Similar motion happens when an animal's tail wags



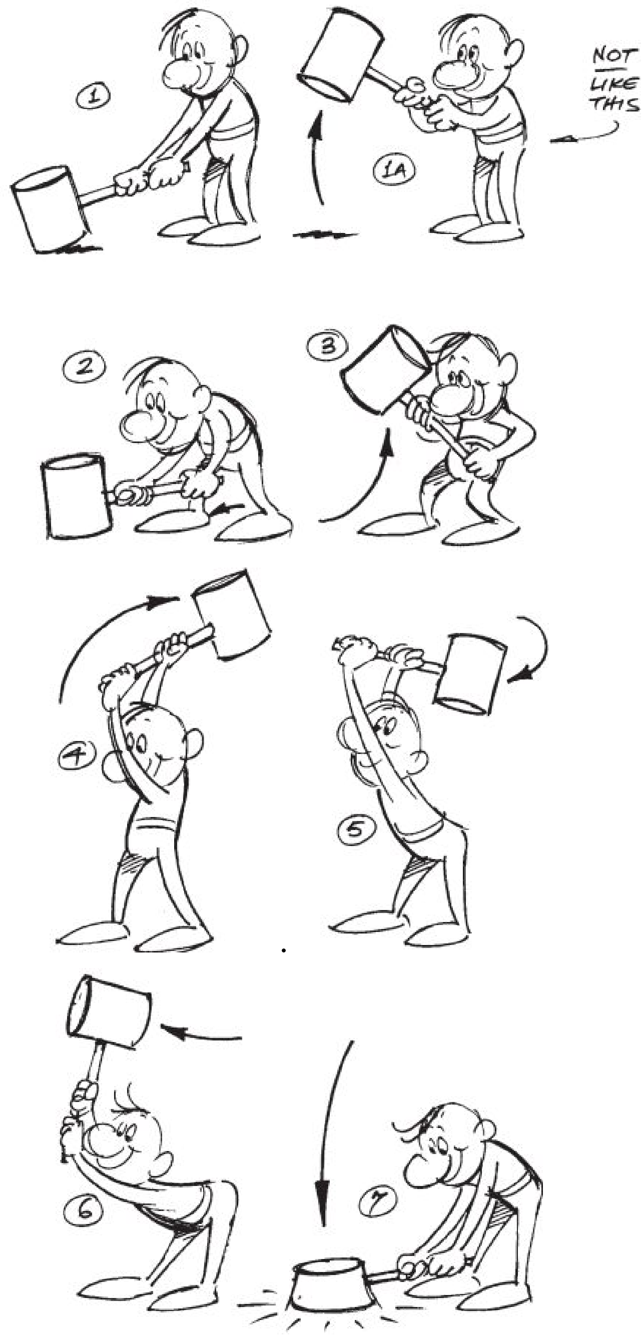
3.2 Timing to Suggest Weight and Force

Any part of a body moves as an effect of some movement of muscles or another part to which it is connected. For example if, as in Fig., one has to give a strong pull on a rope, probably the hips will move first, later the shoulders, followed by the arms and finally the rope.

Instead, if the character holding a rope is being pulled, as in Fig. below, then the sequence is reversed. First the rope is pulled, then the arm, followed by the shoulders and finally the hips.

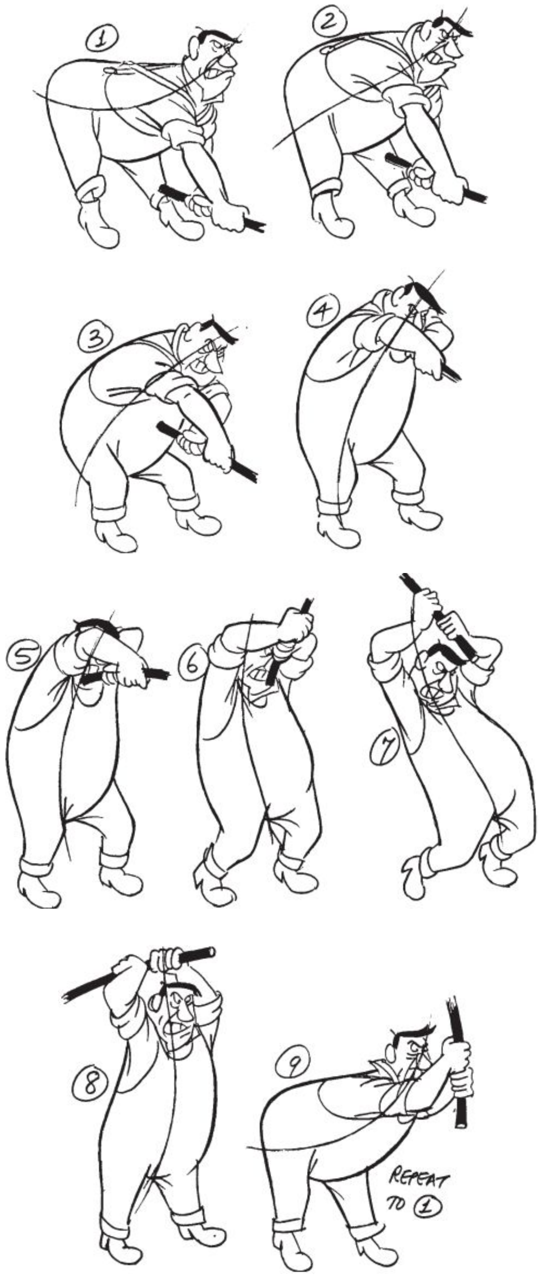


If a character wields a heavy hammer, it's initial position is as Fig. 1, relaxed. To begin the action, he has to lift the hammer which can not be done as in Fig. 1A. If only it was very light, it can be lifted so without the man tumbling over.



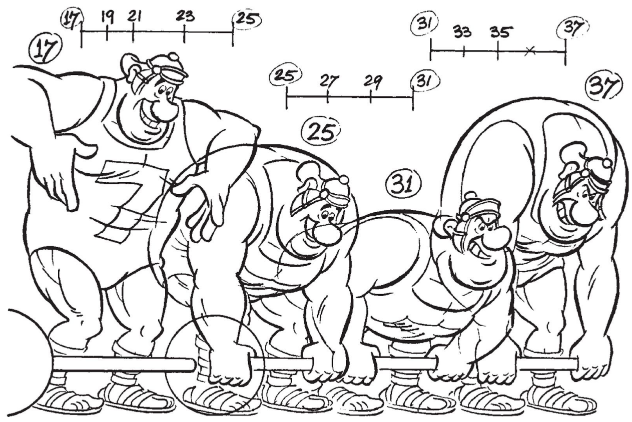
As the weight of the hammer starts to move above his head, his body has to move backwards as preparation for the forward hitting action. Then he simply needs to step back as the hammer falls and hits the peg. This drawing then links up again to initial, Fig. 1 or Fig. 2.

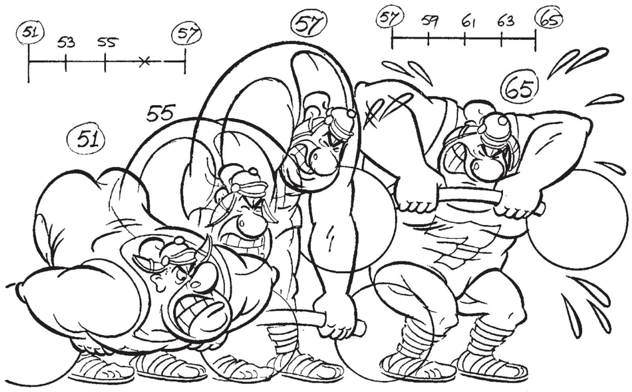
In an even more powerful repeated action, for instance, when a character is hitting with a pitchfork, to achieve the maximum feeling of effort, each body part needs to move in a particular way. After the last drawing, when the drawing 1 is repeated, the vast gap between the pitchforks gives the primary effect of the action.



When a body curvature changes between convex and concave curves, an S-curve is formed in between, as in drawings 2 and 7.

Author explains another example where a figure is going to lift a heavy barbell. He prepares confidently on drawing 17, anticipates on drawing 31 and on 37 tries to lift it. Since it is heavier than he expected, he makes another go with much more anticipation on drawing 51 and bigger pull on 57, finally getting the weight in the air on 65, before collapsing off screen.

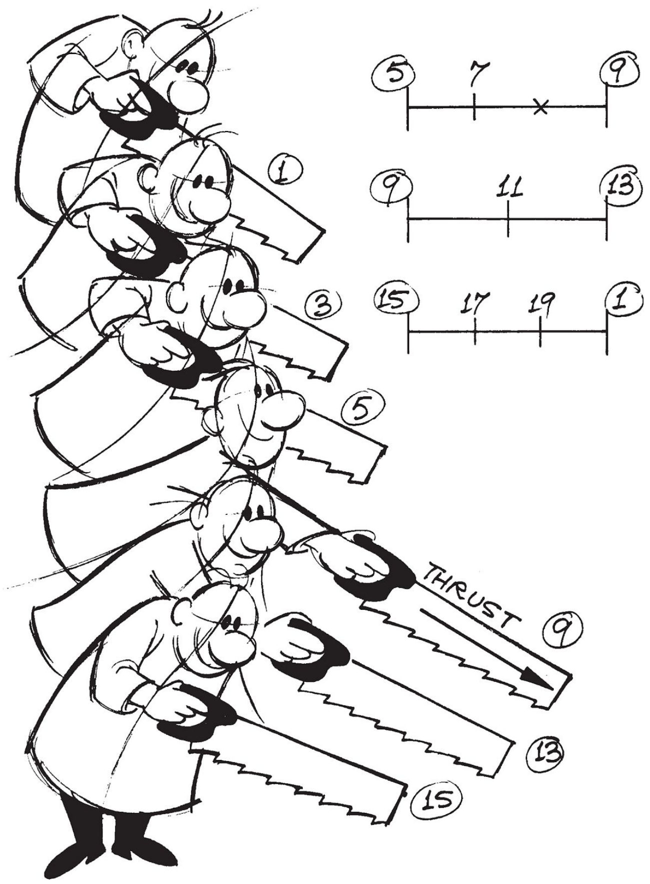




3.3 Timing to Suggest Force: Repeat Action

In a certain to and fro repeating actions, it is necessary to break the motion into smaller chunks to convey the feeling of effort. If only intermediate frames are filled between the forward and backward extremes, it will look effortless and machine-like.

For instance in sawing, the action is basically back and forth between 1 and 9. But to add an impression of effort, intermediate frames 5 and 9 are equally required. Of which 5 is more vital, as the body weight comes ahead to give the final thrust to the arm. On the backward stroke, the series of events is less complicated. To make the animation more fluid, short time lag can be added between the returning movement of the character and that of the saw.



3.4 Character Reactions and 'Takes'

"Without some degree of exaggeration, cartoon animation would not look right."

In animation, reactions can be controlled and exaggerated unlike in live-action films. Here the author states that the success of exaggeration lies in timing.

When a character suddenly sees something that makes him react in surprise, he makes a 'take'. There can be a short time lag of at least 5 frames during which the message reaches his brain.

The 'overshoot' on drawing 9 is the one that gives the indication of surprise, but the hold at the end on drawing 13 is what the audience sees. The latter is, therefore, the one in which the face should project the character's full reaction.

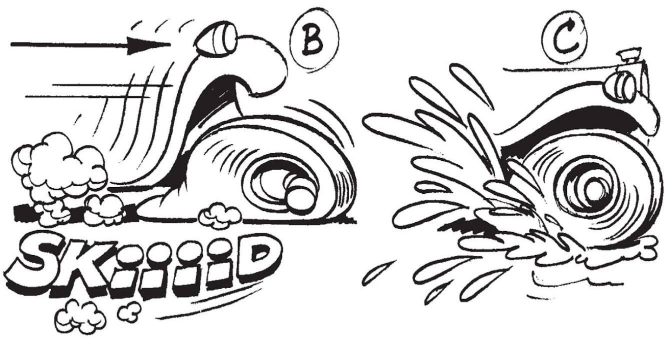
3.5 Timing to Give a Feeling of Size

If a character is to appear large as a giant, who has more weight and mass, hence more inertia and resistance, he would move, change direction and go in and out of holds relatively slower than a normal character. Conversely, a tiny character tends to be quicker.

In his 1984 animated film Nausicaä of the Valley of Wind (Kaze no Tani no Naushika), Japanese director Hayao Miyazaki demonstrates this with the timing of the enormous airplanes compared to the fast moving little humans.

3.6 The Effects of Friction, Air Resistance and Wind

Author explains the concept of friction with the classic example of a motor car screeching to halt. Here, the tires are drawn squashed to provide maximum contact with the road to create the feeling of friction.



In animation, wind is a helpful tool to add life into things, such as plants and trees, that are more or less flexible and have their own natural oscillations. Also to create a certain mood, the speed of the wind is shown with curtains, clothing, etc.

3.7 Timing Cycles — How Long a Repeat?

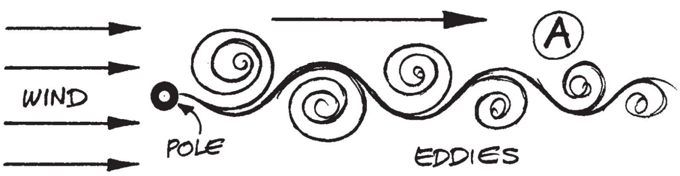
"When an audience is aware of a cycle, the cycle is a failure."

An animator should disguise them so well that the audience can not realise they are watching repeated drawings.

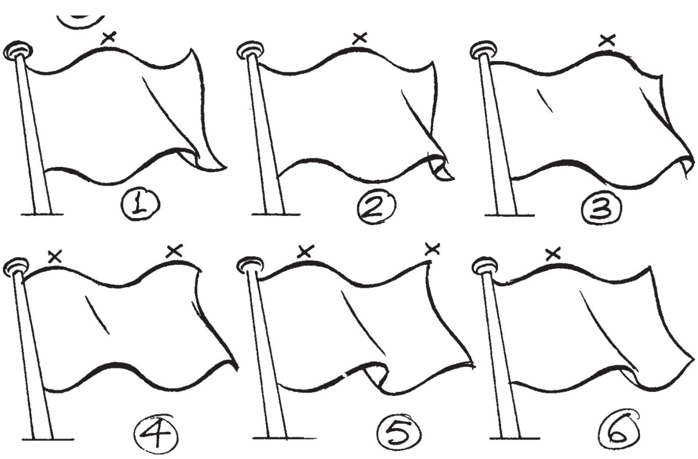
Natural actions which do not repeat exactly, like that of a burning fire, require additional cycles of around one second or more. The number of additional cycles needed to bring variation in the movement depends on how many times it is to be repeated.

In certain actions that can be animated on several levels (foreground, middle and distant), if each layer has a cycle of different length, then the combination loops differently every round giving the effect of a very long cycle.

A Waving Flag



Here, the author describes the working behind the motion of a flag. In Fig A. a smooth wind split into roughly cylindrical shaped eddies is moving at right angles to the flag. The flag blown to the right is sandwiched between alternate eddies.



In this type of movement, there is no 'key' frame as all drawings are an equally important part of the series and each should progress smoothly into the next.

3.8 Multiple Character Scenes

Different movements happening in different parts of the screen at the same time can split up the attention of the audience. Therefore, the secondary characters are expected to move just sufficient to look alive, occasionally reacting to primary actions. Tertiary characters in the far background can move very little or even not at all.

Digital Crowd Scenes

Many contemporary digital software, like Massive (Multiple Agent Simulation System in Virtual Environment) - a 3D animation software, have made it significantly easy to move a huge number of characters.

Also, certain software has made it possible to create complex crowds with programmed behaviours like figures avoiding elephants, swaying a weapon when close enough to an opponent, fleeing away if outdone, etc.

3.9 Effects Animation

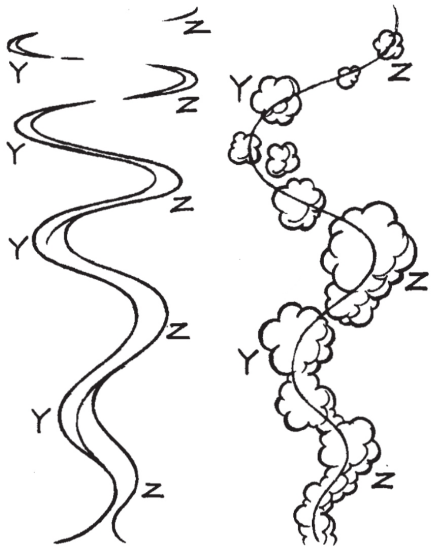
3.9.1 Flames

Timing of a set of flame relies on its size and also the distance from its source. Bigger the fire, the hotter it is and therefore more turbulent.

Similarly, the timing is faster at the base where it is hotter than at the top. Flames can be an exception to the general rule in animation that volumes should be equal throughout. And the surges of fire generally die out slowly but are formed rather rapidly.

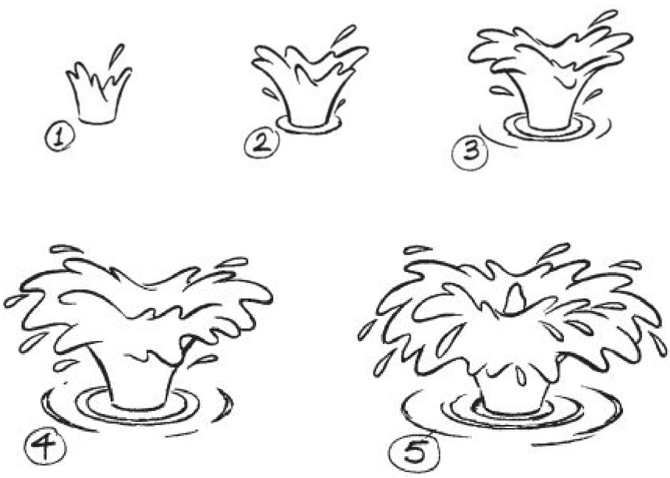
3.9.2 Smoke

The major problem in animating smoke is planning it's cycles that do not look mechanical or repeating. There are many kinds of smoke, but the fundamental idea lies in the arrangement of the puffs. A cycle of puffs moving along a wave pattern would take not less than 32 frames.



3.9.3 Water

In case of water, to gain natural looking liquidity, it's timing is an extremely critical factor. Too slow, it looks like oil or a syrup, and if timed too fast it may loose it's fluidity. Motions of water, or any fluid for that matter, are very peculiar since the matter has no mechanical force and is weakly bound together.

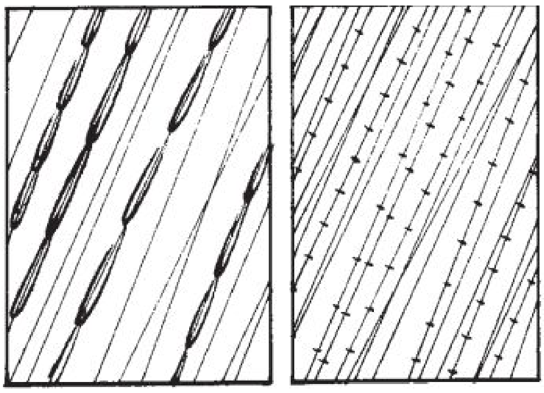


When a stone is dropped into a pool of water, the motion needs to be timed as two separate splashes. Firstly, some water is dispersed upwards and outwards forming the main splash. The stone sinks deeper and as the void created behind it gets quickly filled by water flushing in from all sides, a jet erupts as it collides in the center to form the secondary splash.

3.9.4 Rain

If not timed properly, rain has the tendency to appear mechanical. It is easier and better if it is moving quickly down. Some animators use live action footage of rain to avoid this problem. Most commonly rain is animated on single frames and not on twos.

If drawn on different levels, a feeling of depth can be achieved by animating the farther layer slower than the foreground layer which generally moves across the screen in roughly 6 frames.

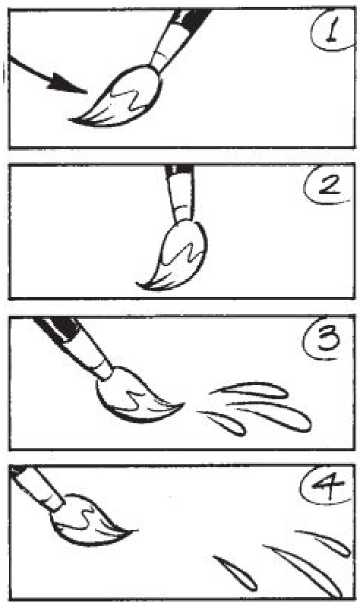


Different moods can be expressed by means of it's timing and direction. Vertically falling rain at about half of normal speed can give a miserable or depressing feel.

3.9.5 Water Drops

When animating drops, they should be moved on a parabolic path, with the drawings on consecutive frames overlapping slightly for a smooth motion. The author says that it is unnecessary to animate each drop to it's destination, as it is sufficient to slower the motion and reduce their sizes till they vanish in the air; they should not disappear at the same time, but with random timing.

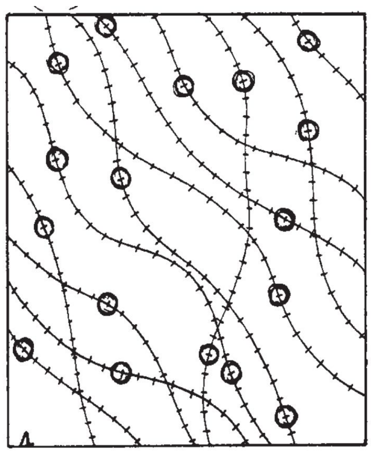
In case of drops falling off from a paint-brush, they should start atleast one frame after the extreme keyframe of the brush's shaking motion.



3.9.6 Snow

Snow, if falling gently, needs even longer cycles than those for rain. Flakes of snow usually fall down in wavy tracks. A cycle to be repeated for multiple times will need more than two seconds.

Similar to the rains, a feeling of depth can be achieved in snowfall. But unlike rains, snow needs at least three layers of differently sized flakes where closer bigger-sized layers drift down sooner than the ones faraway.



3.9.7 Explosions

Since an explosion is aimed at startling the audience, there cannot be animated in a predictable way. But there breathe certain similarities in their timings across most types of explosions.

Explosions start with rapid movements and end in slower timing. An short anticipation, about four or five frames, enhances the effect of an explosion. After an explosion is begun, the screen should get filled, if necessary, in 3 frames, tailed by flickering for about 6 frames and finally clearing slowly with the smoke staying for several seconds.

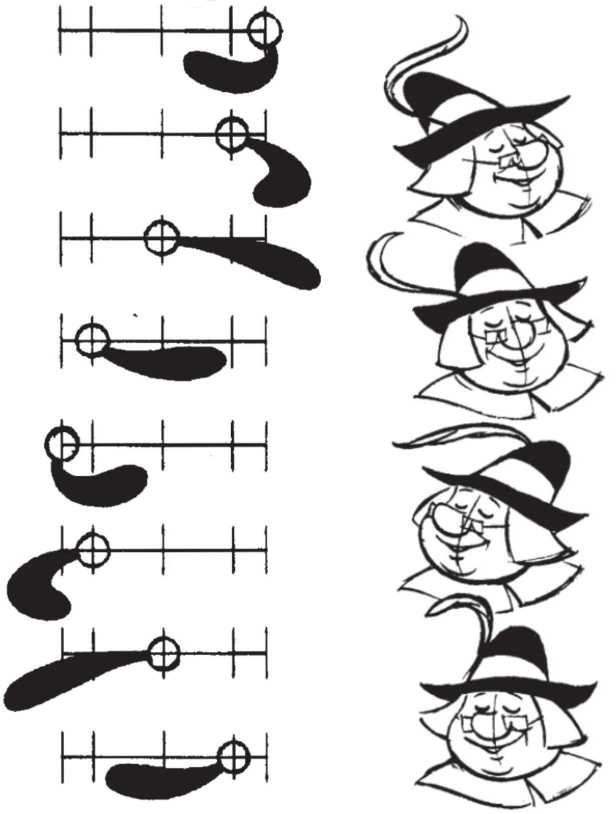
'Splats', smaller versions of explosions, are animated at the point of contact of two objects clashing or a blow in about 5 frames.

3.10 Digital Effects

Many digital effects programs available in the recent years have made it painless to create, otherwise time-consuming, effects like casting shadows. The author says that in the animation industry, these programs are called 'off-the-shelf softwares' while other softwares were proprietary programs specifically developed by the studios for their specific needs.

4.1 Repeat Movements of Inanimate Objects

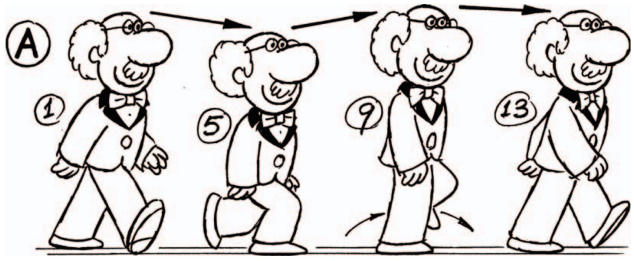
In certain oscillating movements, it may not be possible to reuse the same drawings for the reverse motion. In a flexible movement, a different set of inbetweens is required for the to and fro movements.



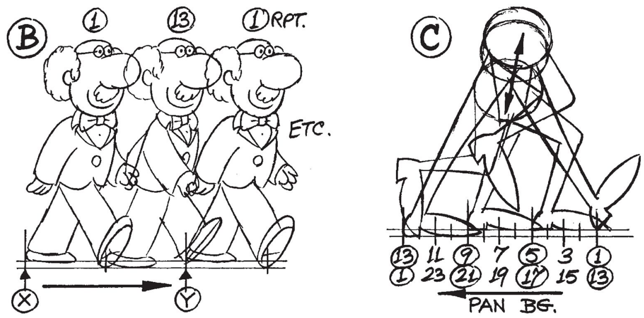
If the same drawings are used for the return motions, an optical problem occurs at the extremes. The drawings will animate in the order 1, 2, 3, 4, 5, 4, 3, 2, 1, 2, 3, etc. where the drawings 4 and 2 are doubled. These impact the viewer's eye more than the extremes of the motions which here are 1 and 5. To avoid this, either the extremes are to be held for long or one of the doubled drawings of 5 and 2 is to be eliminated giving 1, 2, 3, 5, 4, 3, 1, 2, 3, etc. as the favorable order of the drawings.

4.2 Timing a Walk

The position where the heel of the front foot touches the ground is the main key drawing called the 'step'. Next being the 'squash' or the 'down' position, the front leg supports the body weight and the back is bent with only the toes touching the ground. The bent leg then straightens and the body goes into the 'up' position, which then leads to the next 'step'.



A walk can be animated in two slightly distinct ways. One where the character moves along the screen on a stationary background, and alternative being, where the character is animated in the same position while the background pans backwards.



The vertical movement of the character should ease in and out of the keyframes, while the horizontal movement is to be animated at an uniform speed; or the motion appears to 'stick'.

Types of Walk

With variation in the walk cycle, the characters personality can be enhanced or altered. A tired character will walk with his head drooping, arms hanging loosely and his feet dragging across the ground. While a proud character's walk is pompous with the body bending slightly backwards, chest out and plenty of shoulder movements.

4.3 Spacing of Drawings in Perspective Animation

To achieve the feeling of true perspective, complex draughtsmanship is required, with fundamental understanding of geometrical structure of the subject.

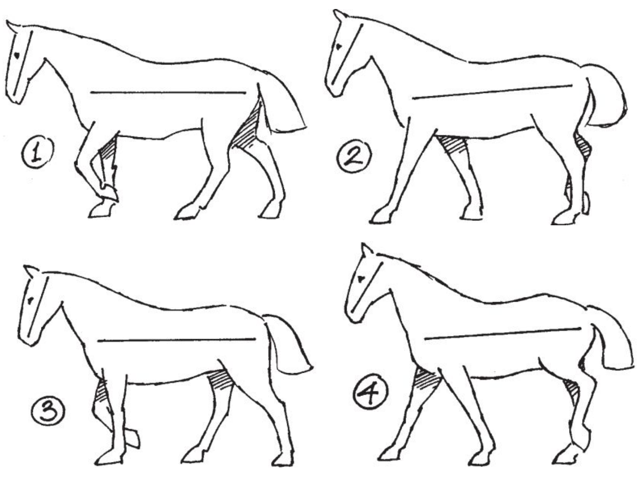
In animation, it is difficult to maintain the proportions of all parts of an object while also increasing or decreasing it's size. Good animation requires movement in depth with the illusion of three dimensional space, without which the animation may appear flat.

It is advisable to use exaggerated perspective to emphasize the movements. If some part of an object is swinging close to the camera, it can be taken advantage of by increase it's size.

4.4 Timing Animals' Movements

4.4.1 Walks: Horses

When a horse walks, his feet touch the ground in the order: back left, front left, back right, front right, etc. And if walking purely free, the feet touch at equal intervals. A stride, from 'back left' to next 'back left', of an horse normally takes about a second to complete. During the walk, the shoulders move up and down and the head is pulled in an out of horizontal slants.

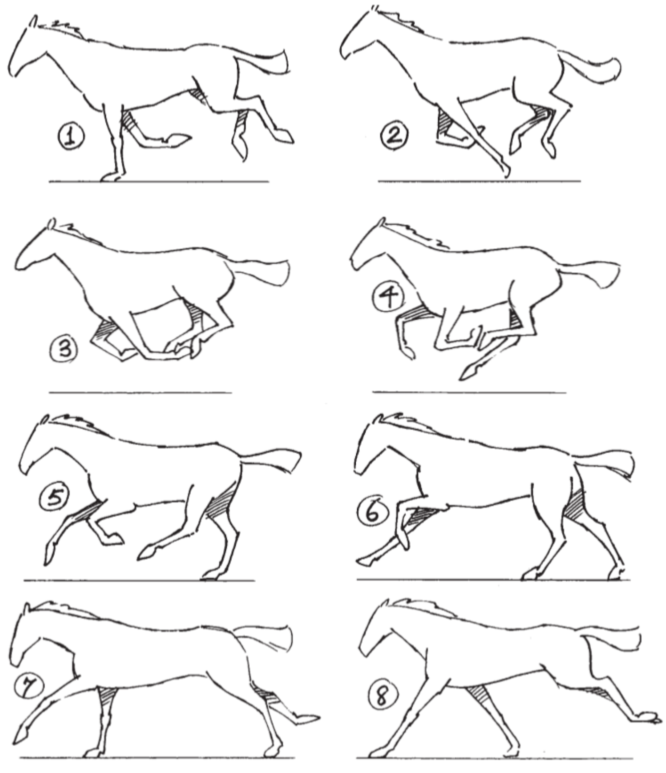


4.4.2 Walks: Other Quadrupeds

Smaller animals like a cat takes half a second or lesser to complete one stride whilst a larger body such as an elephant takes a second and a half. The feet usually move in the same order and head and back follow similar movement patterns to that of a horse. In animal walks, there is no drawing similar to that of the 'squash' of a human walk cycle.

A four-footed animal spends approximately half of it's walking time on two legs and the other half on three legs. Usually one of the hind limbs are used to begin the walk followed by the front limb of the same side.

4.4.3 Timing an Animal's Gallop



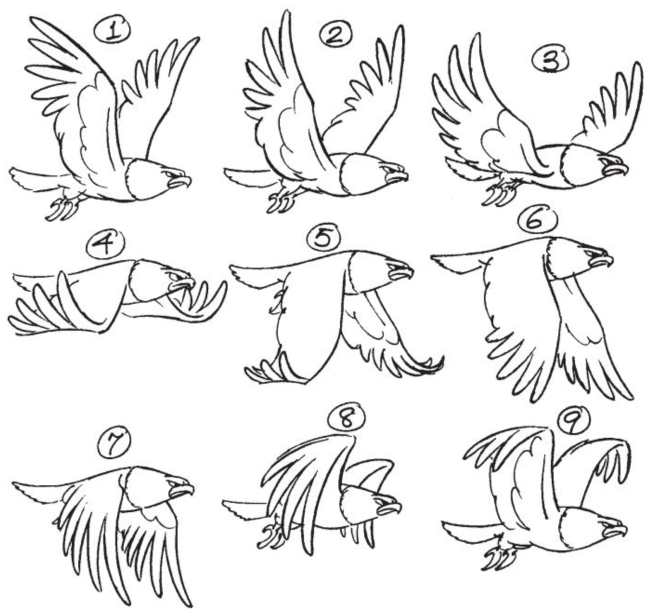
A walk, a trot and finally a gallop is the maximum speed of a horse. In the gallop one stride cycle takes roughly half a second in which its feet touch the ground in a different order: back left, back right, front left, front right — pause — and repeat. The main thrust is provided by the front limbs after which the animal is shortly airborne.

Certain animals like a cat leap with the push provided by the hind limbs, so the order changes to: back left, back right — pause — front right, front left, and repeat. One stride of a cat rough measures about { 1/3 } second.

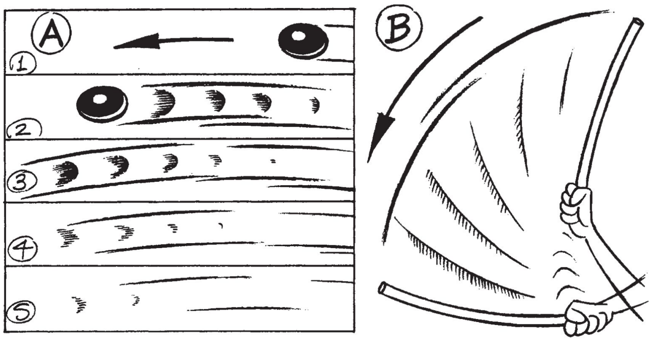
4.4.4 Bird Flight

A smaller bird flies faster than a larger one. The intensity of the downward stroke of their wings is source of ability to move.
For instance, a sparrow flap 12 complete cycles in a second, whilst a stork may flap only twice.

The head is lifted during a downstroke and falls down again during an upstroke. Usually, one upstroke takes about the same time as that of an downstroke. In larger birds, the downstroke may be slower.



4.5 Drybrush (Speed Lines) and Motion Blur



When an object is moving too fast, our eyes see it unclearly resulting in an optical blur, which is illustrated in animation with the use of speed lines and motion blur.

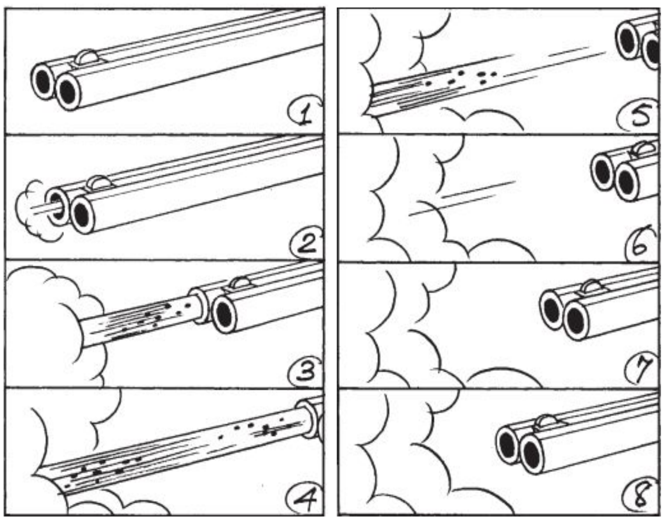
Drybrushing, a traditional effect, is painted directly onto the individual frames. While motion blur is added digitally in a computer and it does not exist on an individual frame. A more noticeable effect can be achieved by increasing the spacing between the drawings

Speed lines are preferably timed quickly so as they vanish just before the audience notices them. These lines are left behind by an object and do not move with it.

4.6 Accentuating a Movement

To draw attention to the movement, especially in case of quick ones, animators use visual effect to increase their animation's intensity. However, the effect should visually complement the action and should be quick.

The drawings where the gun recoiled suddenly, are the accent of the movement. But the movement is visible due to the powerful 'swish' effect and slow puff of smoke.

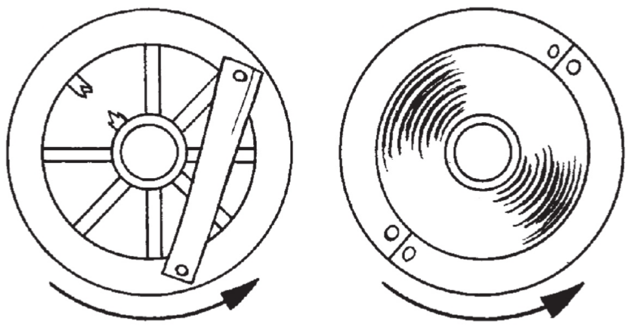


4.7 Strobing

An object with equally spaced identical elements such as bars of a ladder or spokes of a wheel are particularly prone to strobing. If the bars are spaced 1inch apart and the ladder starts moving along its length, it looks fine till it's speed is lesser than ½ inch per frame.

At exactly ½ inch speed, it appears to be flickering on the alternate frames. If it moves even faster, viewers eyes notice the bars that have shorter gaps between them and the ladder appears to move in reverse.

One of the is to add an differential element, such as a broken bar, so that the motion is observed with respect it. Another strategy of avoiding this is by showing the rim of an wheel rotating, but drawing all spokes with simply speed lines.



4.8 Fast Run Cycles

For a quick and vigorous dash, 8 frames run-cycle is enough; while 12 frames is not frantic enough and 16 frames long appears extremely leisurely.

At a higher speed, the drawings are quite widely spaced and therefore need speed lines to make the motion look continuous. To animate a run faster than 8 frames, either several foot positions can be drawn on each frame or it can be drawn without any legs but by speed lines and dry brush effect.

4.9 Characterization (Acting)

“Character animation is the ultimate achievement of animation art.”

A cartoon character is not expected to behave exactly like a human but rather should look simplified and actions exaggerated, sometimes distorted to obtain a comic or dramatic reaction. The features must be maintained simple allowing maximum facial expressions. The important positions being adequately expressive must be held sufficiently long so the motions do not look too human like.

Author says, most animators start by animating themselves And many would improve their animation training with acting and/or miming courses, studying same principles as those written for flesh and blood actors.

“Good character animation is not merely the copying of life — it is the caricature, life plussed.”

4.10 The Use of Timing to Suggest Mood

Creating a mood is an essential for both live action and for animation. But in animation, subtle shades of expression are to be avoided.

The moods of sorrow, depression, dejection and so on make use of slow timing with frequent holds, and the moods of joy, elation, triumph, etc. are timed quicker but it is necessary to ensure the facial expressions have enough time to be read by the audience.

4.11 Synchronizing Animation to Speech

In animation, the speech is taped beforehand, unlike live-action, and the movements are precisely timed to it.

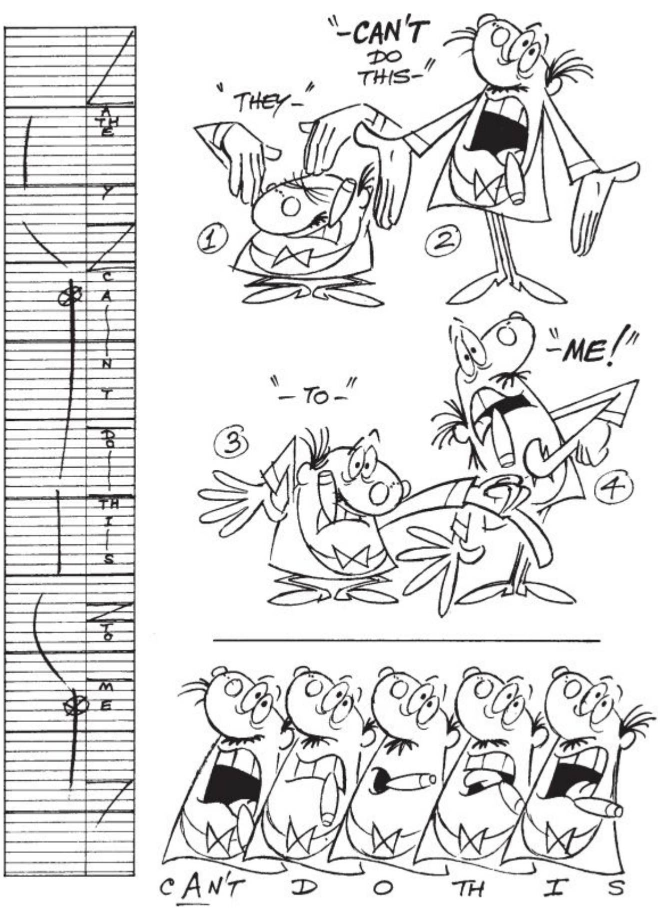
Then the characters' movements are planned based on the manner of the words being said, reinforcing the dramatic effects wherever possible. This is further elaborated in the lip-syncing section of the following chapter.

5.1 Lip-Syncing

After a soundtrack is made available, it's phonetic frame-by-frame breakdown is indicated by means of a flowing line and small symbols in a special column of the exposure sheets. By listening repeatedly, the rise and fall of the voice, main emphasis - keywords, phrasing, the rhythm of the speech, etc. are too specified.

Along with the phonetic break down, a line is drawn moving left and right which suggests the rise and fall in the voice. And further, it becomes thinner or thicker based on the emphasis on the words and letters.

The movement of the character should accentuate the vowels in these keywords. Most often, the mouth opens for a vowel and shuts for a consonant sound. Next, the facial expressions and the arms, body, etc movements are planned to underline the purpose of the dialogue.



In the fig., important emphases are 'can't' and 'me', hence the sounds of the vowels in these words are intensified.

In TV shows where the time for the production is limited, the dialogue carries the primary interest and there is almost no animation apart from the characters' mouths.

5.2 Timing and Music

Music is a benefit for animation as both have basic mathematical foundation and can be matched to a determined speed.

Generally, it is easier to follow the beats of a musical composition than to follow the rhythm and mood. Tapping of the feet is synchronized to the beats, but it can be better emphasized by the use of the whole body.

To match the beats, sometimes, animations alternate between single and double frames.

5.3 Camera Movements

5.3.1 In Traditional Animation

Simple camera set-ups like the 'Rostrum camera', an 'Oxyberry camera' were used to shoot the animation before the digital era. The camera was mounted on a vertical column on which it could move closer or farther (truck-in or out); from the drawings placed horizontally on a table which rotated for tilted angles, had pegs used to move (pan) and had a light-box. These movements are planned beforehand and noted on the exposure sheets by the director. These sheets are used by cameramen to execute and record the motions.

5.3.2 In 3D Animation

Traditionally the camera movements were planned on paper and marked across X and Y fields. It is now replaced by digital tracking of a ‘path of action’ which can be controlled and modified using splines. A pre-visualisation director plans a rough camera pass during the animatic itself. Which are later finalised with consultation of a layout supervisor. With the benefit if 3D digital medium, the director can alter the motion, change lens, etc affecting as minimum as possible to the main animation.

5.4 Peg Movements

5.4.1 In Traditional Animation

Dissimilar to the camera movements, peg movements can not be left for later, they need to be included in the character and scene animations. An animator is required to calculate the distance, speed, acceleration, etc. beforehand. Accordingly, the cel containing the character is moved and in some cases there is a need to draw on long cels.

5.4.2 In Digital Animation

Digital 2d animation includes peg movements similar to the traditional methods, but moreover provides for scaling and repositioning of the characters.

While in 3D animation, the character has a real position in a virtual set. Most times, the peg movements can be achieved by manipulating the camera’s path of action itself.

5.5 Editing Animation

Against the common belief that animation needs less editing than a live action film as it is well planned out beforehand, a professional tightening touch for animation is an essential.

Different videos require different editing styles. In a rock and roll, rapid cuts will work while in certain videos require realistic feel, hand-held camera feels, etc. The Kung Fu Panda, a Dreamworks animated movie, uses the split screen editing — two or more scenes occurring simultaneously.

Next, the author explains the editing for feature films, television episodes, childrens’ programs, and for internet downloads.

For films, the audiences’ taste changes with time. Therefore, to keep up with the pace, experiments are necessary for animated feature films. Some studios try out a technique in a short video and based on their learnings, they adapt it into the feature film.

For television, the animations are produced in mass quantities. The scenes that require cutting in away actions can be understood without showing them. Repeating facial drawings and saving the full animation for important scenes is helpful.

Animation for children's programs have particular set of rules; with minimal overlapping dialogues, sufficient pauses for young brains to catch the ideas, gentle actions and dialogues, friendly colours and avoiding fast cuts or heavy effects.

Recently, the world has experienced more animation hand-held devices than in theaters. With our decreasing attention spans, increasing competition and availability of many videos, the cleverest concepts and cutting edge ideas reach large audiences. Smaller and simpler animations bits can be read better by the target audience most of which is probably viewing in a noisy open space.

5.6 Games

Most game projects can be divided into two parts — the body of the game and it's cinematic backstory. I'd the budget permits, the cinematics can be animated as excellently as a theatrical film.

A game is defined by its ’assets’ — number of bones in the rigs, library of pre-made character motions, etc. An animator is required to connect the pairs of actions that often happen consequently. For highly realistic games, human motion capture is used for most of the actions in a character’s library.