Animators face many difficulties in the creation of their art—difficulties that are not restricted to simply overcoming the technical challenges they face or the practical issues of managing a production. These challenges may indeed be considerable, as are the creative and conceptual issues of original productions. The difficulties animators face extend to the manipulation of models and objects, pixels, or drawings in their effort to interpret and replicate all kinds of movement.

A Little History

From a very early point in the history of animation, some practitioners began to analyze movement and started to formulate the basic principles of animation. This was done at least in part to accommodate the ever-increasing demand for more animation of a higher quality. As the popularity of animation increased significantly, driving demand for new product in turn meant that many more animation studios were created to meet that demand. However, the quality of the animation was somewhat variable, and unfortunately the majority of the work fell lamentably short of the standards reached by the likes of Winsor McCay.
Training soon became a vital part of the industrialization of the art form; establishing animation principles did much to enable individual animators’ development and increase the studios’ productivity. Since they were first formulated these animation principles have offered animators a system not only for the study of movement and dynamics but also for the creation of naturalistic and believable movement through animation.

During the first decade of the 20th century, simple animated movements of characters were usually enough to satisfy an audience, so naturally the studios were content to provide them with that. As competition for audiences became more intense, the demand for higher standards began to increase. Some studios rose to the challenge; others were content to continue producing what they had always done. No prizes for guessing which studios thrived and which ones began to struggle.

During my years as an animation teacher I have heard young aspiring animators utter many misconceptions. One of the greatest of these is the mistaken belief that the principles laid down by some of the pioneering animators no longer apply to modern-day techniques. These young animators couldn’t be more wrong. Beyond a doubt, there have been some fantastic advances in production processes since those pioneering animators made the first animated films in the emerging studio system of the early 20th century. Indeed, there have been many changes since I first began animating in the early 1980s. But the principles hold as well now as they did way back then.

Approaches to Animation

Before we start to look in some detail at the animation principles themselves, we should look at three rather distinctive approaches to animation. These are not animation principles but rather guidelines that offer animators a way of looking at and classifying animation. We may find it useful to divide animated motion into three separate categories of movement: simulation, representation, and interpretation. Each one of these classifications provides a distinctive context in which the animation is seen by the audience. In addition, it may help to create a framework for the production of the animation.

Simulation

Animation that could be classified as simulation has a high degree of accuracy in its replication of naturalistic actions. Movement of this kind replicates exactly, or nearly as possible to exactly, the actual action or dynamics of objects and effects. It should be possible to test the results of simulated animation against real objects or events. Simulation is often used for highly naturalistic movement of objects and figures as well as effects such as water, flame, and smoke that appear in live-action films. The purpose of animation
that simulates various effects in live-action films is to work seamlessly with the live-action elements.

To do that, the suspension of disbelief must be total. The film *The Perfect Storm* (2000) relied heavily on the accurate animation of the behavior of a hurricane and very heavy seas. To maintain believability, it was necessary to create the illusion of water in all its separate forms: the overall swell of the ocean, the giant wave that finally overturned the boat, individual waves that occurred on the surface of the giant wave, small wavelets, spray, and spume. All of these effects combined to create a magical but totally believable event. Many of the animated sequences were cut together with live-action shots of water, which placed extra emphasis on the accuracy of the simulated action.

The use of animation in most live-action films calls for this high degree of realism. It is this realism that is the key factor in audience acceptance.

Computer-generated animation allows for a high degree of mathematical accuracy and occasionally even completely negates the hand of the animator.

**Representation**

*Representational animation* does not have the same constraints as simulation animation. It is usually made in a manner that demands less accurate movement than can strictly be evidenced in the actual behavior of the subject. Such a classification of animation may be extended to movements that may pass as “real,” even if the actual movements themselves cannot be evidenced as such.

Consider the animated movement of dinosaurs. There is no doubting that these animals were real, but we have no hard evidence of how they moved. Therefore the animator is left with the option of making animation that is a representation of what we believe to be true. Animators may gather some insight into the way dinosaurs moved in life from the evidence offered by their fossilized remains, though even these remains may generate a degree of disagreement among paleontologists. Even so, we can make reasonable assumptions about dinosaurs’ movements and very good or at least acceptable representations of their actions. We gather information about their size, an estimation of their weight, and theories about the articulation of their joints. All these pieces of information offer valuable clues for the animator.

It is possible that completely fictitious creatures may be represented in a “believable” manner if the animator uses reference material gathered from appropriate sources that allow for comparison with these subjects. Using animals and humans of a similar nature to the imagined creatures may offer a guide to the types of movement required if we look at each creature’s shape and size, flexibility, and weight as a starting point. So, it is perfectly possible that unicorns, dragons, trolls, and hobgoblins—even the Devil himself—may all be represented by levels of believable motion. Some of the
animated elements in *The Lord of the Rings* (2001–2003) integrated within the live-action footage are completely convincing. The evil Nazgul’s dragon-like steeds are not only terrifying, they are totally believable.

**Interpretation**

*Interpretive animation* allows for a more creative use of animation and dynamics and leaves room for more personal expression that does not depend on either naturalistic or believable movement. Although the abstraction of movement and dynamics, and even the creation of completely abstract animation, falls into this area, interpretation is not limited to abstract forms. If we consider some of the best-known and well-loved cartoon animated characters, we can see that they are interpretations of the subjects they represent. Due to their very design, some human cartoon characters are destined to display movements that clearly do not reflect the actual movement of a human. Cartoon characters often have extraordinarily large heads, proportionally far larger than we would normally expect to see in real life. As a consequence they move in a manner we could consider cartoon-like. Indeed, cartoon characters of all kinds seem to obey the cartoon laws of motion rather than the laws of physics the audience experiences on a daily basis.

Striking a more abstract note, animated characters such as Daffy Duck and Bugs Bunny have few if any discernible qualities of either a duck or a rabbit. Yet we still accept them as representatives of their animal forms because, despite their abstraction, they possess the minimal requirements for recognition. Despite walking upright and looking more like a youth in a gray suit, Bugs has long ears, buck teeth, and a fluffy tail like a rabbit. Daffy has the same overall physiognomy as Bugs and he also walks upright, but he has a yellow bill and a small feathered tail like a duck. Other than these details there is little to commend them as either rabbit or duck. Instead, we recognize them not as their animal forms but as characters.

Other cartoon characters are even more abstract in nature. Ren and Stimpy, a cartoon cat and Chihuahua dog, barely resemble animals, let alone a cat or a dog. The artistic liberty animators and designers are able to take is extreme. These more abstract designs are open to interpretation because they are not being measured against anything that the audience has experience of, so they become acceptable as cartoon characters.

**Four A’s of Animation**

Over the years I have considered the hierarchical nature of animated action, leading me to come up with an additional way of classifying animation to help us better understand and appreciate the nature of animated dynamics. These classifications are not an alternative to the principles of animation that are set out in this chapter; rather, they offer a useful addition to those principles. I call these concepts the *Four A’s of Animation*. 
There are four distinct levels of animated action that identify the nature of movement from the simplest to the most complex. The Four A’s may best be considered in a sort of hierarchical fashion, with the most simple at the bottom and progressing upward to the most complex and sophisticated actions at the top. These categories of animation set out to differentiate between these levels. The categories are:

- Acting
- Animation
- Action
- Activity

These levels of animated action are appropriate to certain animated movements. They are not a ladder for the would-be animator to climb, nor are they meant to imply the ability of the animator. They identify the nature of movement in various subjects. The animator, regardless of the discipline he or she works in, the techniques used, the format of the production, or the intended audience, will at some point or another encounter all of these—sometimes all in a single shot.

**Activity**

The activity category describes the simplest of the four forms of movement and is at the bottom of the Four A’s of Animation. Such movements are extremely basic and describe a type of dynamic that cannot easily be associated with any naturalistic movement. An object or image moving in this mode would not describe the behavior or movement that was recognizable as belonging to any given object. Activity is evident when an object or image appears at a particular point in space at a particular moment in time. This object or image would then be seen as either the same object or a different object at a second moment in time and point in space. The location in space and the place it appears on a timeline may be completely random, or it could follow a structured pattern but a pattern that does not conform to a movement the viewer would recognize as belonging to a subject in nature.

By way of illustration, let’s consider for a moment the static “snow” on a television set that is not tuned in and receiving a clear signal. We witness a flurry of vigorous movement but not of a type that relates to any naturalistic movement. The individual sparkles move across time and space, though they do not represent the identifiable movement of any object. Sparkles on moving water, though not entirely random, could be said to represent simple activity.

Another example of animation that we may consider simply as activity is often evidenced in the credit sequences of nonanimated films. The moving text, whether scrolling down or across the screen, fading, flickering, or presented in a host of other ways, is clearly animated but has no form of movement that we can attribute to the image itself. The text in this instance is not represented
as a natural way of moving, since typography has no natural way of moving, though we still witness the movement. This is simple activity. It is possible for animators to create the illusion of a recognizable dynamic using typography as a subject, and through their skills they may make that type appear as heavy as stone, as light as a feather, or as fast as a hawk and then be recognized.
as having movement that relates to those things. In general terms, the movement of text on a screen usually conforms to simple activity. Movements that relate to and demonstrate such qualities as weight or balance come under the next category of animation: action.

**Action**

The *action* classification of animation relates to the identifiable movements of an object or image that are natural to that object. The nature of the animation that falls under this classification depends on a number of factors, principally the nature of the object itself. The material the object is made of will influence the action. The reason a tennis ball bounces more than a cannonball is due, at least in part, to the material of which it is made, which allows for more bounce; it is more flexible, being made of rubber rather than the metal of a cannonball. We can all easily recognize the flexible movement of wooden planks in a footbridge, though the flexibility is less evident in shorter and thicker pieces of wood; we understand how cloth flutters when made into a flag that hangs at the top of a flagpole and how it is less prone to flutter when made into garments. We know that flesh is soft and metal is hard, that concrete crumbles but does not do so as readily as biscuits.

Now consider the movement of the flame of a candle, smoke billowing up from a garden fire, waves on water, leaves on a tree blowing in the breeze, and thousands of other examples. All may be said to possess the kind of dynamic range that can be attributed to those known objects and that the actions are recognized by the viewer as belonging to those objects. There is even more to take into consideration in animating subjects with an attributed action. Objects not only demonstrate an action determined by their material or their shape and size; their actions are also demonstrated by the external forces that act on them. Gravity will impart an action; air resistance and wind power may

**FIG 3.2** The movement of the candle flame, the flaring match, and the water droplets are classified as "action" within the four A's of animation.
impart another kind of action, as will rain. The action of a bouncing ball on a street will be very different from a bouncing ball on the moon or the same ball at the bottom of the ocean. The one thing all of these “naturalistic” actions have in common is that they are all subject to the same laws of physics.

The nature of movement is inextricably linked to the nature of the subject. Boulders roll down a hill in the way they do because they are made of rock, they are heavy, and more often than not they are uneven in shape. Leaves fall to earth from a tree because they have been blown by the wind, but they do it in a particular way due to their weight, shape, and size as well as the material of which they are made. These characteristics give these objects a particular and recognizable action. The key point here is that all of the subjects we have covered move without the intention to move at all, let alone in any given way; it is simply in their nature to move the way they do. The movement that we witness demonstrates only those actions that are related to the object itself and the forces acting on it. The intention to move is the topic that takes us one step higher in the hierarchy of action.

**Animation**

The animation level of action classification describes all the movements, naturalistic or not, that are generated from within an object or image itself. Although these images or objects are still subject to external forces acting on them, the motivating factor behind this movement comes from within. A bouncing ball from our earlier example does not generate its own movement; external forces do that. The external force made the ball move in the first place; gravity causes it to fall, and the surface it hits and the material properties of the ball determine the bounce. In contrast, cats and dogs and mice all move as a result of their intention to move. The complexity and range of dynamic possibilities of the various kinds of movement are almost endless. If we simply look at the various types of locomotion, we can see how they relate to the varying nature of the structures that undertake locomotion; fish swim, birds fly, frogs hop, and humans walk upright. The various types of physiognomy of the subjects—some with legs (of varying numbers), some with fins, some that are smaller than a pinhead, some larger than a London bus—determine the various types of movements they make. Not all fish swim in the same manner, and not all birds fly using the same flying technique. Some variations are down to the choices the animal makes; other differences are a result of physical and behavioral dissimilarities. These differences, along with the various influences (physical and psychological) by which the creatures are motivated, simply determine the type of action. Big or small, swimming or flying, living creatures and their various movements have one thing in common: They demonstrate a choice in their movement, and that is the key to animation in this context: intention. A flag does not intend to wave, it does so because of its nature and the forces that apply to it under any given circumstance. However, a spider does intend to crawl across the floor, a lion
Motivation is as varied as the forms of physiognomy. Psychologist Abraham Maslow’s hierarchy of needs goes some way to classifying these motivations:

- **Self-actualization.** Morality, creativity, spontaneity, problem solving.
- **Esteem.** Confidence, achievements, respect.
- **Love/belonging.** Family grouping, sexual intimacy.
- **Safety.** Of body, of resources, of family, of health, of home.
- **Physiology.** Breathing, food and water, sex, homeostasis.

Clearly, not all living beings are motivated to respond to the same degree, and for some organisms these ‘rules’ may not even apply at all. The epic journey that salmon undertake from the sea back up to the river in which they were born in order to spawn and then die is motivated by sex and the need to pass on their particular genes. The bounding action of a gazelle as it makes its way through the African bush demonstrates a survival tactic to avoid predators. The human commuter running to catch a train during the morning rush hour may not be doing so to guarantee his genetic heritage or in an effort to avoid predation, but nonetheless he may still be motivated by a factor of great concern: earning money. We are all motivated by different things.

The motivations that drive this vast and varied range of movements and actions we see within all living creatures are likely to shift and change, creating shifts and changes within the patterns of movement of the individual subjects. These changes may occur over various periods of time. External forces may motivate and trigger certain actions at different time scales. For example, every day the onset of evening brings about activities in moths and their hunters, bats. Every autumn the shortening day results in the mass gathering of martins and swallows for their annual migration from Europe to Africa. Some motivating factors are even longer: The periodical breeding cycle of some cicadas can be as long as 17 years.
In most cases the shifts in behavior are brought about over very short periods of time. It is those internal psychological and emotional forces that motivate actions that we will look at in the next and highest A of animation: acting.

**Acting**

It is perfectly feasible for a student of animation to gain a grasp of animation timing very quickly. Understanding the principles of animation may take a little longer, but they can still be acquired over a reasonably short period. Acquiring the knowledge and expertise needed to create believable, naturalistic animation will almost certainly demand a more prolonged period of practice.

Then there is the task of mastering the art of performance-based animation. This is more akin to becoming an actor; it is likely to take a great deal of time and effort. It not only requires an understanding of the craft skills; it may also demand an understanding of the human condition, something that takes both time and experience to acquire. Acting is the highest form of action in animation. For the performance to be believable, it must transcend the manipulation of the physical and deal with mood, temperament, personality, and thought. Acting in animation deals in thoughts and feelings; the emotional range of the animated characters underpins all good performances. Without it we are left with moving manikins.
The characters in the animated film *The Incredibles* (2004) are some of the most well-defined and well-rounded personalities that have ever been seen in animation. They transcend their physical appearance and are emotionally complex. It is because they are so completely believable that the audience becomes emotionally engaged.

In the film we see the characters take on several guises. One of the main characters is Helen Parr; in her everyday role she is a typical young American woman, though in her role as superhero she is Elastigirl, doing her bit in the fight against crime. As Mrs. Incredible she is wife to Mr. Incredible and the mother of three children; she is the glue that keeps this family, with all its pressures and stresses, together. She is no simple superhero with special powers (however impressive those powers are); she is a real person and as such is completely believable and engaging. We see her, as a mother and housewife, trying to do the best for her family, balancing the different needs and demands of everyday experience—the school run, the trip to the market, feeding the baby, keeping a home, and being a loving wife to a loving husband. When she discovers evidence that she mistakenly reads as the infidelity of her husband, she reacts and behaves in ways based on her emotional responses. We feel her anxiety, disappointment, and anger. In the performance of this character we witness animation as acting. The complex emotions she exhibits are the motivating factor behind her actions.

These psychological and emotional motivations bring about the shifts in movement and action that determine the nature of an animation and a performance. For animators (actors), these psychological and emotional aspects of animation take the greatest time to master. Perhaps we never truly master the craft of acting for animation; perhaps we merely develop and refine our abilities. This is the height of our craft.

Even in the most humble of animated action, the psychological state of a character may be in evidence. The nature of a walking figure will vary depending on the mood and temperament of the character walking. According to the veteran animator Richard Williams, a regular walk cycle conforms to march time and is completed over 12 frames. Although this may provide a reasonable walk cycle, it is a little simplistic to suggest that all walk cycles will be of the same duration. A character that is unhappy or depressed may walk more slowly (certainly not in march time), taking shorter steps and completing the cycle over many more frames. A walk undertaken as a result of a character being elated, let’s say at the news that the individual has just won the hand of a beautiful woman, would probably result in the figure walking rather faster than normal and with a lighter step, perhaps even quicker than march time. The point here is that these walk cycles, though still modes of locomotion, will all vary depending on the psychological and emotional state of the walker.

For the most part animators deal with the issue of animated movement that asks for action and animation in their subjects. The use of acting, certainly acting that demands the highest level of emotional engagement, is less
frequent. Appreciating all these separate A’s of animation and being able to
differentiate between them, as well as seeing how they might work separately
or in combination, will enable the animator to gain a better understanding of
animation and develop toward becoming a master of his or her craft.

Timing for Animation

I have lost count of the number of times students have asked me, “What is
good animation timing?” Like any teacher, I am always very eager to help
and be as much use as I can to my students in their efforts to make the most
of their education. So I strive to tell them and demonstrate to them what
good animation timing is. The truth is: I can’t. Well, that is not strictly true.
What I always try to emphasize is not good animation timing but appropriate
animation timing. What is appropriate timing for one type of animation may
be completely wrong and inappropriate for another type of animation. Only
once the animator has established the demands of the animated film can
that animator make a judgment about what constitutes good or successful
animation timing. Naturalistic animation timing is not the same as cartoon
animation timing and may not necessarily be the same as comedy animation
timing.

All good comedy is a matter of timing. In this regard it is easier to establish
what is good timing or not. If the timing of a gag is wrong, it simply won’t be
funny. However, this is easy to say but a good deal harder to explain or teach.
Good comic timing is not a simple matter of saying that a successful pratfall
is funny if it’s over 12 frames, whereas one over 16 frames is unfunny. Good
comedy acting is a matter of experience, not a formulaic approach to timing.
It is difficult to learn and takes a great deal of practice and experimentation.

The use of animation timing is the principle source of all naturalistic or
abstract actions and all animated performances. Regardless of discipline,
technique, or process, animation timing is central to all animation; regardless
of discipline, animation timing takes a great deal of patience and practice to
fully master.

Timing for animation can be divided into three very distinct types that
describe the various aspects of animated film: pacing, phrasing, and animation
timing. Let’s look at each in turn.

Pacing

Pacing describes the variations in the dynamics of a film narrative and
the animated film in its totality. This form of animation timing describes
the manner in which a story is expressed within a specific timeframe. It
determines how a film narrative develops, how the tension is built through a
series of sequences, how mood is established, and how action is driven along.
Fast action sequences work together and interweave with slower sequences
in an elaborate pattern to build a varied narrative and cinematic dynamic. Building such a dynamic draws in the audience in order to build suspense, create tensions and stresses within the framework of the film, and develop a mood response in the audience. The result takes an audience on an emotional journey, one that is varied, exciting, interesting, and engaging. This is possible only if the pacing of the film changes over the timeframe.

Again, there are no hard and fast rules regarding structuring and pacing in a film, but in general, fast-paced sequences are used to create high drama and action, and slower sequences help develop gentle intimacy and the opportunity to establish mood, location, or characterization. Pacing is concerned with narrative and storytelling rather than the actual timing of objects moving across the screen. That is covered by both phrasing and timing.

**Phrasing**

Phrasing aims to describe the variation in the speed and dynamics of a series of movements over a short time period, often in a short sequence of shots and within a single scene. This classification of animation timing does not refer to the overall narrative of a film but rather the relationship between actions within a sequence. The key point to bear in mind here is the relationship between a series of actions. It may be very useful to consider phrasing as a form of animation choreography. This idea is not limited to dance; it applies to all forms of animation, though it is perhaps within figurative animation, particularly animation of multiple characters, that it is most clearly evident. Rather like most dances, phrasing of action consists of fast, medium, and slow actions that work together to create a series of movements that demonstrate meaning and shifts of mood within a sequence. The way these movements are made and the way they are timed create the animated performance. The variation of timing between the individual movements is essential. If every single action within the shot moved at the same speed, there would be no sense of either naturalist action or a performance. We would be left with just movement—movement that would be pointless and would generate no meaning or context for the performance.

Acting is a matter of thinking, and this thinking then leads to action. Thinking brings about change within movement, a change that is brought about by various motivating factors. The change in speed of the animation denotes the thinking process within a character and subsequently a change in behavior brought about by that thinking. Such phrasing is not limited to animated characters that have personality; such changes will also take place in animated creatures and animals that have no discernible personality but are still driven by psychological factors. Phrasing, when applied well, can even create personality in abstract animation. Chuck Jones’s *The Dot and the Line* (1965) is an excellent illustration of this concept.
**Animation Timing**

The term *animation timing* aims to describe the speed of a single movement of a character, object, or animated effect. Animation timing does not deal with the overall narrative or the acting or performance within a narrative; instead, it deals with such issues as the speed of an object’s actions. This covers all actions, everything from a bouncing ball to a man’s hand reaching out to pick up a cup of tea, a bucket of water falling over and splashing its contents onto the floor, a child turning her head, or leaves blowing on a tree. Animation timing is not restricted to naturalistic animation; it also refers to cartoon-based animation and even completely abstract action. The wonderful animation created by Oskar Fischinger depends no less on a profound understanding and mastery of animation timing than does the figurative work by master animators such as Barry Purves, Hayao Miyazaki, or Glen Keane and Andreas Deja. Regardless of style or technique, format or audience, it is animation timing that gives meaning to motion.

The basics of animation timing are really very straightforward: The closer images appear to one another on subsequent frames, the slower the movement will be. The further apart the images appear on subsequent frames, the faster the animation appears. It is as simple as that. However, it is the complexity of the variations in the movements—fast and slow, acceleration, deceleration, and constant speed—that forms the basic currency of animated dynamics. Using this basic currency of timing, animators are able to construct all manner of sophisticated movement, making elaborate performances possible.

Things in nature seldom move at a constant speed. They have a tendency to accelerate and decelerate at different moments within an action. Movements begin and finish at different moments, actions instigate other actions, they overlap one another, they repeat and they cycle; actions reverse and they progress at different rates. Actions are immensely complex.

In all forms of animation, regardless of process, timing is the one thing they have in common, and the one thing that all students or practitioners of animation should bear in mind all the time is that timing gives meaning to motion.

**The Hierarchy of Animated Actions**

When we look at the nature of articulated movement—that is, movement in subjects that have constituent parts such as limbs or appendages and are not simple objects with no discrete and separate elements capable of independent animation or movement—we may witness a form of hierarchy of dynamics within the movement of the subject. More simplistic objects, such as rocks, planks of wood, tables and chairs, apples and pears, cups and saucers, and any single-celled creature that does not have articulated
parts, would not possess the capacity for such a hierarchy of action. We may consider those subjects that do have articulation and are capable of using their different parts independently of one another as having the potential for a hierarchy of action. These I have divided into three areas: primary action, secondary action, and tertiary action. Each of the separate parts of a subject may possess its own range of movements, some of them capable of primary motion, others only having the ability to move as tertiary action. Arms are usually able to lift objects; the tails of some animals can’t. Each of the different elements of an object or a living being may also demonstrate different kinds of movement as they react to the external forces that act on them. Consider the effect that a light breeze has on hair; this effect will be very different from the breeze’s effect on the head on which the hair grows.

The hierarchy of actions that I set out here is not necessarily set or fixed; it can shift throughout a particular movement. During one phase the primary action may be located in one part of a figure. As the action progresses and changes, the source of the primary action may also shift and change.

**Primary Action**

The term primary action is an attempt to describe the types of actions and the sources of those actions that drive a particular movement. For some types of movement, the primary source of the action may be constant throughout the action; for other actions the primary action may change and shift throughout the movement.

Let’s take a look at a couple of examples. First, consider a figure walking in a regular fashion on a flat and even surface. The primary action and the source of the movement in this walk are located in the figure’s legs and hips. A human figure walking could be described as controlled falling. The balance of the figure is thrown forward (for forward motion) and each leg in turn is swung forward from the hip until the foot is placed on the floor, which prevents the figure from falling to the ground. Parts of the figure other than the legs may be in motion during a walk, but they are not the source of this form of locomotion. It is only the legs swinging forward and the hips rotating that provide the primary source of action. Certainly motion in other parts of the anatomy during the walk may be considered primary, but for the animator’s purposes it might be useful to limit the attention to the legs. The primary source of action throughout a regular walk cycle is located in the hips and legs and for the most part will not change or shift throughout the action.

Now let’s consider the action of a human figure lifting a heavy object from the floor. The principle action will shift throughout the animation of the lift. Initially it may be located in the legs and hips as the figure bends down to prepare for the lift. As the dynamics of the lift progress, this action will shift to the arms as the object is picked up. This action may then transfer back to the legs as the weight is lifted, though it may be transferred to the spine as
the action of the lift concludes. Some elements, such as the movement in the head, may remain constant throughout the action, though this movement would not be considered primary action. All three elements—legs, arms, and back—may be thought of as the primary action at certain points throughout the movement, whereas the movement in the head may not make a direct contribution to the lifting of the object.

Secondary Action

The kind of animation that we may consider as secondary action occurs as a result of the primary action and may even assist in the overall dynamic of a moving subject. However, even if these secondary actions help with
locomotion by creating balance or efficiency in movement, they do not drive the movement.

These secondary actions may often make for more effective, efficient, and economic movement in the figure as whole, but it may still be possible for the figure to move without the use of these secondary actions.

Secondary actions occur in all manner of movements. Although they might not be the focus of an animated movement, they will often provide the necessary element to make the animation appear believable. If they are omitted from an animated action, the results are at best rather ordinary and at worst lack naturalistic and convincing movement.

The action of the arms during a walk makes a contribution to the overall movement, providing a twist to the upper torso and a countermovement to the legs. However, the animation of the arms isn’t critical or even necessary for that particular movement to be made. Although it might look a little unusual or even completely unnatural, it is perfectly feasible for a figure to walk without swinging its arms. The action of the arms during a run is more dynamic and more pronounced than in a walk; the role the arms play in assisting the overall dynamic of a run may be far greater than in a walk. Once again, it is still possible, if a little more awkward, for a running figure to keep its arms motionless and hanging by the side of the body throughout the action.

**Tertiary Action**

Finally, let’s look at tertiary action. This action, like secondary action, is a result of movement brought about by primary action. Tertiary actions are those that are a result of the main movement or secondary actions and do not themselves assist or necessarily contribute to the effectiveness of the overall movement. In addition to being instigated by primary action, tertiary action

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**FIG 3.6** The arms may assist a figure in locomotion but they are not vital to the action. As such, they demonstrate secondary action.
may also be brought about by the less dynamic movement of secondary action. Tertiary action is usually associated with the appendages of a figure such as hair, mane, or tail. Because these appendages do not have the ability to generate movement of their own volition, tertiary action very seldom occurs in limbs or parts of the anatomy that are capable of independent movement.

Think about the different flowing actions of the mane and tail of a horse as it walks, canters, trots, or gallops. The mane and tail will stream out behind the horse to varying degrees as a direct result of the movement generated by the animal’s running action. Now consider the action of the long, floppy ears of a dog as it runs. The ears may be animated with a very vigorous action, moving upward and downward because they are attached to the dog’s head, but the dog’s head is demonstrating secondary action. The head moves the way it does because the entire animal is being driven by the primary action of the

FIG 3.7  a. The tertiary action is evident in the movement of the garments worn by this running girl. b. The movement of the hair is tertiary action.
legs and the spine. In the process of this action the ears will demonstrate the animation principles of drag and overlapping action but will add nothing to the dog's running action.

Tertiary actions are also often associated with costumes and props. Take a look at the way the various fabrics of clothing move with a figure. The nature of the material itself will determine, in part, the manner of the movement. A very light silk will move more freely and readily than a heavy cotton or woolen garment. The movement of air across the clothing will perturb lighter fabrics more than heavier ones. The style of clothing will also generate different kinds of motion. Tight trousers may demonstrate very little tertiary action, whereas very baggy trousers or ones with flared legs will demonstrate more movement. Even very heavy objects may move quite freely, depending on how they are attached to the figure. A heavy sword hanging from a belt around the waist may swing and sway quite a lot, particularly if the figure begins to move at speed.

For animators to create naturalistic animation, it is important that they become aware of these different types of action and have a good understanding of how they relate to and interact with each other. Such understanding will then enable the animator to prioritize his or her efforts in the creation of believable animation.

Animators may choose to undertake the primary animation of a figure before attempting to deal with secondary or tertiary actions. This makes for a systematic approach to creating animation, one that often leads to a more effective and economical way of working. Clearly, however, this approach is not always possible, depending on the nature of the subject being animated, the techniques being used, and even the animation discipline, and it might not always be desirable. Each animator will find his or her own particular way of working; occasionally animators may find that they get better results by working with the separate elements of the animated figure all at once. Making straight-ahead animation often provides an additional vitality to the animation, something that keyframe animation may occasionally lack or even work against. Even when one has the option of keyframing it may not always be the best option. If the action is fast and chaotic and contains figures that have a lot of detail, with appendages and props and irregular movements that vary in timing and that change direction on a regular basis, straight-ahead animation may be the best way to deal with this action.

Of course, some animators need to consider primary, secondary, and tertiary actions all together. Stopframe animators face these constraints each time they animate, as straight-ahead animation is part and parcel of their craft skills. Straight ahead animation demands that all aspects of the animation must be completed at the same time, with each of these different types of action being made on each progressive frame of film. This clearly illustrates just how important it is for all animators but particularly those involved in stopframe animation to have a good understanding of the nature of the various types of action.
The Principles of Animation

The principles of animation came about through a perceived need to improve the standards in animation and animated performances. What started out as a way of defining animation and improving practical methods of production soon resulted in the establishment of certain working practices and processes. More important, it was a development in the approach to making animation. These working practices were found to have almost universal application to animation and as such became the principles of animation. Now, all these years later, through the use of the animation principles and an understanding of dynamics, animators are able to make the most believable and compelling animated sequences.

Of course, these principles apply to both naturalistic and abstract animation, even though abstract animation may not necessarily conform to the laws of physics. Via these principles, animators are able to apply types of movement that imbue objects, abstract shapes, and even simple marks with a quality and nature such as weight, articulation, inertia, and momentum that lend authenticity to the abstract form. Naturalistic animation also benefits from the application of these principles, since some of them relate directly to the qualities everyday objects possess, such as weight and balance.

One of the greatest challenges the animator faces is the creation of believable characters. This depends on many factors and is not simply limited to the way they move. However, for those characters to deliver a believable and engaging performance, it is important that they are convincing within the particular context of a given narrative or film. Therefore it is usually necessary that animated characters move in an appropriately believable manner. Understanding the notion of “appropriately believable” may be valuable at this stage.

Let’s consider two very different productions with distinctive approaches to animation. In animation, feature film work has the highest production values and highest production budgets to match. TV series animation generally has lower production values and is far cheaper to produce. For our first example we will look at the Disney classic Bambi; the TV series category will be illustrated by Ren and Stimpy. The intention here is not to state that one form is better than the other; they are simply different. What they do have in common is that both are of the highest order within their particular format.

All the characters in Bambi represent real animals that for the most part undertake naturalistic action, though animal behaviorists might dispute that claim. For our purposes it is appropriate to call them naturalistic. On the other hand, neither Ren nor Stimpy behaves in any way like either a cat or a dog, which they represent. Their movements, as abstract and cartoony as they are, still owe a lot to the application of the same principles of animation as the characters in Bambi. It is the level to which these principles are used that differs. The limited use of squash and stretch in naturalistic animation may enhance the dynamics of the character and create more engaging
and, in the context of entertainment, more believable animation. It is not important here for the movement to be correct but to appear to be correct and therefore acceptable. The extreme use of this same principle, squash and stretch in cartoon-based animation, does not simply enhance the movement in an effort to make the action realistic; it creates a distinctive form of movement all its own. We no longer compare the action to our own knowledge or preconceived ideas of movement; we are more than content to accept the action as appropriate to the form. Clearly what is appropriate usage for one may be inappropriate for the other. If the animation used for *Bambi* were expressed in the same manner as *Ren and Stimpy*, with shifts in volume, unnatural timing, and lack of perceptible weight, the bounds of believability would be broken. Conversely, if the animation of Ren and Stimpy conformed to an accurate illustration of weight and balance, timing, and the use of volume, it would lose much of its appeal and almost all its humor. It is the appropriate level of animated movement that creates a relevant and appropriate performance for individual productions. The point here is: If it looks right, it is right.

These principles, applied to animated actions, are not limited to character-based animation. They apply equally to animated effects such as water, fire, smoke, wave actions, and the animation of materials such as fabrics, metal, and wood.

It is my intention in this chapter to cover each of these principles in some detail. The principles of animation that were set out by the early Disney animators are a good starting point in covering this topic. Those principles are:

- *Timing*
- *Secondary action*
- *Slow in and slow out*
- *Straight-ahead action and pose-to-pose*
- *Squash and stretch*
- *Anticipation*
- *Staging*
- *Blow-through and overlapping action*
- *Arcs*
- *Exaggeration*
- *Solid drawing*
- * Appeal*

Although these principles may have been useful to animators in the 1930s and 1940s who were striving to improve not only their own work but to raise the level of craft skills and in doing so develop the art form, they do not necessarily reflect all forms of modern animation. Since those early pioneers of animation first struggled with creating animated performances, the craft of animation has moved forward a good deal, and it may be that today’s principles of animation are slightly different from those identified in the Disney studio. At least there may be additional identifiable principles to be
added to the original list as a result of those developments. The majority of these principles clearly remain relevant to animators working in any discipline, despite the fact that these were established before any form of digital animation was available. In those days 3D animation simply referred to what is now termed stopframe animation. There was only one form of 3D animation; it involved using actual objects moving in the real three-dimensional space. Now when we think of 3D animation we understand it to mean geometry-based computer animation.

If one original principle laid down by these pioneer animators might not have made the transition to universal relevancy for all forms of animation, it is solid drawing. This is a principle clearly more appropriate to animators who work in 2D classical animation. Solid drawing is still relevant and very useful for drawn animation, but it generally applies to drawn animation of a particular type—one that depends on a more academic approach to form, the understanding of form often gained through observational drawing and academic life drawing.

Though I see the relevance of all these principles, I would like to suggest a couple of additions to them, in part as a response to more recent developments in animation production processes:

• Drag
• Balance and weight
• Solid modeling
• Energy flow

I will go on to deal with these topics and leave it to the reader to assess whether they are worthy of being called additional principles of animation. We’ll discuss the details in good time, after we’ve examined the original list.

Timing, Secondary Action, and Slow In and Slow Out

I have grouped these three principles together because they were already covered separately earlier in the chapter. In doing that I hoped to link these topics with other aspects of animation and animation timing. I think there is little point covering them separately here as well. Let’s move on to cover in detail those other animation principles laid down by Disney animators during what became known as their Golden Age.

Straight-Ahead Action and Pose-to-Pose

I am choosing to deal with the principle of straight-ahead action next because it relates directly to animation timing and the mechanics of timing and animation production more than some of the other principles do. The two main modes of creating animation, straight-ahead animation and pose-to-pose animation (also known as keyframing), offer animators an opportunity to approach making animation in different ways. These different approaches each have their benefits and drawbacks and are very
useful tools in creating vibrant and believable animation effectively and economically.

Straight-ahead animation is called that because the animation is made by creating one image after another in sequence, starting at the beginning of an action and moving progressively forward—that is, straight ahead—toward the end of the action. Image one is made, followed by images two, three, four, and so on. All stopframe animation is made using straight-ahead animation. It is in the nature of the discipline and as yet there is no alternative method available to animators who manipulate actual objects within a real space to create their animations. The process for Stopframe animation using straight-ahead techniques is deceptively simple: A model is positioned and then filmed for a given number of frames; it is then repositioned and filmed again. The process is repeated again and again until the action or shot is completed. The discipline needed to undertake this kind of animation calls for a high level of concentrated effort, particularly if the animator is using multiple characters in a shot. The process of straight-ahead animation is not the sole prerogative of stopframe; animators working in 2D classical animation or digital animation may find benefits to working this way.

If the action required is a fast one and the animation has a high degree of complexity to it, with plenty of separate elements all requiring animation with their own discrete timings, it may be more effective and economical to use straight-ahead animation to deal with all the elements at once. Trying to work out the keyframes for all these separate elements may be far too laborious and restrictive.

One disadvantage for the 2D classical animator working in this way is that the drawn figures may appear to shrink as the animation progresses. This is a result of very minor differences between subsequent drawings. The individual variation may be only the width of a pencil mark, but over the duration of 50 or 60 drawings, this will be a considerable difference. Care must then be taken to ensure that shrinkage does not occur.

FIG 3.8 a: Straight-ahead action. b: Pose-to-pose animation, images 1 and 4 being keyframe.
Animation made using the straight-ahead method often has more liveliness to it, a vivacity that may not be easily achieved using the pose-to-pose approach, but the latter does allow for more control. The term pose-to-pose comes from the way animators make individual drawings of the key poses with an action or sequence of movements, with the intention of then animating from one pose to the next—thereby pose to pose. Using such poses allows the animator to identify the key moments in the action—hence the name of these drawings: keyframes. This technique, developed for use with 2D classical animation long before the availability of computers for animation, is now standard practice for animators working in computer-generated imagery (CGI). Making such drawings (or positioning models and images on a timeline in digital animation processes) allows the animator to plan, in some detail, the exact movement of either a single figure or object to multiple characters. The positioning of these keyframes along a timeline allows action to shift either backward or forward in time by the addition of frames or the reduction of frames. This helps ensure that an action takes place on exactly the frame on which the animator requires it to happen, allowing for a great deal of control. It may be a useful method, but used clumsily, it can result in actions looking a little wooden.

Consistency of drawing is much easier to achieve using pose-to-pose animation because comparison can easily be made between keyframes, ensuring that scale is maintained throughout the action. Using keyframes as a guide, the inbetweens are far less likely to vary in size.

Many animators regularly use a combination of the two methods, straight-ahead and pose-to-pose animation, within a single action or sequence. This approach to using the technique most relevant to the demands of the animation can result in more believable and fluid movements, an added level of control allowing well-structured phrasing throughout the animation, and complexity of movement and timing, and finally, it gives the animation a liveliness that it might otherwise not possess.

Squash and Stretch

The term squash and stretch describes the action of an object put under certain pressures. Push down on a rubber ball and it will squash; pull a sheet of rubber and it will stretch. However, squash and stretch does not simply apply to rubber balls or rubber sheets; it can apply to everything, or almost everything.

Most things in life possess a certain degree of flexibility. Certainly living flesh has a great deal of flexibility, no matter how bony the underpinning structure. The use of squash and stretch in animation allows for a degree of flexibility in all animated objects and figures. When a person smiles broadly, it isn’t just the mouth that moves—the whole face animates and demonstrates a high degree of flexibility. Everything from flexing an arm as it lifts a heavy
object to a figure running or jumping will express varying levels of squash and stretch.

Let’s consider the movement of a very heavy character such as a giant ogre as he takes a stride. The entire figure may squash down slightly on impact, making him look heavy and cumbersome. Lighter characters, such as fairies, may need to demonstrate less squash, since they are infinitely lighter than giants.

Before animators began using this technique, animation was rather wooden, stiff, and awkward. When used clumsily, squash and stretch may result in all the animation flexing and bending with no real objective and to no real effect. Some of the early animators tended to flex all aspects of a figure almost indiscriminately, resulting in what became known as rubber-hose animation. This was because characters ended up with limbs with little or no structure—no shoulders, elbows, or knees, just bendy tubes rather like … well, rubber hose.

The use of squash and stretch may enhance movement, whereas in nature no such action would be evident. A bouncing ball on impact with the ground would clearly flex and squash downward, but as the ball begins its fall, its shape will remain spherical. However, if the animator chooses to add

**FIG 3.9** Squash and stretch is evident in the cheeks and chin of the figure. The use of squash and stretch can also help generate the illusion of weight.
a little stretch to the ball on the beginning of the fall, the action of the fall is enhanced. Squash and stretch may even be used to good effect in animating objects where no squash and stretch could be possible. A little squash and stretch may be applied to quite rigid material such as glass or ceramic—material that would not normally be subject to squash and stretch. If this is done subtly, it will enhance the action. If it is overdone, which can easily happen, it will make the material look like rubber and will destroy the illusion. One of the key things to bear in mind in using squash and stretch is that although the object may deform in shape, it retains volume. In this regard it neither grows nor shrinks—it merely changes shape.

When taken to extremes, squash and stretch creates very cartoon-like animation, which may be very good for comedy effect but is less useful for naturalistic actions. The master animator Tex Avery regularly used squash and stretch in his animation to such extreme levels that the movement looked completely abstract. His almost unique approach to the animation principles makes his work distinctive and almost instantly recognizable.

### Anticipation

Most actions undertaken by most living creatures capable of independent thought and motion are anticipated in some way or another. Though the anticipation of a movement often begins as a thought process, sometimes conscious but on other occasions completely instinctive, it instigates a form of physical anticipatory movement quite separate from (but not independent of) the main movement itself. Reflexive movement brought about by unanticipated external forces such as receiving an electric shock, a physical impact, and steady pressure from something like a high wind or the ocean's wave action will not be accompanied by anticipatory actions. The preparation for an action varies depending upon the nature of the action and may be very slight or rather extreme. A human figure making a simple upward jump does not simply entail the upward movement of the figure; it is preceded by a downward movement by bending the knees in order for the figure to contract muscle and limbs, very much like a compressed spring. This is done so that the figure can then push off against the floor, flexing muscle and stretching limbs quickly to create the jumping action. The movement of an athlete making a jump may be far more exaggerated in the anticipation of the jump itself because more energy needs to be expended early to fuel the greatest jump possible.

An anticipated action does not have to be undertaken by the entire body; it may be limited to a part of the anatomy such as the arms, the legs, the head. To throw a punch, for example, it is necessary to draw the arm backward, again rather like compressing a spring, before releasing it with a high level of energy. A punch may entail the movement of the entire figure, but it need not. If we consider a fisherman about to cast his line into the river, he must raise the rod tip over his shoulder and move it backward. This action will more than likely entail not only the movement of both arms but also a
rotation of the upper torso and, depending on the nature of the cast, maybe even movement in the legs and feet. These movements, probably quite slow ones, are in anticipation of the very rapid forward and downward movements that constitute the cast itself. The first movement is not the actual cast but an anticipation of the cast; the cast is an action that would not be possible without this first anticipatory action.

In cartoon-based animation, the sharp, rapid turn of a head in reaction to something happening or said, termed a *take*, relies heavily on anticipation. Although this anticipation is generated in the mind as a reaction to some external stimuli, it is made visible to the observer by a distinct movement of its own. Without this anticipation the take becomes a simple turn of the head.

Anticipation leads one action into another and flags to the audience what is about to happen. It is a useful device in guiding an audience's attention, though if it's taken to extremes the action will look artificial and cartoon-like.

**Staging**

The animation principle of *staging* refers to the manner in which the action is presented in order for it to be read and understood by the audience. Action is generally presented in such a manner that enables the character to be recognizable and so that the individual actions that make up content of the individual shot or sequence of shots is clear. Staging is all about presenting the work in such a way as to create or enhance the mood within the narrative and to present only those aspects of the narrative that the director intends. Staging clarifies the action, the action supports acting, and the acting delivers the story.
The same action may be presented in hundreds of different ways; each one of them will present different outcomes offering differing levels of clarity, drama, and audience interpretation. The key point here is communication.

There is a wonderful shot in Disney’s *Hunchback of Notre Dame* (1996) where the harlequin leads the parade of fools into the square at the front of the cathedral. There is action everywhere in the scene. Crowds of onlookers are making merry, waving flags and cheering, while a procession made up of various characters in their festive costumes all show off to the audience with their own distinctive movements. While all of this is going on, the harlequin leads the festival attendees into the square as he performs his song. Over the top of this background, multicolored pieces of paper gently rain down on the whole scene. It sounds completely chaotic, but it isn’t. It is very busy and it is very lively, but because of the way it is staged, the action is very clear. The audience’s attention is drawn to exactly the point where the animators intended; they see only what the animator wants them to see and in exactly the manner the animator intends.

The way an action is staged for clarity not only allows the audience to focus on any given action; it may also offer a nuance in the script, allowing for subtlety of characterization and relationships—relationships that may shift during the shot. Any such shift of emphasis throughout a scene is often determined by the way it is staged and is not at all random. A shot or sequence is usually planned well before the animation begins through storyboarding and the use of animatics and character layouts. Each of these tools provides a level of staging for the action. Storyboarding, or blocking out an action within an individual shot by positioning the characters or objects in a shot along a timeline, provides a very good indication of what is happening and when, and more important, what the audience will see. Blocking out the action this way gives the animator a clear indication of how the action may shift throughout a shot or a sequence, enabling the animator to make decisions about the performance before committing to animation. Clear communication is the key to good staging.

**Follow-through and Overlapping Action**

In the early days of animation, animators would either move a character or leave it at rest, regardless of its design or any detail it had. Seldom do we experience in nature all actions beginning and ending at the same time or moving at the same rate. Actions of a single figure will generally overlap one another; the actions begin at different points in time, depending on their nature and the inertia they possess, and they end at different times, again depending on their nature. This, logically, is called *overlapping action*.

The action of an object made up of a number of parts, often from different materials or at least of a different nature—the hair on a young woman’s head, a dog’s floppy ears, the fabric of a long garment, a sword hanging at a knight’s side—all demonstrate overlapping action and follow-through as the
figure moves. Consider a dog with long, floppy ears. The dog does not have the ability to control the ears independently of the rest of its body (apart perhaps from twitching the base of the ear by flexing the attached muscle). The ears do not possess the potential for independent movement. When this dog begins a very fast run, the head moves up and down. As the head moves

![Diagram of dog's ears demonstrating overlapping action](image)

**FIG 3.11** a. The action of the floppy ears on this dog demonstrates overlapping action. The upward and downward action of the head is countered by the ears. b. Overlapping action occurs in the legs and arms during this cartwheel action.
upward, the ears trail behind, facing downward. As the head begins to move downward, the action of the ears continues to move upward—in other words, the action follows through. When the dog comes to a halt, the ears will once again continue to move forward until the action is arrested, because of the ears' attachment to the head. One action stops, the second continues to move in the direction of the force. The action has followed through.

Overlapping action describes how various parts of a figure in motion move at different rates and at different times. As a standing figure turns to walk away, the action may start with a slow turn of the head followed by the upper torso, the hips, and then the legs. There are often no hard and fast rules as to how a figure will behave or the exact sequence in which the separate elements will move; it is enough to state that these separate parts of a figure will almost always move at different times. The actions will overlap one another.

**Arcs**

In nature, objects seldom move in straight lines. This kind of action is more associated with mechanical actions like those of human-made objects such as machines, engines, and robots. Linear actions may be exactly the right ones for abstract actions, but such movements will look very unnatural in more organic subjects. If you look at the arm action of a human figure throwing a ball using an overarm motion, you will see that the hand describes a very large arc, starting from behind the figure and progressing to a position directly over the figure before extending in front of the body, then finally moving downward, then back toward the body.

However, arcs are seen in all manner of movements, not just the more extreme actions such as a throw. Consider the hand action in a walk cycle. The main action is obviously with the legs and the swinging arms, but through
observation you will see that there is a slight backward and forward motion of the hands. Even this very slight action describes an arc. One of the biggest mistakes inexperienced animators make is to put inbetween drawings exactly between two points on the key drawings when what is needed is for the inbetween to be slightly offset, to create a more believable arc within the action. It is attention to this level of detail that turns simple motion into true animation and makes movements convincing.

Exaggeration

One could easily mistake the reason for using exaggerated movements as to simply make exaggerated animation. There are indeed plenty of examples that use such exaggeration to create cartoon animation that has an abstract dynamic resembling nothing in nature but that is more about design than it is about naturalistic movement. The fantastic animation created by Chuck Jones used exaggerated action and timing to great effect. Though this technique was completely convincing for the movement of such wonderful characters as the Road Runner or Wile E. Coyote, the actions never attempted to describe the real movements of either creature.

**FIG 3.13** The drawings are an exaggeration of the photographed action.
It would be a mistake to think that there is no place for exaggeration in more naturalistic actions. The important point here is that the use of a little exaggerated motion will make the animation appear to be naturalistic. A little bit of squish and stretch on a falling object may just add that touch more spark to the action and give it a little more snap. When used well, this level of exaggeration is felt within the action rather than seen. Without it the movement may seem a little flat.

Animators will exaggerate the action either for obvious visual effect or simply to make an action a little more readable and apparent to the audience. The first may be cartoon-like and stylized, the second may be less obvious but have no less impact for all that. Used with intelligence, appropriately exaggerated action will enhance almost all animation.

**Solid Drawing**

The term solid drawing refers to an approach to making drawings that deals with form, volume, weight, balance, space, and surface values. Many of the pioneers of animation dealt with a much simpler form of animation drawing that didn’t have to demonstrate that the characters were anything other than flat, graphical representations. They had few if any three-dimensional qualities, and the use of perspective drawing was minimal. The volume and shape of early characters would often change in even the shortest of animated sequences, which may well have suited the stylistic fashions of the day but did little to address more naturalistic drawing or animation.

As the art form began to develop and a more naturalistic approach to animation began to emerge, animators became aware that movement and timing were supported by a higher level of drawing. Academic drawing skills that could encapsulate intricate forms capable of suspension of disbelief were needed if the animation was to imitate nature. Character design, then, needs to be undertaken in such a way as to allow a character or a figure to make naturalistic actions. Heavily stylized designs may be very interesting and attractive, but they offer far less potential for natural action. Consideration must therefore be given to the possibility of animated movements when we’re designing characters, and an understanding of basic anatomy will certainly help in this regard. The ability to draw well is an obvious advantage in making 2D classical animation that uses naturalistic figures and characters.

**Appeal**

The principle of appeal deals with the relationship the animation creates between an audience and the characters on screen. This is not a mere matter of design, though it is with character design that the process begins. Through good design, appropriate animation, good staging, and
believable performances, animators are able to make characters attractive to the audience. As a result, the audience will find the characters interesting and engaging and ultimately more able to carry and develop a complex storyline. Appeal in a character should not be misinterpreted as meaning that all characters with appeal are cute and cuddly—far from it. Some of the most memorable characters are villains, who often have more interesting personalities than the “good guys.” Appeal is at the heart of all good character-based animation; without it the work is reduced to movement and the characters become simple manikins.

The script is the source of the emotional engagement, but the acting and performance are what develop characters to a point where they possess appeal. This should not be considered necessarily as being dependent on naturalistic movement; simple actions or exaggerated movements can do much to enhance a character’s appeal. For example, the very simple animation of the characters in South Park is very much part of their appeal, whereas the extreme gymnastic display by Spider-Man is as much a part of his persona as is his distinctive costume design. Both types have appeal but for very different reasons.

I think that the additional topics I cover in the rest of this chapter are worthy of consideration separately from the principles set out in the earlier portion—not that they necessarily occur separately from any of the principles, it is just that they are such important factors in animated movement.

Drag

We will cover the issue of drag in more detail later, when we look at animal locomotion. For this chapter’s discussion it might be enough to say that drag acts on an object as it moves through a gas or a fluid. Resistance is encountered on the surface of the object as it moves through the fluid or gas, creating drag on the surfaces and trailing edges of the moving object and resulting in turbulence.

For the purposes of this discussion we can see how an object will move; as a result of drag, part of that object will be delayed in its movement. A figure wearing a coat with very long sleeves might illustrate the point well. If the outstretched arm in the long sleeve makes a rapid sideways movement, the inertia in the arm is overcome before the inertia in the long sleeve that hangs limply down. When the sleeve does move, the area nearest to the arm moves first as it is drawn through space with the arm. The cloth that hangs farthest from the arm moves at a later time and trails behind the action of the arm. As a result of drag on the trailing edge of the sleeve, a curve occurs in the flowing material.

We may see evidence of drag in all manner of objects. Though it applies to all moving objects (it is only the amount of drag that varies), it is particularly evident in things such as long hair and fabric.
Balance and Weight

One of the greatest difficulties animators face is creating the illusion of weight in an object or character. This is such an important aspect of animation that it is worth linking with the principles of animation. The balance of an object or a figure depends on both its weight and its shape. As a figure moves, shifting its weight to adjust its balance, it undergoes a shift around its center of gravity. Identifying and working with this center of gravity and the shifting of the weight around it are central to creating believable dynamics in a figure. An object’s weight may be illustrated in a number of ways, and the timing of the action will illustrate the amount of inertia a figure, or a part of a figure, possesses. Timing also illustrates momentum of a figure, with both inertia and momentum directly linked to the mass an object possesses.

It is the illusion of weight and balance that gives drawings, models, and images of other kinds a level of believability in their movement. This illusion may be achieved through the use of squash and stretch, overlapping action, follow-through, and drag. Balance and weight are among the basic currencies of animation; if they are not achieved in an animation, more elaborate aspects of movement linked with acting and performance will become difficult, if not impossible.

Solid Modeling

As with solid drawing, solid modeling deals with aspects of form, volume, space, and surface values that impact the animation of any character. Solid modeling can also give a character a good deal of appeal. The transition from design to build is a very important one, and retaining the qualities of the concept art or the character design is important but often presents difficulties when translated into three dimensions. The practicalities of articulating a figure, particularly one that needs to demonstrate naturalistic and believable qualities, are substantial. Poor modeling will not only restrict the way a figure moves and behaves; this restriction in turn will definitely impede performance. Lack of solid modeling may also mean that the character not only lacks any kind of appeal but appears “dead” and incapable of expressing the spark of life that all characters must have if they are to be believable and capable of expressing emotion.

It is important that any figure be built in such a way that the animator is capable of using it to create the animation necessary for the narrative. If movement is restricted at all, it is doubtful that the animator will get the best from the model, regardless of that animator’s skills.

Energy Flow

With a figure in motion it is possible to track the way energy is directed through the body as an action progresses. This capability may prove very useful in thinking about how the body shifts and rotates and how the various
tensions and stresses within the figure contribute to an action or how they counter weights or stresses applied to the figure.

If we consider the action of a figure throwing a javelin, we can see how the action of the throw progresses through the figure and how the energy of the throw flows through the body. If the figure is throwing the javelin from a standing position—that is, not running—we may see how the movement starts from the ankle. The entire body will begin by moving forward and slightly pivoting at the ankles. The energy quickly moves on to a movement in the legs and progresses to a twist in the hips. This creates a rotation in the upper torso. At this point there is considerable momentum in the throw, which is increased as the shoulders continue to rotate around. The energy of the throw is evident through the progressive movement of the upper arm, which moves rapidly forward, an action taken up by the forearm, then the hand, and finally the fingers, before the javelin is released. In this model we can see how the energy flows from the ankles right through the fingertips to complete the throw.

Not all actions are as extreme as a javelin throw, and the flow of energy will be different in each case, but if the animator understands this flow of energy, it will invariably make for more fluid motion and naturalistic animation in the animator’s work.