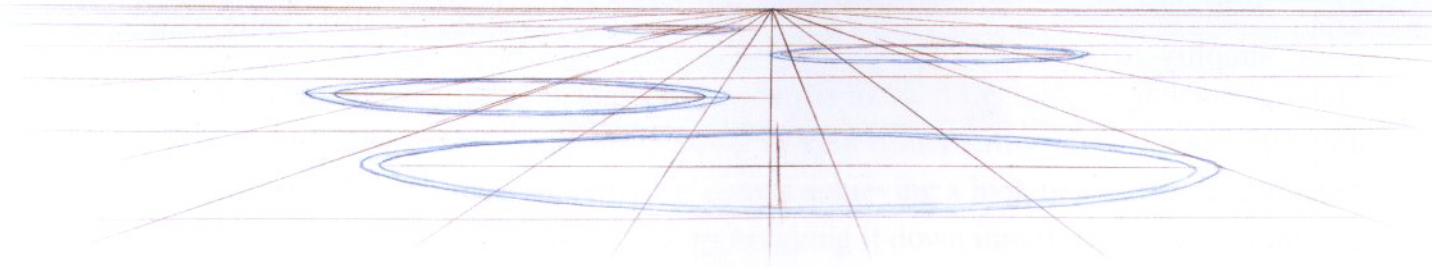
It is extremely important when attempting to draw water, to learn how to break down the shapes we see in natural water formations into much simpler shapes and designs. The amount of detail in even the smallest, simplest splash is intimidating.

Just tossing a medium-size stone into a swimming pool will generate hundreds of droplets breaking up off of the main mass of displaced water, with an extremely complex design of over-lapping ripples radiating outward, as the hundreds of droplets all fall back into the water. If we attempt to draw all of it, we will quickly be overwhelmed by the details.

Even the most complicated water animation is highly simplified compared to the real thing. This can be said of most effects elements we will be discussing in this book, so watch out for it. Very, very important to simplify and stylize!

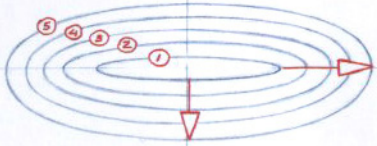
Perspective is extremely tricky to master when animating water. Such apparently abstract shapes don't at first glance appear to fall under the rules of perspective as they are generally taught, working with vanishing points and a predetermined perspective grid against which a given image is constructed. However quite the opposite is true. I have seen a lot of fantastic water animation that is plagued with fundamental perspective drawing mistakes, in high-quality animation films.

How a splash integrates with the perspective of its environment is extremely important if we expect our animation to feel natural. We must determine our perspective grid before attempting to animate any water surface or splash, and then determine how the circular or elliptical shapes that underlie the structure of our water designs sit upon that perspective grid. Our effects must always integrate themselves credibly with their environment, or else the viewer will feel that something is amiss, and their attention will be drawn away from the story. Properly executed special effects should not draw undue attention to themselves.

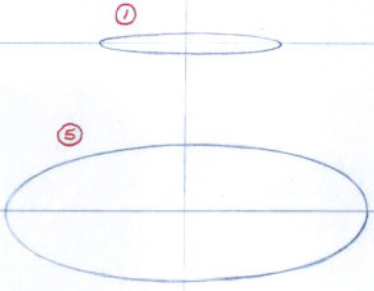


A perspective grid must be established when animating effects which occur on a surface. The ellipses of ripples caused by a splash must always conform to this perspective grid.

DON'T DO IT THIS WAY!

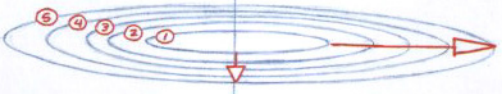


If we animate ripples expanding uniformly in every direction, we lose the correct angle of the perspective.

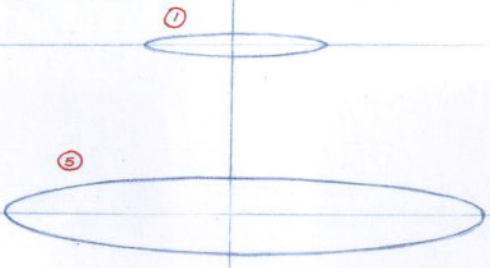


Ellipse 1 is quite narrow vertically, and describes a sharp perspective on which the ellipse is sitting. Ellipse 5 has expanded incorrectly and now sits on a much flatter perspective.

DO IT THIS WAY!

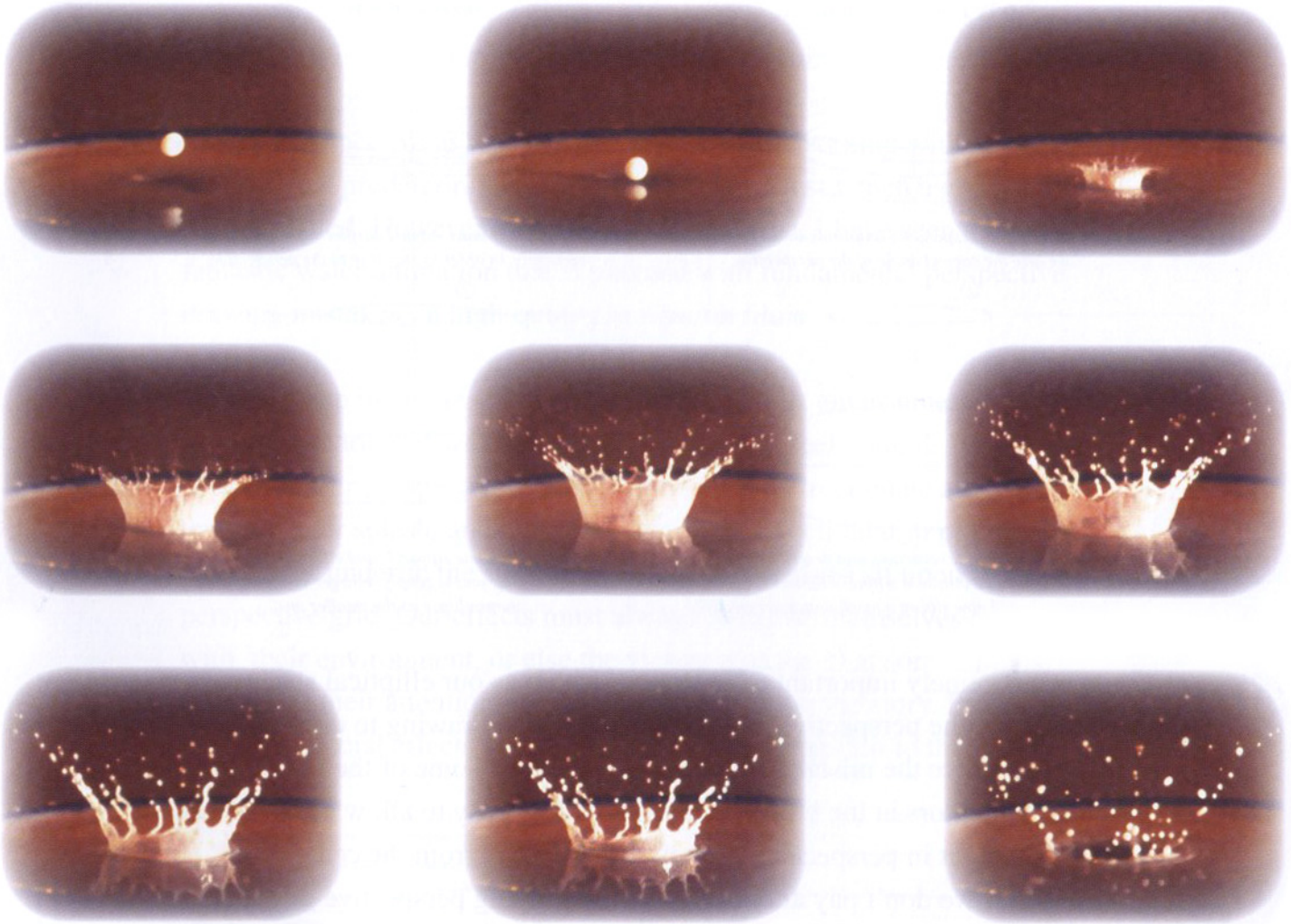


Ripple ellipses must expand farther horizontally than vertically, in order to stay true to the perspective.



Here we have the same ellipse 1, and ellipse 5 has stayed true to the perspective, and is simply a larger version of the exact same ellipse as the smaller one.

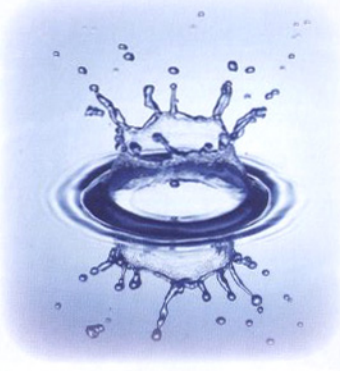
Also extremely important to remember is that as our elliptical shapes animate—the perspective must be retained from drawing to drawing. This is where the mistake is often made, even by some of the best effects animators in the business. It is incredibly easy to allow our ellipses to flatten out in perspective, as they expand away from the center of a splash, if we don't pay attention to the underlying perspective grid and follow some basic principles of how ellipses expand in perspective. Now let's look at the forces at work in the anatomy of a splash, and break it down into simple steps.



This high-speed photography sequence of a drop of milk landing in a bowl of milk, illustrates very well just how complex even the smallest splash can be. In order to draw this phenomena, we need to stylize and simplify. At the same time the effects animators have an advantage, because they can also exaggerate the design and physics of a splash, to make it more snappy, flashy, punchy, and dynamic!








In these beautiful high-speed water droplet splash photos by Andrew Davidhazy, we see a brilliant array of perfect designs. These photos are random and do not represent a sequence of action. Each splash, either the initial splash or the secondary splash, is as unique as a fingerprint! It is important to keep in mind always, that while we do learn a great deal from observing reality, it is the special effects animator's magic to be able to exaggerate and thus almost improve upon nature's staggering beauty.

Raindrops are the simplest, shortest splashes. In these sequences, only four drawings are used. In some cases only three or even two drawings can work reasonably well. Personally I always like to go a little bit farther even with something as simple as a raindrop. This is a straight on side view. The drops on this page would be hitting a solid surface.

It is plain to see, that these are much simpler designs than something like the photos of the milk drop on the previous pages. This is especially important when you are animating lots and lots of raindrops, but it also looks cleaner and neater than getting too detailed with your splashes. This is a slightly downward view of a raindrop.

This is a straight down shot of a raindrop splashing on a solid surface. Again, this formula is not carved in stone. If I am animating a lot of raindrops I might do the majority in three drawings, some in four drawings, and the occasional one in five or even six drawings. This would introduce a nice amount of variety to the look and implied scale of the raindrops.

A splash's proportion, or size, is a very important thing to consider when animating a splash. The #1 splash here is roughly the size of a big raindrop splash, or a small pebble being dropped in the water. It should only last about half a second, or 12 frames of film and the ripples resolve almost immediately. The secondary splash of this tiny splash, is no more than a tiny droplet on top of a little jet, shooting up for 4 to 6 frames. The second, splash #2, is about the size of a splash created by a baseball or a fist-sized rock. It should last about 24 to 36 frames, or a little over a second, and its ripples could carry on as long as two or even three seconds. Its secondary splash should be substantial.

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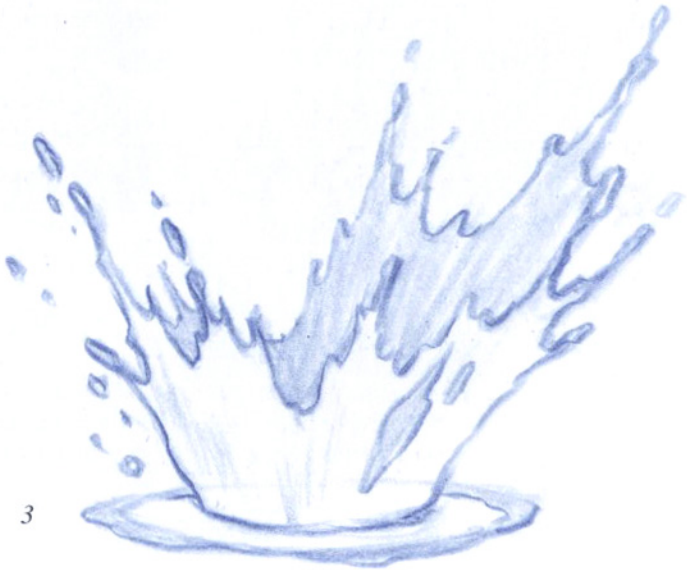
The #3 example is a medium to large splash, as might be created by a basketball-size rock. It should last about 2 or 3 seconds; its ripples could carry on outward away from the point of impact for several seconds before resolving, and its secondary splash might be as big as its initial splash. The key to the size and duration of a splash, is how much water is being displaced.



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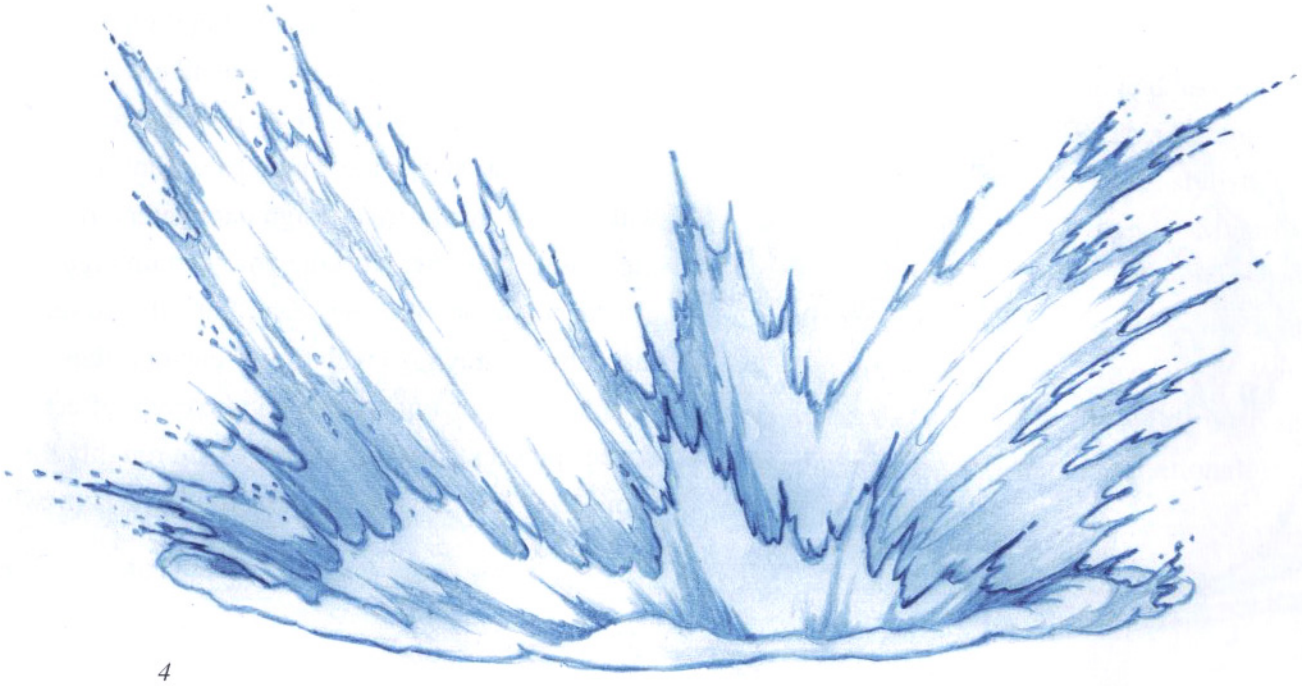

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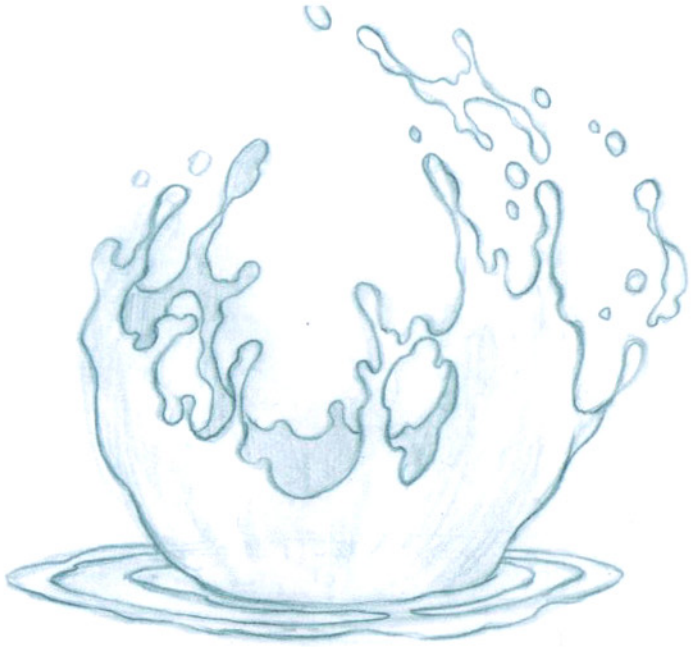
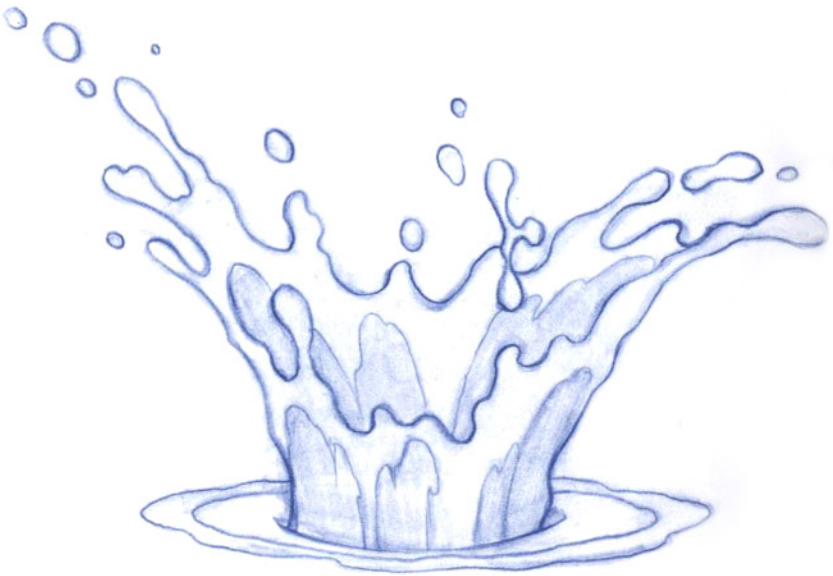
The #4 splash is absolutely enormous—the kind of splash that might be created by a breaching whale or a chunk of glacier ice falling into the ocean. The sheer volume of water being displaced is tremendous, and to really get that feeling of immense volume across to the viewer, the effects animator needs to make this splash move relatively slowly after the initial explosive impact. The secondary splash will also be huge and a splash like this doesn't just generate ripples, it generates waves, which can follow through for several seconds. This kind of effects animation takes a great deal of finesse, labor, and patience to do properly. There are no fast easy ways to make something this big look convincing.



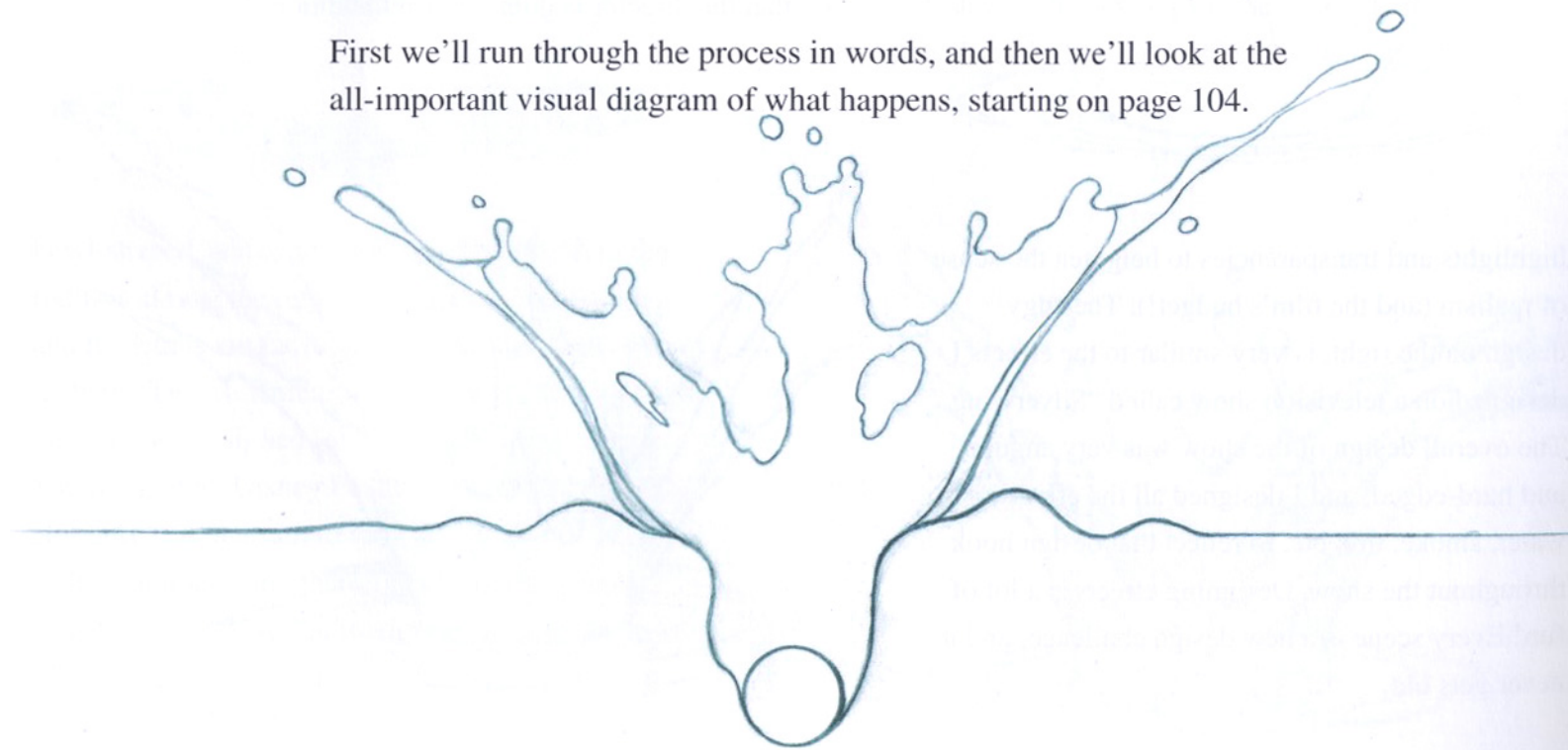
A splash's design is a wonderful thing! One of my favorite aspects of animating special effects like water is that there is always room for quite a bit of personal design interpretation, even if you are bound by a film's design to stay within some fairly strict design parameters. It is interesting to note that after working with certain highly talented effects animators over the years, I am able to recognize their effects drawings with only a cursory glance. A bit of an artist's personality can go into every effect. All of the splashes on these two pages are roughly the same size. The first one on the left here, is somewhat bowl-shaped, and fairly realistic. The splash to the right, is almost the opposite shape of the first one, and its details are far more globular and slightly less realistic. This is similar to the style of effects drawings that we designed for the feature film, "Lilo & Stitch", at Walt Disney Feature animation in Florida. Not only is it pleasant to look at, it is also a far easier style to animate, and therefore cheaper to produce. Less full, "cartoony" animation might go even farther in this direction, simplifying water design to its most basic forms, in the best interests of economy—both visual economy—and fiscal economy!



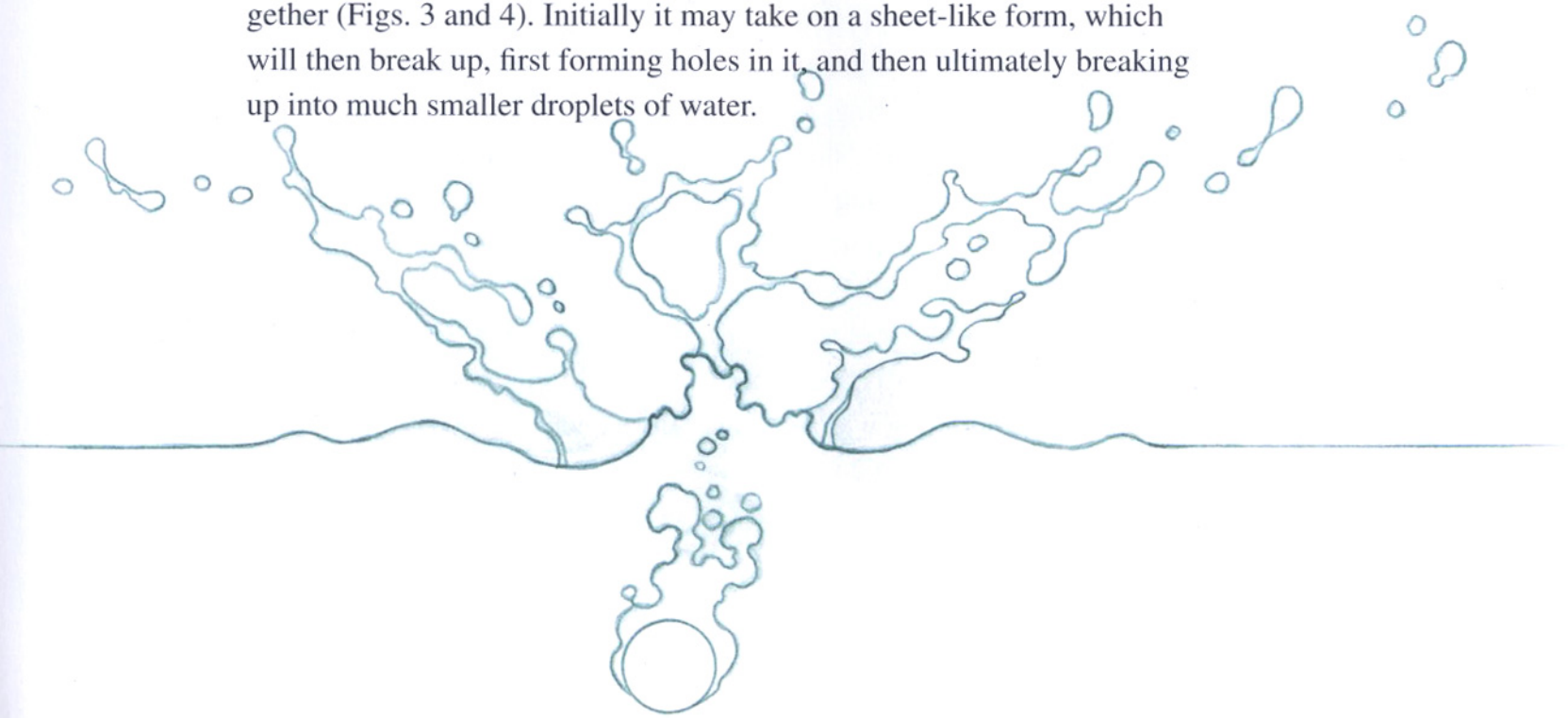
This splash is a far more elegant and less cartoony approach to designing a splash. This style might be more suitable to a more dramatic, stylistically sophisticated film, like Walt Disney's "Mulan" or Dreamworks "Prince of Egypt." Being more realistic and far more detailed, naturally is also more time-consuming and expensive to produce. With effects this realistic looking, it is almost a given that the director is going to want additional highlights and transparencies to heighten the sense of realism (and the film's budget!). The edgy design on the right, is very similar to the effects I designed on a television show called "Silverwing." The overall design of the show was very angular and hard-edged, and I designed all the effects, water, smoke, fire, etc. to reflect that design hook throughout the show. Designing effects is a lot of fun! Every scene is a new design challenge, and it never gets old.

The primary force at work in any splash is generally an object entering and displacing the water, forcing it to move out of the way, or pushing it aside. The energy of the object entering the water, its size, shape, density and velocity, all contribute to the splash's attributes, as well as the tendency of all liquid to displace itself on a molecular level quickly and efficiently as governed by its viscosity and the forces of gravity. In the case of a medium-size splash, let's say a baseball landing in the middle of a swimming pool, there is actually quite a violent reaction by the water as the baseball collides with it.

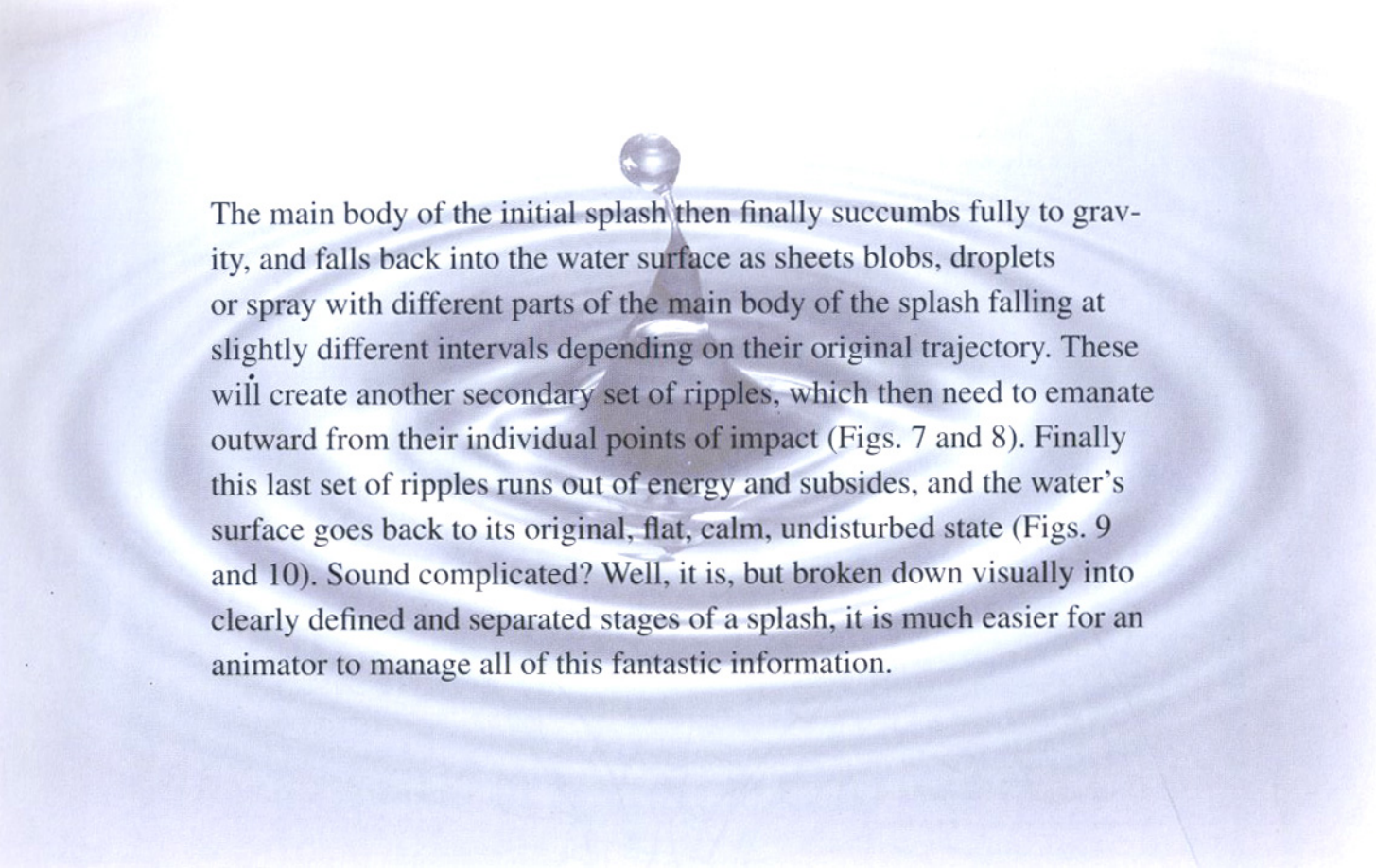
First we'll run through the process in words, and then we'll look at the all-important visual diagram of what happens, starting on page 104.



Initially, the energy and mass of the ball entering it forces the water forming the actual splash violently outwards and upwards (Fig. 1). The ball drags a bubble of air underwater with it, which breaks apart almost immediately into smaller air bubbles. Waves or ripples emanate outward in a circular pattern from the point of impact. As the main body of the splash, the water that was first displaced continues its trajectory up and away from the point of impact (Fig. 2), it begins to succumb to gravity, and at the same time it begins to be pulled apart by the effect that movement and energy have on its ability to hold its viscosity together (Figs. 3 and 4). Initially it may take on a sheet-like form, which will then break up, first forming holes in it, and then ultimately breaking up into much smaller droplets of water.



During this process, the mass, sheet, or droplets of water will reach an apex in their trajectory path, where they will slow down before beginning their continued path of motion downward, back toward the water's surface (Figs. 4 and 5). We refer to this slowing in and out at the apex as "hang time." It is a clear illustration of the force of gravity at work. This hang time is an important aspect of any splash animation, and will largely determine the scale and dramatic effect of our splash. As this apex hang time is occurring, ripples continue to emanate outward from the initial point of impact, slowing down and diminishing in size and intensity as they go. During this mere fraction of a second, water also rushes back into the air hole that was punched into it by the ball in the first place; this often creates what we call a secondary splash or jet, as the water fills the hole and is propelled upward, however, this secondary splash does not always occur and is generally much smaller than the initial splash. Its timing will also differ from and overlap the timing of the initial splash (Figs. 5 and 6).



The main body of the initial splash then finally succumbs fully to gravity, and falls back into the water surface as sheets blobs, droplets or spray with different parts of the main body of the splash falling at slightly different intervals depending on their original trajectory. These will create another secondary set of ripples, which then need to emanate outward from their individual points of impact (Figs. 7 and 8). Finally this last set of ripples runs out of energy and subsides, and the water's surface goes back to its original, flat, calm, undisturbed state (Figs. 9 and 10). Sound complicated? Well, it is, but broken down visually into clearly defined and separated stages of a splash, it is much easier for an animator to manage all of this fantastic information.

(This is a straight-on horizontal side view of a splash as if it were cut in half)

Fig. 1

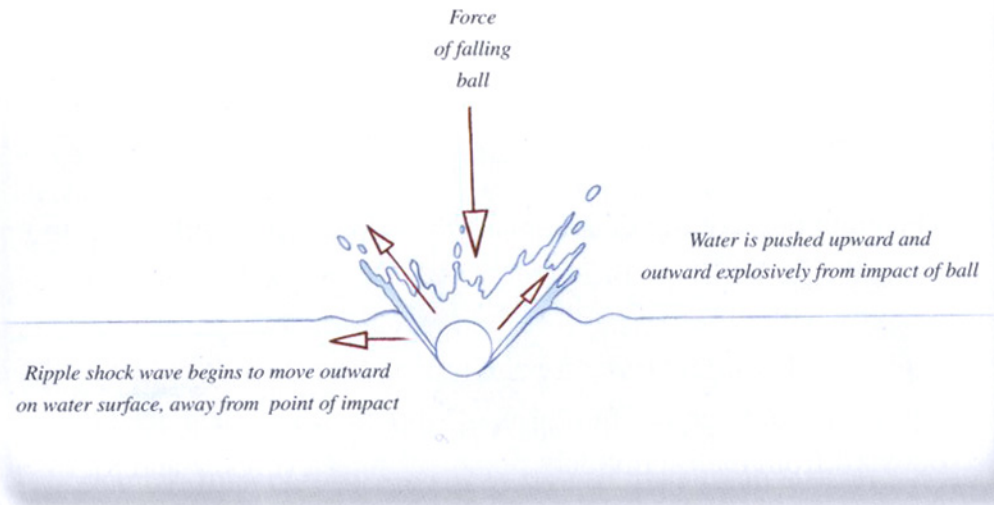


Fig. 2

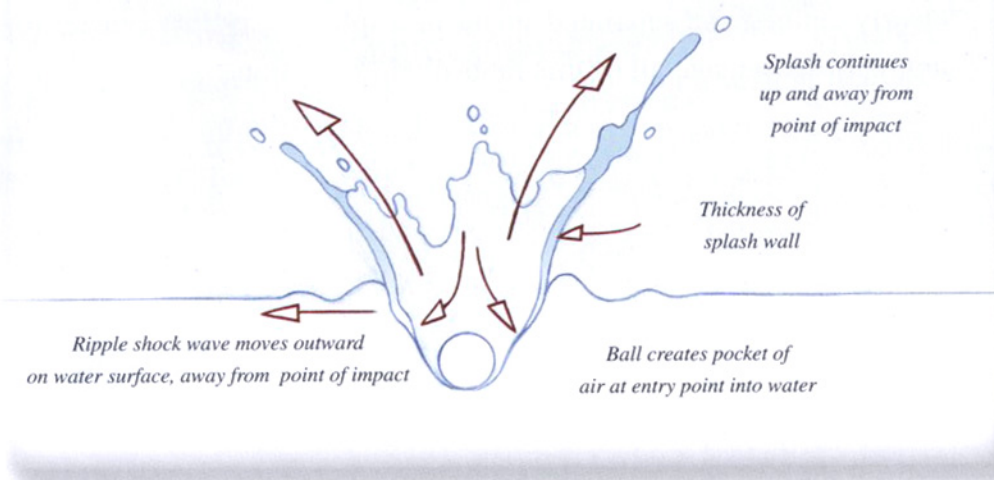


Fig. 3

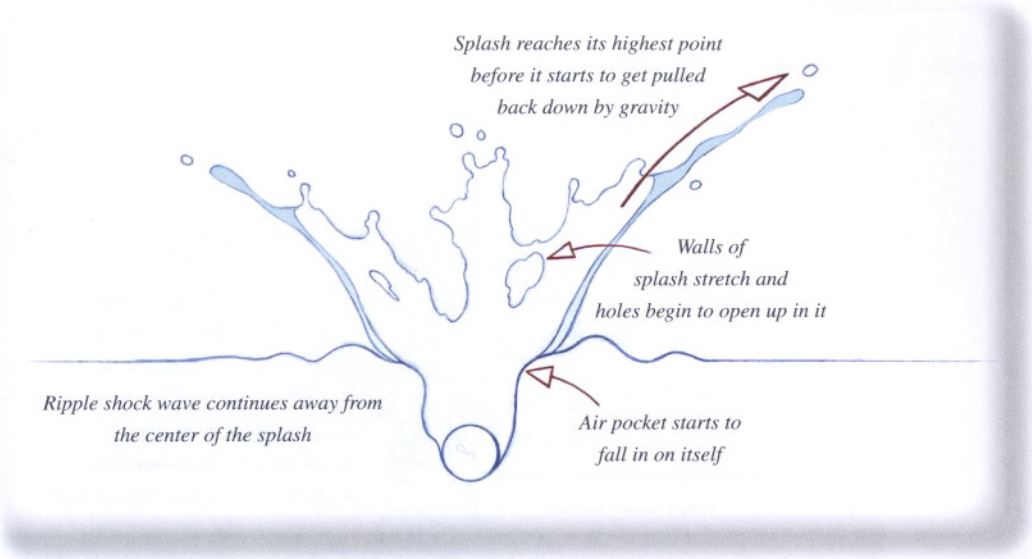

Splash reaches its highest point
before it starts to get pulled
back down by gravity
Walls of
splash stretch and
holes begin to open up in it
Ripple shock wave continues away from
the center of the splash
Air pocket starts to
fall in on itself

Fig. 4

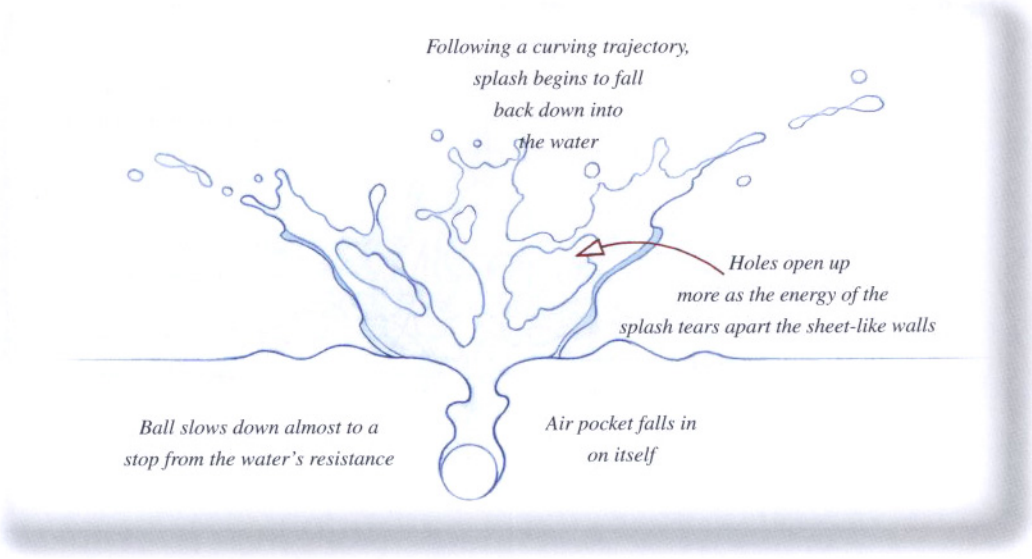

Following a curving trajectory,
splash begins to fall
back down into
the water
Holes open up
more as the energy of the
splash tears apart the sheet-like walls
Ball slows down almost to a
stop from the water's resistance
Air pocket falls in
on itself

Fig. 5

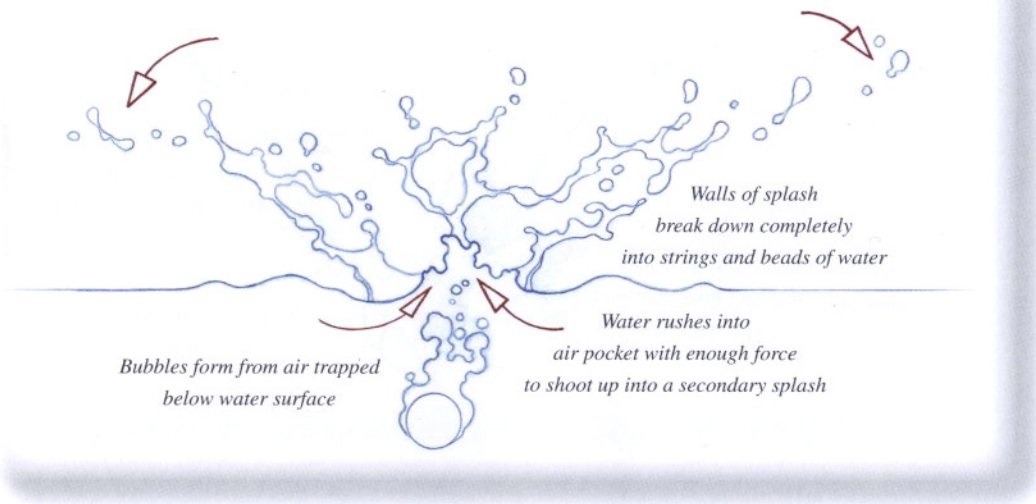

Walls of splash
break down completely
into strings and beads of water
Water rushes into
air pocket with enough force
to shoot up into a secondary splash
Bubbles form from air trapped
below water surface

Fig. 6

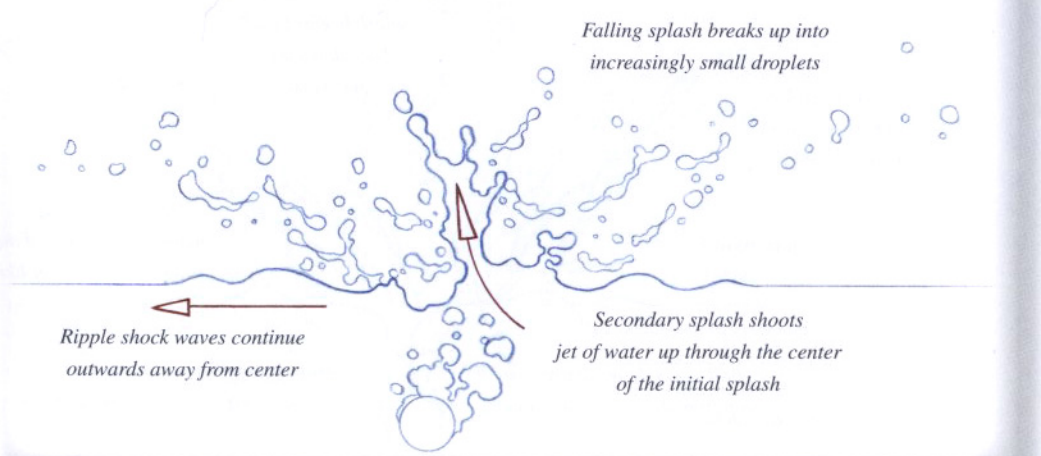

Falling splash breaks up into
increasingly small droplets
Ripple shock waves continue
outwards away from center
Secondary splash shoots
jet of water up through the center
of the initial splash

Fig. 7

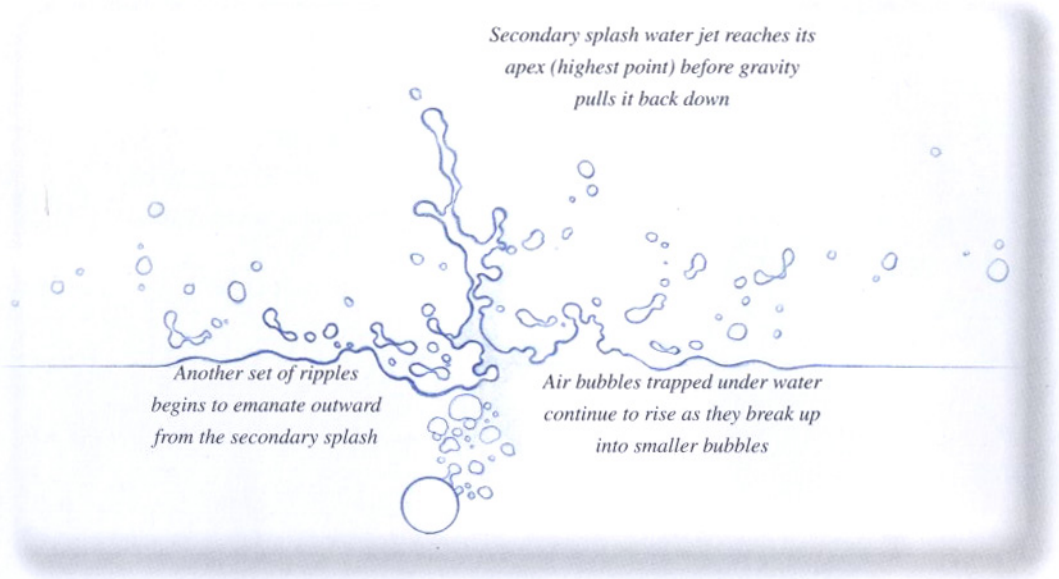

Secondary splash water jet reaches its apex (highest point) before gravity pulls it back down
Another set of ripples begins to emanate outward from the secondary splash
Air bubbles trapped under water continue to rise as they break up into smaller bubbles

Fig. 8

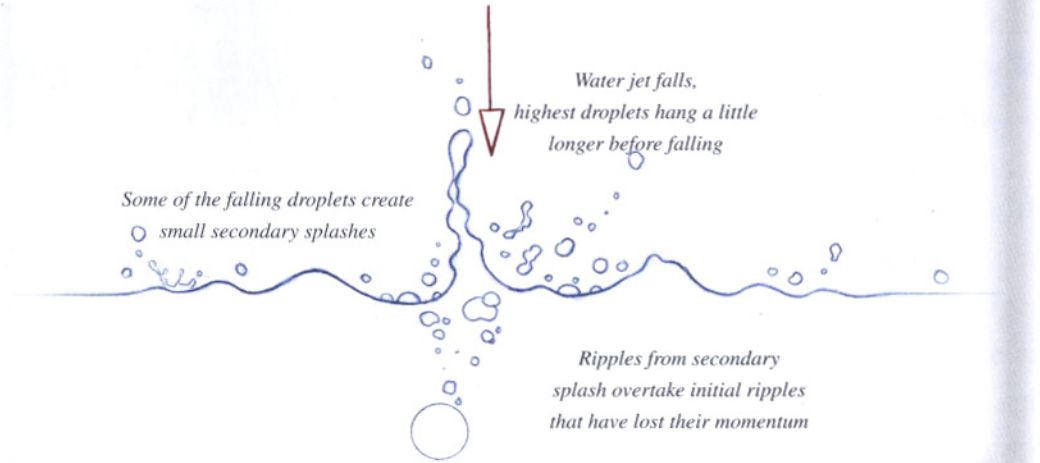

Water jet falls, highest droplets hang a little longer before falling
Some of the falling droplets create small secondary splashes
Ripples from secondary splash overtake initial ripples that have lost their momentum

Fig. 9

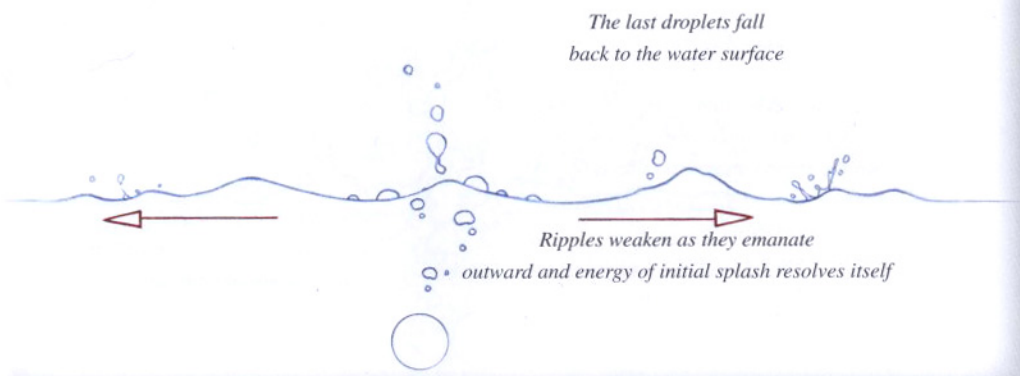
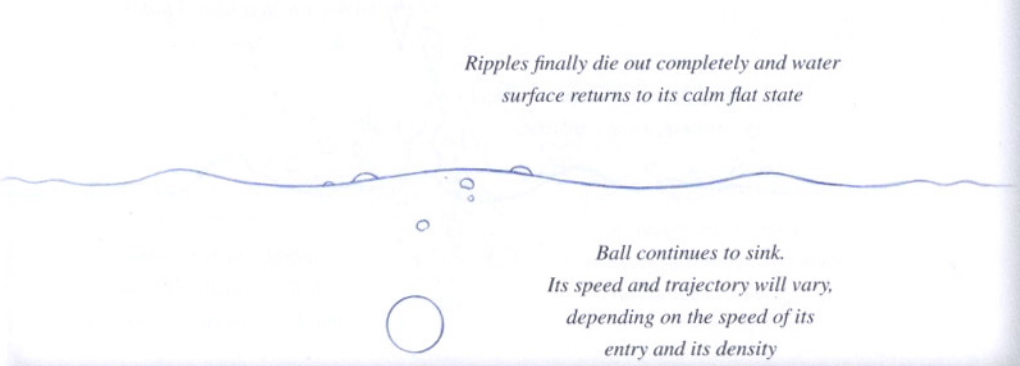
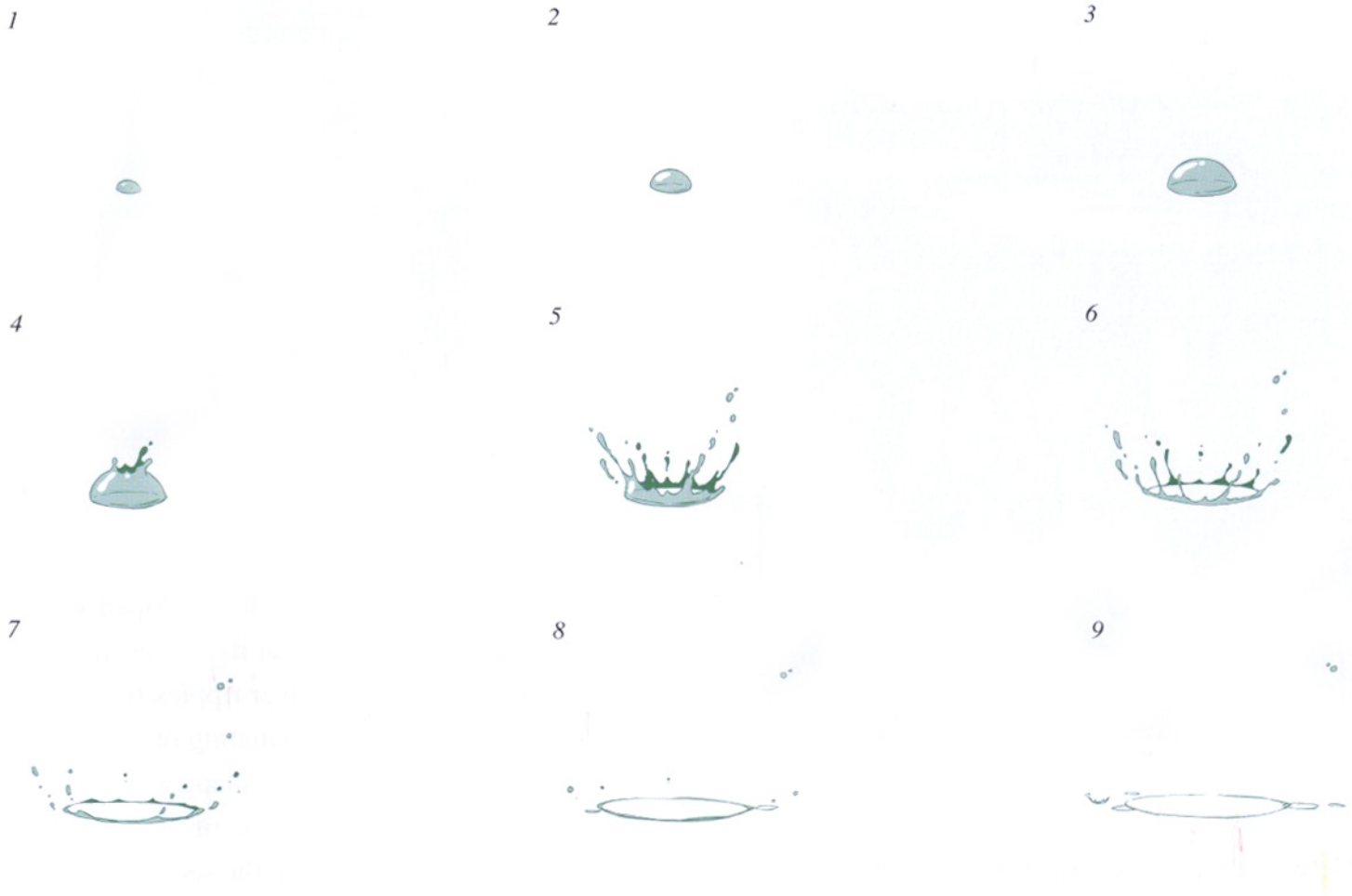

The last droplets fall
back to the water surface
Ripples weaken as they emanate
outward and energy of initial splash resolves itself

Fig. 10


Ripples finally die out completely and water
surface returns to its calm flat state
Ball continues to sink.
Its speed and trajectory will vary,
depending on the speed of its
entry and its density

Here's a real splash that was created by tossing a rock about the size of a baseball into a river. The walls of the splash are breaking up, and the secondary splash, or jet, is just starting to shoot up the center.

Here is a photo of a well-developed secondary splash, or jet, at its highest apex. You can see the leftover ripples from the initial splash, still emanating outward. Depending on the size, shape, weight, trajectory and entry angle of the object that caused the splash, the secondary splash can vary greatly in size relative to the initial splash. In some cases it is much larger than the initial splash, but it is generally a much smaller splash.



A small water or soap bubble bursting creates its own tiny splash. A bubble can form extremely quickly, suddenly appearing on a water surface, or it can expand slowly as it reaches its breaking point. When it does reach critical mass, a tear first appears on the top of the bubble, bursting outwards very suddenly (4, 5, 6). After the initial tear in 4, the bubble breaks down very fast as in 5.

As the bubble breaks down completely, the force of its bursting creates a unique little splash, which then resolves itself much as a larger splash created by an object which has been thrown into the water, just on a much smaller and lighter scale. In this bubble animation, I added a secondary splash caused by one droplet which lands after the main splash has resolved (15 through 18).

This splash is very similar to the more technically drawn diagram of a side view of a splash on the preceding pages. A splash of this size and intensity could have been created by an object about the size of a golf ball being thrown into a calm pool. In drawing #1 we see the initial impact, which should have an explosive energy to it, appearing as an already well developed little splash shape. If this stage is animated too slowly, with the splash growing gradually in the first 6 to 8 frames, it will not have the necessary impact, it will look slow and unreal. As the splash continues its trajectory upward, its wall begins to become too thin for the

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water molecules to hold it together, it begins to stretch and tear, and we see holes begin to open up in the thin sheets of water. Always keep in mind the directional energy that originally created the splash! As the walls of the splash tear apart into droplets and fall back to the water's surface, we see a secondary splash, or water jet, shoot straight up the middle of the splash's point of impact, as water rushes in to fill the hole created on impact. Drawings #10 through #15 show the secondary splash shooting up and falling back down, creating yet another tiny splash. The overlapping timing of these different splash elements is what gives good splash animation its dynamic and entertaining quality.

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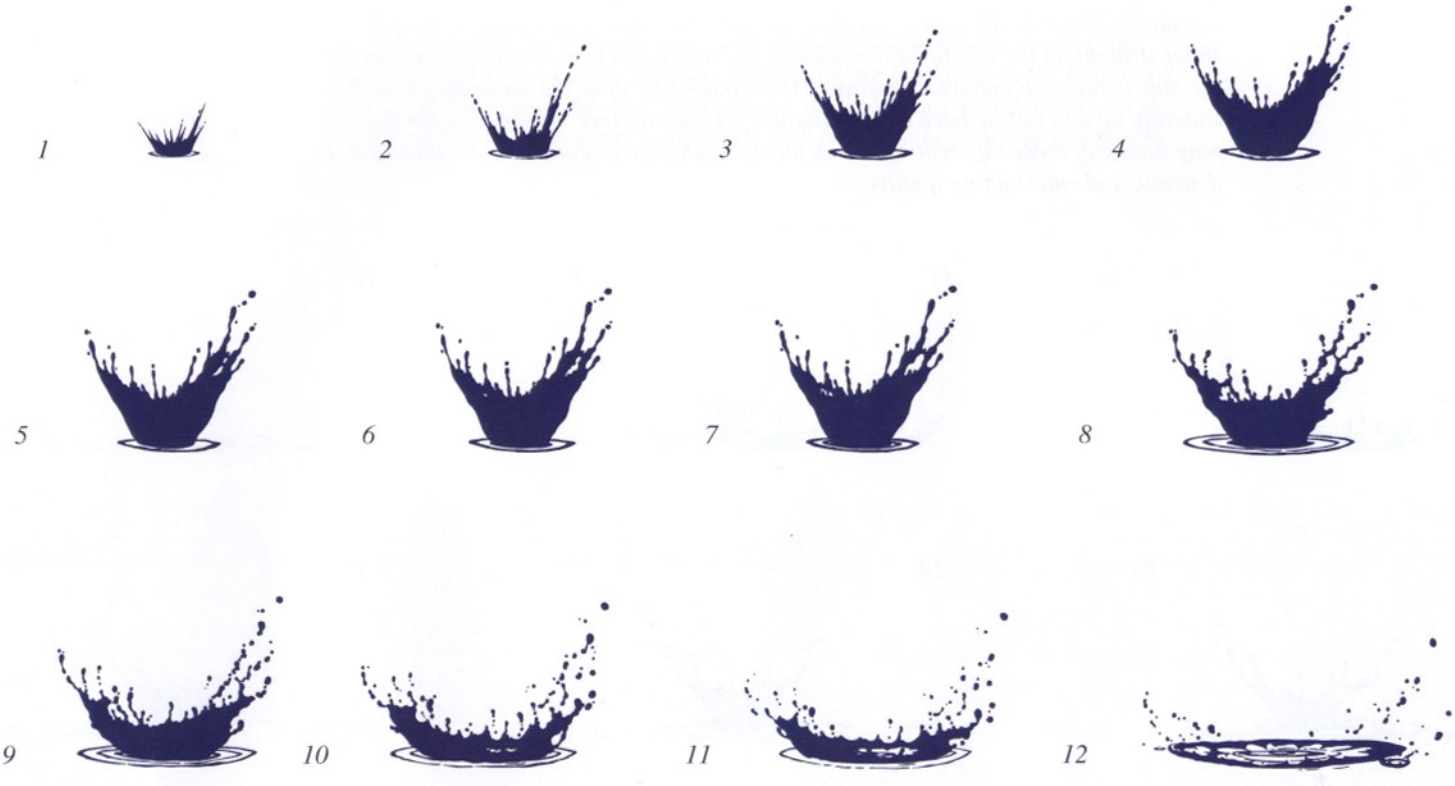

The splash on these pages is a medium-size splash, as if we dropped a baseball in the water. I have silhouetted this animation to show more clearly the importance of asymmetry when designing a splash. The sequence of separate events that make up this splash are basically identical to the smaller splashes in the preceding pages. The initial impact, drawings #1 through 4, in which the shapes are most pointed and directional. This must not be too slow or effect will lack impact.

The next stage is the apex, or highest point that the water will reach as it shoots upward. The drawings get closer and closer together as the splash slows to its highest point in drawings #5 through 7. The walls of the splash stretch and begin to tear. From drawings #8 through 12, the splash falls back down, continuing to tear apart, accelerating as it goes the drawings getting farther and farther apart as they get closer to the surface. From drawing #12 through #18, the splash does its final resolve, with the main ripple that was caused by the initial impact slowing down as it spreads out.

Care must be taken to assure the elliptical perspective is kept consistent. Several droplets create tiny secondary splashes as they land, giving a nice overlapping feeling to the overall timing of the splash. Although there may have been around fifty droplets visible around drawings #9 through 12, only four or five actually splash down, but that is enough to suggest that they all landed. Adding too many landing drops will just make your animation overly busy!

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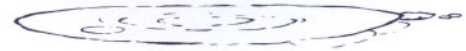
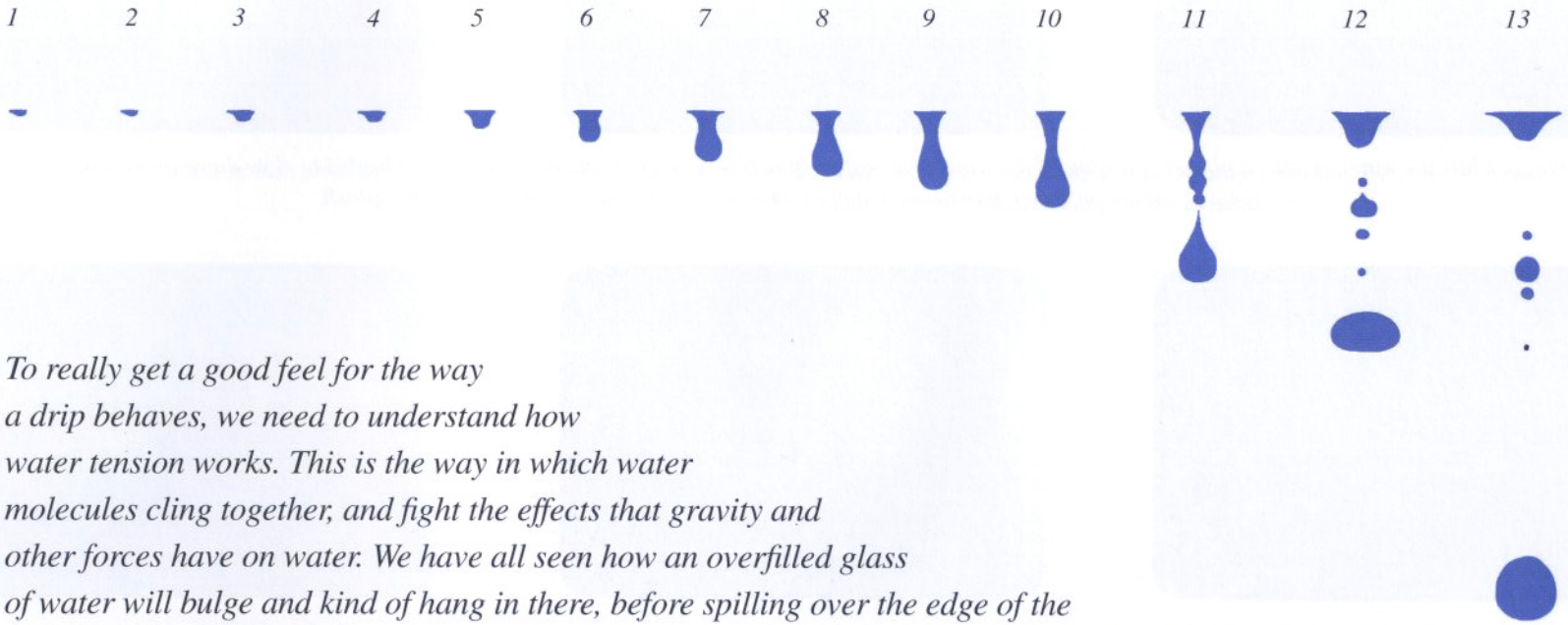
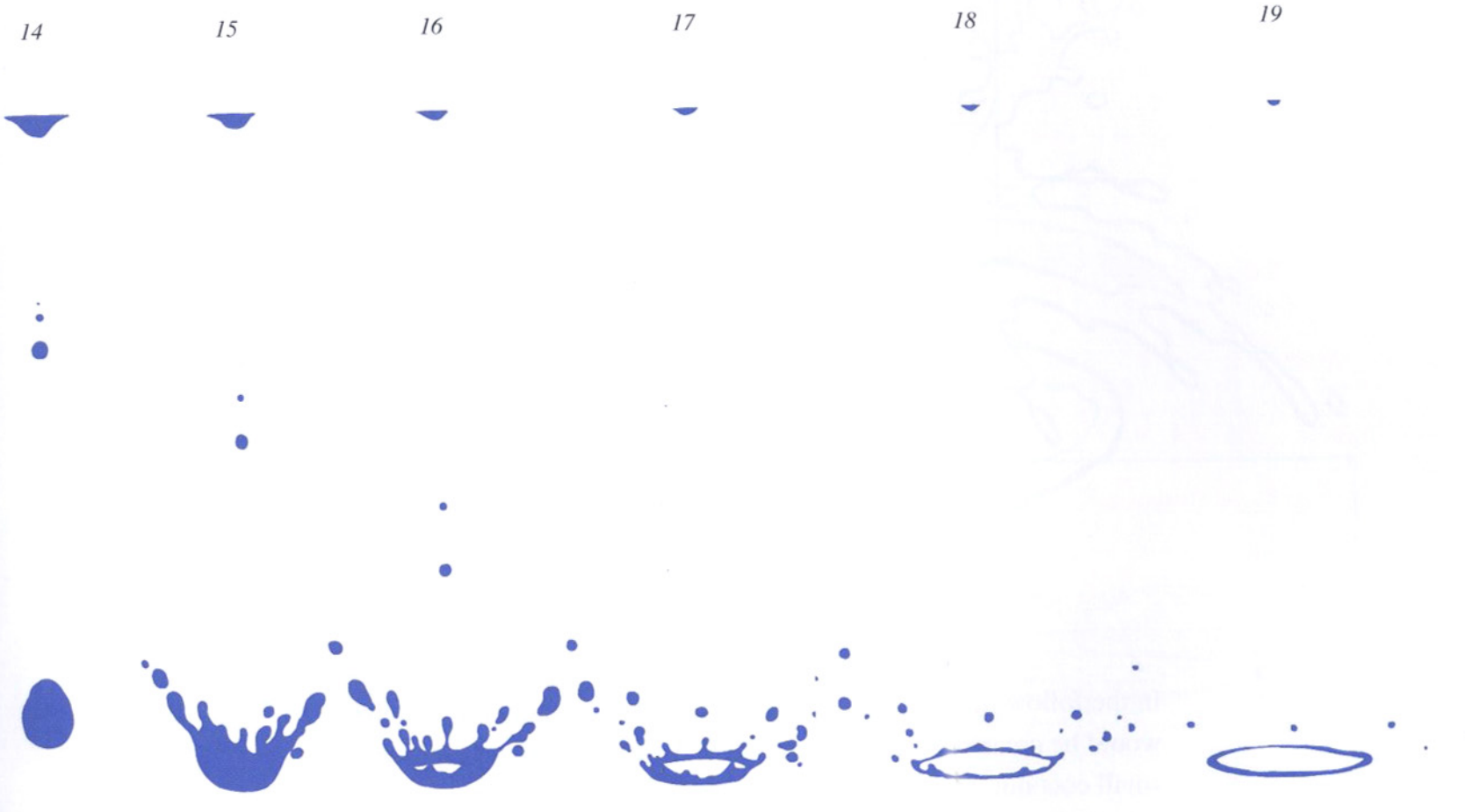
18 

Here is a sequence of a typical drip like we might see coming out of a tap that isn't quite turned off.



To really get a good feel for the way a drip behaves, we need to understand how water tension works. This is the way in which water molecules cling together, and fight the effects that gravity and other forces have on water. We have all seen how an overfilled glass of water will bulge and kind of hang in there, before spilling over the edge of the glass. That is water tension, and it is responsible for all the fascinating shapes that occur when water is pushed around, splashed, falling or flowing. In drawings #1 through 9, we see the water tension holding a small volume of water together as it builds up and increases in size, until the effects of gravity on its weight are stronger than the water tension holding it together. It stretches and strains to the breaking point in drawing #10. Immediately upon snapping, the effects of water tension take over again, pulling the molecules together to form a beaded string of droplets. It is important to vary the size of these droplets, for a more dynamic-looking effect. As the largest droplets falls first, it stretches and then squashes as it falls in drawings #11 through 17. If we were to watch this sequence in slow motion on live action film, we would see that the droplets jiggle like jello as the water tension attempts to pull them back into a perfectly spherical shape, and they recover from the snap of the stretching water breaking off. The splash when the droplet hits is exactly like the splash of a raindrop, although the droplet probably didn't have the velocity that a raindrop does, thus its splash is somewhat more subtle and globular than that of a raindrop.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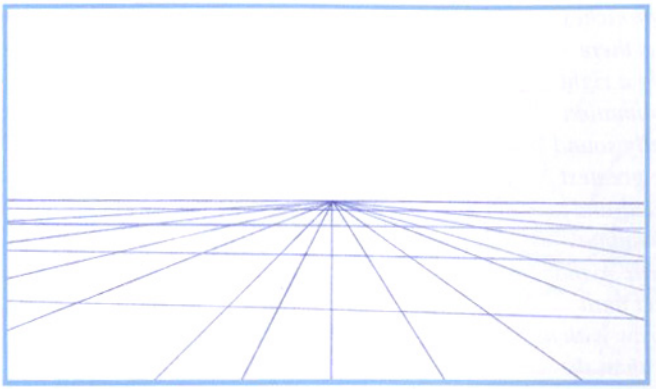
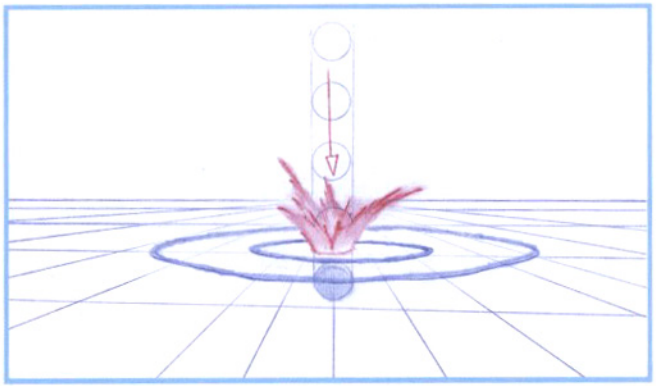
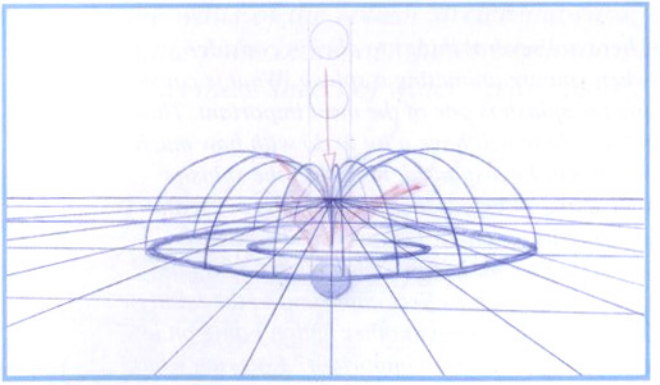
In the following splash sequence, the splash is roughly the size that would be created by a small cannon ball, or a rock about the size of a small coconut, being dropped into the water. This approach to drawing/animating a splash, is clearly not an attempt at realism. This particular design and approach owes its look and physics to the Disney effects animator's animation of the 1930s, 40s and 50s, and is very similar to splashes seen in films like Dumbo and Peter Pan.



Of course, the first thing an animator must do, before forging ahead with animating an effect, is have a plan. The very first step in this plan is a simple perspective grid, inside a frame, or field. This is the stage on which the animation is set, and it needs to work with whatever other elements there are in the scene's layout.



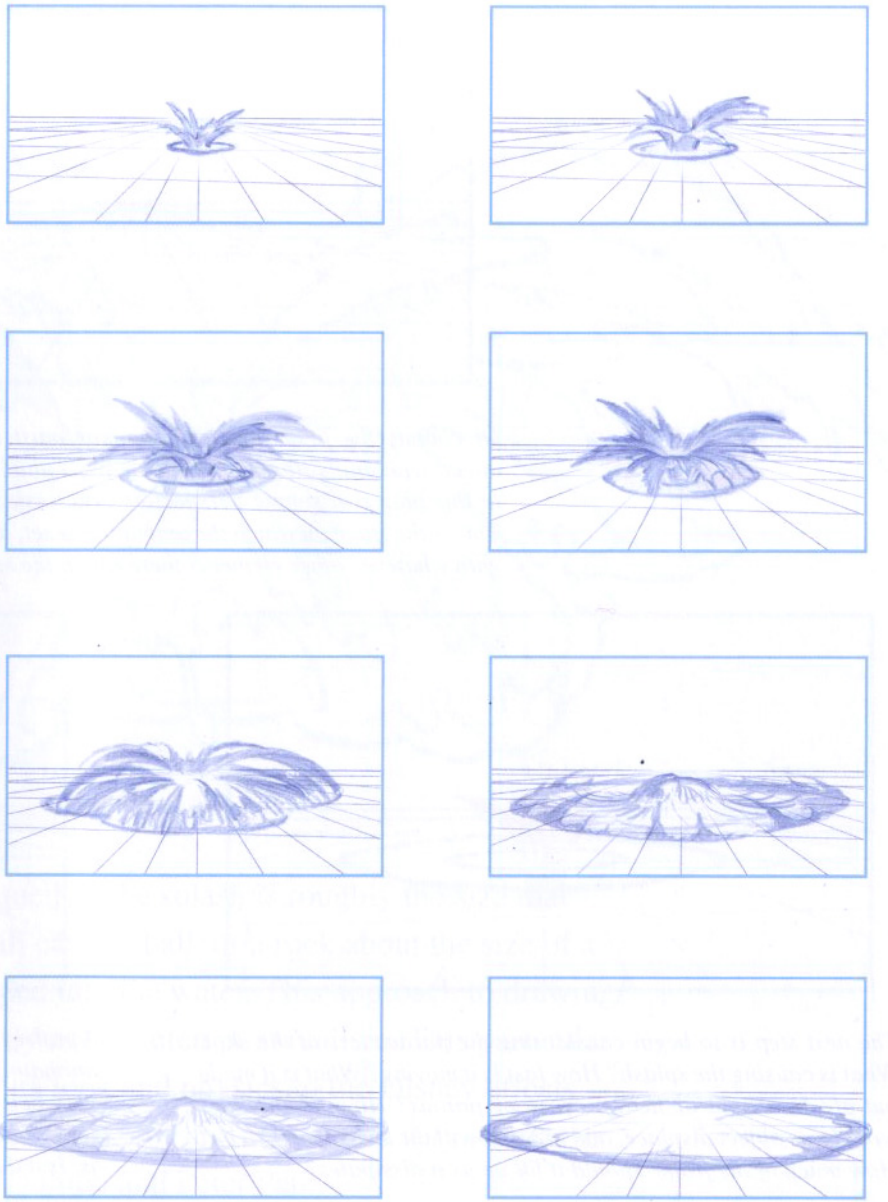
The next step is to begin considering the parameters of the shot. What is causing the splash? How fast is it moving? What is it made out of? Is it light or heavy, dense or porous? How much water would this object displace, and how big will the splash have to be? How much of the frame should it fill up as it dissipates?



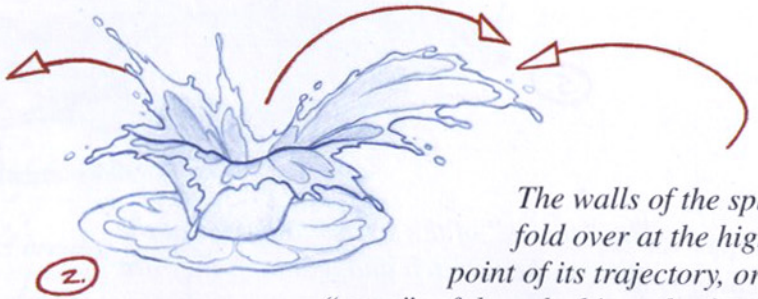
A path of action for the effect should be established before we begin animating. This serves as your guide as you animate, and can be very helpful in keeping the proportions of the effect accurate. Always consider as well, what the intention of the effect in the scene is. Is it the star of the scene, or does it only have a supporting role? Know what the scene requires in every way before starting!

There are as many subtly different approaches to animating a special effects scene, as there are animators. There is not necessarily a right or wrong way, as long as your final animation looks good! But there are fundamentally sound ways to proceed that will give you the greatest chances of success. By far the most tried-and-true technique for hand-drawn effects animation, is to roughly animate to begin with. Avoid thinking about the details of your effect until the overall motion is working well. Draw with a loose hand, think of the energy rather than the design, and push your drawings dynamically as if they were actually moving on your page. Don't be tentative at this point! The finely detailed and clean splash drawings on the following pages, got their energy and direction, from dynamically drawn, rough preliminary drawings.

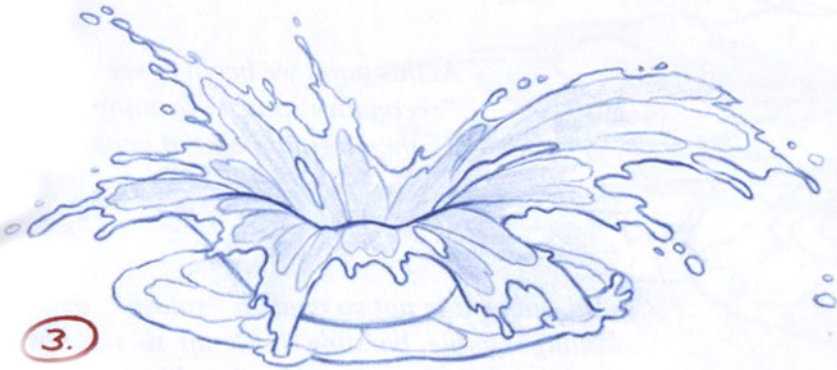
There are several things to always consider when you are animating a splash. What is causing the splash is one of the most important. That factor alone will have a lot to do with how much water will be displaced, how high the splash will shoot up before it succumbs to gravity, and how big its secondary splash will be. Always remember to think about what else is going on in the scene. Is the effect important to the telling of the story? Is there another action going on in the scene that is more important? Knowing what is causing the splash, what the splash's role is, and then integrating the effect with the overall style of the film is a great recipe for successful splash effects animation!



This is a very classical, stylized approach to animating a splash. The initial splash shoots up and outward, like a blossoming flower.

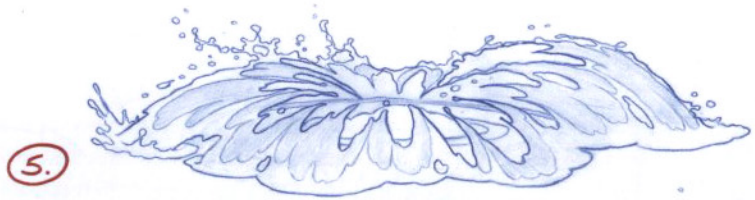


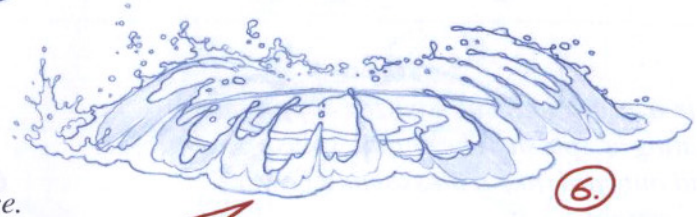
The walls of the splash fold over at the highest point of its trajectory, or the "apex", of the splash's path of action.



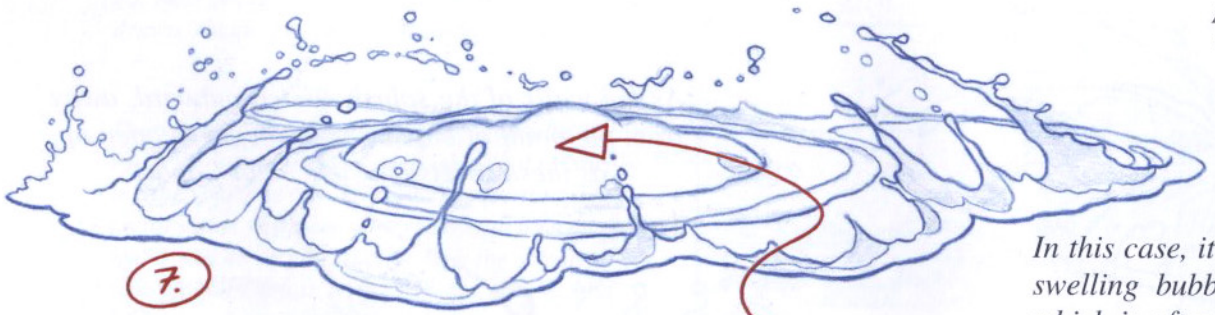
As the walls of the splash stretch outward, away from the point of impact, holes begin to open up, as these sheets of water "tear" apart.

The leading edges of the initial splash fall back to the surface first, and are absorbed into the surrounding water surface, creating a new set of ripples.





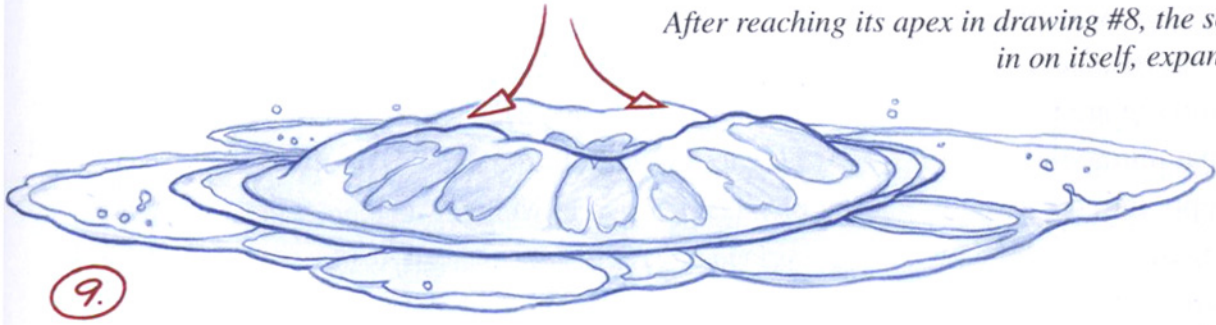
The "sheets" of the splash fold over at the apex as they stretch and tear, and they are finally absorbed back into the surrounding water surface.



At this point we begin to see the "secondary splash" forming at the original point of impact.

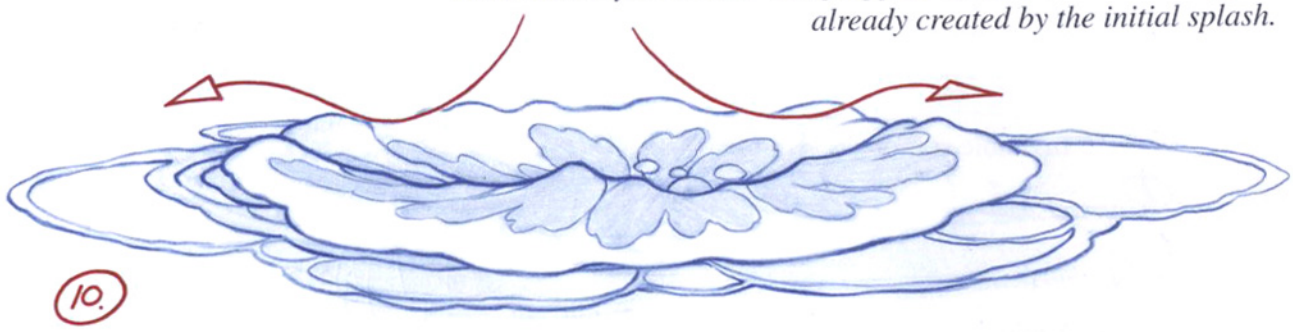
In this case, it is not so much a "splash" as a huge swelling bubble bursting back up to the surface, which is often the case when the object causing the splash is very heavy, or dense.

After reaching its apex in drawing #8, the secondary "swell" falls back in on itself, expanding outward as it resolves.



9.

This creates yet another set of ripples which overtake the ripples already created by the initial splash.



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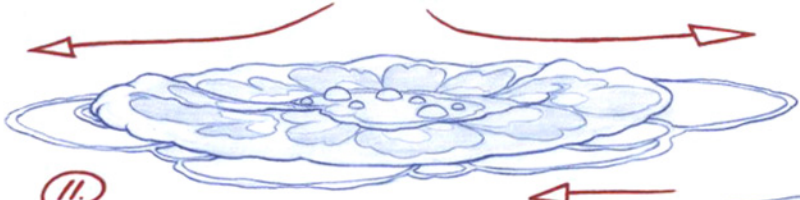
Finally, the last set of ripples created by the secondary splash, flatten out as they expand outwards, losing the energy generated by the initial impact and fading out completely.



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