The Art and Science of Better Landings

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Bring Consistency and Mastery to your Touchdowns
With Applied Science and Just a Little Bit of Zen

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# The Art and Science of Better Landings

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Introduction

As pilots, we judge our own worth by the quality of our landings. We might be great at holding altitudes and headings, but the real measure of our skill is decided by the smoothness with which we touch tires to pavement.

A CFI has the benefit of analyzing the rights and wrongs demonstrated by hundreds of pilots making tens of thousands of landings. Personalities vary, weather comes and goes, but the same problems exhibit themselves over and over again. Where landings are concerned, it is obvious that virtually all pilots commit errors from the same pool of common mistakes.

Unfortunately, professional instruction has operated on the premise that if a pilot performs enough landings, he or she will eventually get them right. And, yes, the School of Hard Landings will eventually graduate all of its pupils. But the time, expense, and stress that a pilot incurs while trying to perfect landings could be significantly decreased if he or she were simply shown exactly what to do and what not to do.

Much of the landing process is art. It can be roughly explained, but the real teacher is repetition. But before art is attempted, the science that supports it must be understood. Without the knowledge of types of paints, complimentary colors and shapes, perspective, and basic technique, it is highly unlikely that a new artist will paint any masterpieces. The same thing goes for pilots. Trying to master the art of landing without a thorough understanding of the supporting science is a terribly inefficient way to go about it.

You may be surprised to find out that the majority of the landing profile is pure technology – no art required. Science dictates 80% of the traits required for a good landing. That removes an awful lot of the gray area. If you are willing to invest the time to simply learn this stuff – make it yours – you will be rewarded with better landings. I say this without equivocation. You learn it and you will get noticeably better touchdowns. Learn it and apply every bit of it and I guarantee you will achieve your goal of consistent smooth landings.

The Zen of it all is that we shouldn’t be constrained by custom. We should be willing to do whatever it takes to master landings with the minimum effort. And that is precisely what I intend to teach you in this book.

Although the fundamentals for good landings are very similar in almost all piston-engine airplanes, this book assumes that the reader is flying a single engine airplane with tricycle landing gear.
Chapter 1                  The Big Picture

Whether you are a pre-solo student or a 300-hour private pilot, odds are that good landings are one of the issues that cross your mind on a fairly regular basis.

At one end of that spectrum, you are desperately seeking confidence that you can produce smooth, controlled landings consistently. You feel pretty good about being able to survive your own landings, but it would be nice to know that the airplane would be reusable afterwards.

At the other end of the spectrum, you know from experience that you are capable of smooth, controlled landings, but your ability to reproduce them on demand is questionable. You grease it in two-thirds of the time, but you seem unable to schedule the other third of your landings when there are no passengers aboard.

In either case, you are a student at the University of Hard Knocks. Every one of us has attended.

It doesn’t matter where you are in your training. The factors involved in good landings are the same. Experience – the School of Hard Landings (at the University of Hard Knocks) - makes it easier for pilots to identify these factors and line them up in a neat row. That’s why student pilots have more trouble with it than more experienced aviators. They have simply done the drill fewer times.

Students have seen the good sight pictures and the bad sight pictures, but not enough times for the differences to be instantly apparent. With enough classes at the School of Hard Landings, it gradually sinks in, but this brute force method is less than ideal. There is a better way.

On Art, Science, and Zen

As with everything else in aviation, landings require a mastery of skills which are a little bit art and a little bit science. The two blur into a homogenous reflex, their default state, unless we take the time to carefully separate and examine them. And to understand them that is exactly what we need to do.

Without becoming intimately knowledgeable with every aspect of a given flight envelope, we can never expect to take complete control. And it is precisely the uncontrolled nature of things that keeps our goal - consistently soft landings down the centerline - just barely out of reach. Through ignorance, we
All of these factors promote a sense of control, allowing us to maintain our decision-making and act in a way that reflects our preferences and priorities. By focusing on what we can control, we can achieve a sense of mastery and empowerment, which can be especially valuable in the face of uncertainty and challenge.

This bears repeating. In order to be in control, we must become knowledgeable regarding every aspect of a given flight envelope. If we are not in control of our landings, we place ourselves at the mercy of other powers. The one that comes to my mind is the power of physics and it can be brutally unforgiving. Personally, I’d rather be the one in control and I will do anything it takes to achieve that.

Using the scientific process, others before us have discovered the laws that rule the operations of flight. They are finite, determinate, and cut-and-dried. If we fly an airplane at a specific setting of pitch and power, we will get a predetermined level of performance. The airplane will either climb, remain level, or descend, and whatever it does, it will do so at a predicted airspeed. There is no need to think about it or weigh alternatives. We don’t have to worry about how it makes us feel. If we know what we want the airplane to do, we can configure it to known settings and it will comply with our wishes every time.

When we consider the artistic aspects of landings, they are not parts of the landing at all. They are aspects of the way we witness and react to the landing environment. Multiple overlapping factors, each quantifiable individually, meld into a compound that we process more by feel. Differences are subtle and hard to distinguish. The environment at that instant cannot be evaluated in terms of precise readings of attitude and airspeed. Instead we roll with it, feeling our way with our senses of sight, sound, and equilibrium. We interact with the process in the same way that a surfer shifts his weight to stay balanced in the sweet spot of a wave.

Art gives us a shortcut. It allows us to develop reflexes that handle split-second fine-tuning. Certain parts of a landing flux too quickly and are too complex for considered cause-and-effect processing. It is during these periods that we call on our artistic abilities.

After the roundout, for example, we have neither the time nor the mental bandwidth to calculate the precise ratios of airspeed and pitch needed to maintain an altitude just a few inches above the pavement. Art, however, gives us this ability. We control the airplane by feel without regard to the exact numbers.

Art is developed, not learned. But the factors that coalesce, requiring an artistic response from the pilot, can be learned and understood in terms of their science.

The science of landing is relatively easy to learn. You simply have to dedicate the time and effort. The art of it may seem easier to master since you don’t have to spend time buried nose-deep in a book. You improve your artistic response through practice. But don’t underestimate this fact: you will more easily and quickly master the art if you understand the science that supports it.
Art – Doing it by feel. Humans are intrinsically lazy. Thus, by default we try to do everything by feel. It’s easy and doesn’t require any forethought. But it doesn’t always work so well, either. Science frequently dictates the easiest and most efficient way to succeed at a task. We simply have to invest the time to learn the proper technique.

Science - Doing it by the numbers. Certain parts of the flight envelope are best controlled by specific settings, deduced by science. But other parts are too complex or occur too quickly to allow rote responses. This is where we must rely on our instincts and apply artistic solutions.

Zen - Achieving enlightenment through the most direct method possible. Zen tells us to do art or science as needed. Our job is to learn which one is preferable in a given situation.

Our goal is to improve our touchdowns. It doesn’t matter how we achieve that goal. Tradition be damned; all that matters is the end result – consistently good landings.

We will develop rules and we will do things the same way every time we are presented with a given set of circumstances. We can learn physics, line up bug splatters on the windshield, peek out the side windows, or wait for the numbers at the far end of the runway to disappear. Or all of the above. Or none of the above. There is no such thing as cheating. We will learn any technique that works, take any shortcut that eases our workload, and recite any mnemonic that helps us get the job done.

If there is one key point to embrace, it is one mentioned by Tom Benenson, a longtime writer for Flying magazine. “The trick to performing smooth passenger-pleasing landings is to make every landing approach as consistent as possible.” That is it in a nutshell – learn your procedures and do them the same way each time you are greeted with a given scenario.

As pilots we must always keep one tenet in mind: we may be able to influence which circumstances are presented to us, but the environment we are confronted with at any given instant is the one we must respond to. There is no gray area. Our wishes are totally irrelevant. Yes, it would be nice if we didn’t have this fifteen-knot crosswind. But we do.

Pilots must be able to ascertain and objectively understand what is happening to them and their craft at all times. There is no room for emotion when making decisions in the cockpit. Save that for the end of the day, after you’ve tied the airplane down.

Please visit www.betterlandings.com/multimedia and read the supplemental article entitled Decision by Indecision.
Landings are generally considered to be one of the biggest challenges facing new pilots. But there is one more issue that is repeatedly mentioned: Talking on the Radio.

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“Just sit back and listen.”
Chapter 2          The Traffic Pattern

Now if you are really sure you understand the geography of the traffic pattern, I suppose you can skip this section. But I really hope you won’t. It is important that we join together in agreement regarding names and objectives. The Pilot/Controller Glossary defines a traffic pattern like this:

The traffic flow that is prescribed for aircraft landing at, taxiing on, or taking off from an airport. The components of a typical traffic pattern are upwind leg, crosswind leg, downwind leg, base leg, and final approach.

• a. Upwind Leg- A flight path parallel to the landing runway in the direction of landing.
• b. Crosswind Leg- A flight path at right angles to the landing runway off its upwind end.
• c. Downwind Leg- A flight path parallel to the landing runway in the direction opposite to landing. The downwind leg normally extends between the crosswind leg and the base leg.
• d. Base Leg- A flight path at right angles to the landing runway off its approach end. The base leg normally extends from the downwind leg to the intersection of the extended runway centerline.
• e. Final Approach. A flight path in the direction of landing along the extended runway centerline. The final approach normally extends from the base leg to the runway. An aircraft making a straight-in approach VFR is also considered to be on final approach.

All right, we are all in agreement on the names of the legs. But there is a qualifier that is needed to fully define any individual leg. It specifies the direction of turns in the pattern.

Pattern legs, with the exceptions of the upwind and final, are all properly qualified as being “right” or “left”. Thus, there is a right downwind and a left downwind. Traffic on both are sequencing to land on the same runway even though they are on different sides of the airport.

In the interest of safety, it is absolutely crucial that you qualify all of your position calls by referring to the legs as being “right” or “left”.

TPA (traffic pattern altitude) is generally 1000 feet AGL (above ground level) for single engine aircraft. Be aware, though, that this number is not universal. There are exceptions. 800 feet AGL is not terribly unusual so make sure you know what the correct TPA is at the airport at which you are landing.
The Traffic Pattern

Right Downwind

Right Base

“abeam” point

“abeam” point

Left Downwind

Right Crosswind

Left Crosswind

WIND
The Traffic Pattern

**Upwind Leg** – The *AIM* and *Pilot/Controller Glossary* are not in explicit agreement on this one. Both specify the common definition that the upwind leg is any leg parallel to the runway centerline in the direction of landing. Thus, an inbound airplane could enter the pattern on the left upwind (which is the same as the right downwind) and proceed on around the left crosswind, to the left downwind, and then on to the left base leg and final.

The *AIM*, however, also defines a departure leg. This is the straight out leg that an airplane flies immediately after takeoff. Thus, the departure leg is an upwind leg that exists on the extended centerline. I mention this to alert you to potential confusion when you hear an unexpected call from an aircraft saying he is upwind for 2-5. Is he taking off from runway 25, or is he entering the pattern for 25 on an upwind leg?

We will add clarity by going with the *AIM*. When discussing the upwind leg after a takeoff, we will refer to it as the departure leg.

**Departure Leg** – This leg is defined by the *AIM* as “The flight path which begins after takeoff and continues straight ahead along the extended centerline. The departure climb continues until reaching a point at least ½ mile beyond the departure end of the runway and within 300 feet of the traffic pattern altitude.”

Keeping in mind that the *AIM* is not regulatory, I, along with a lot of other instructors, believe it is generally better to begin your turnout at 500 feet above ground level (AGL). This increases your chances of being able to turn back to the airport during an emergency. Additionally, at busy airports, it gets slower aircraft off the departure course more quickly.

Your goal on the departure leg is to climb to the appropriate altitude while maintaining the runway’s extended centerline.

**Crosswind Leg** – The leg 90 degrees from the departure leg is the crosswind leg. Its purpose is to provide a path to the downwind leg. Continue your climb on the crosswind leg until you reach that artfully defined point where you turn to the downwind, or you reach traffic pattern altitude, whichever occurs first.

Deciding where we make the turn from the crosswind to the downwind leg is primarily art. It is based on the aircraft, the speed you will fly in the pattern, obstacles on the ground track, and local customs. Generally, in most single engine airplanes, you will turn to the downwind when you reach a point that places the downwind leg approximately ½ mile from the runway.
The Traffic Pattern

**Downwind Leg** – The downwind leg is flown opposite the direction of landing (which usually places the wind at your back) and parallel to the runway. Once you have reached traffic pattern altitude (TPA) you stop the climb by pitching for level flight and reducing power. No art here; you fly at pattern altitude the entire length of the runway.

**Abeam Point** – This is the position on the downwind leg where you find yourself directly adjacent to the your landing aim point. Generally, that will be the approach end “numbers” on the runway. This is where you will begin your roundout.

Although you aren’t planning on actually touching down on the numbers, using them as a reference for your abeam point is a good idea. It sets you up to use the entire length of the runway for your landing. No art here, either. You’re either abeam or you aren’t.

At the abeam point, you begin configuring your airplane for landing. You make another power reduction, slow the airplane to your approach speed, possibly add flaps, and initiate your descent at your approach speed.

**Base Leg** – The 90 degree turn from the downwind leg toward the runway’s extended centerline defines the beginning of the base leg. Artful pilots will look over their shoulders at the approach end of the runway. When that angle with the downwind leg is roughly 45°, they make the turn. Scientific pilots have learned that if they continue their descent from the abeam point to an altitude 200 feet below TPA, they are also at the approximate point for an optimal turn to the base leg.

**Final Approach** – The final is defined by the runway’s extended centerline. Assuming that you reached it from the base leg, on a perfect day you’ll find yourself approximately 500 feet AGL as you roll out level on final. That’s a scientific observation of the results of artful flying.

**Relative Altitude** – During our discussions of position in the traffic pattern, this term will come up. It refers to an aircraft’s altitude with respect to its distance to the touchdown zone. An absolute altitude of 500 feet might not be low, but if you are a mile out on a long straight-in final at 500 feet, your relative altitude is low. Thus, relative altitude is a function of where you are in the traffic pattern. It is not measured in feet, but is simply specified as being high or low.
Chapter 3 The Anatomy of a Good Landing

Good landings follow a standard profile starting on the downwind leg. In closed traffic (e.g. a touch-and-go) a climbing entry from the crosswind leg will be the norm. Coming into the pattern from the outside (i.e. an arrival) will generally entail a descent to traffic pattern altitude. In either case, your good landing is a process that begins as soon as you attain TPA on the downwind leg.

Let’s break the landing profile into its individual pieces and analyze their scientific and artistic qualities. This will allow us to define what we do and when we do it.

**Downwind Leg** – All science. Set your power and maintain level flight at TPA. Do your GUMP check, and talk to the tower or make your position report.

**Abeam Point** – Mostly science. Reduce power to the predetermined setting and gently raise the nose. This allows a deceleration and a descent to begin. Trim for the desired airspeed. (Possibly flaps and/or carburetor heat depending on your airplane model.)

**Base Leg** – Mostly science. If you were at TPA at the abeam point and did your setup properly, turn onto the base leg when your altitude is 200 feet less than traffic pattern altitude. *This assumes a TPA of 1000 feet AGL. If the TPA is 800 feet AGL, turn base after descending only 100 feet.*

Continue the descent. You may or may not opt to add more flaps. If all is ideal, your descent rate will probably be between 400 and 500 feet per minute.
**Final** – If all remains optimal, you should be about 500 feet AGL when you turn onto the final approach leg, right on the extended runway centerline. Now the art starts creeping in. You will slow the airplane 3-5 knots by raising the nose, while simultaneously reducing power to prevent a short-term climb. When your speed is perfect, trim to keep it there. The yoke should feel light in your hand.

You now must subconsciously evaluate the ratio of your altitude to the remaining distance to your roundout point (your “relative altitude”). It’s all art. You may feel too high for the distance remaining, you may feel just right about it, or you may feel too low. You make any needed corrections with power (or if you are really high, decreased pitch with more flaps and maybe a slip).

Once your speed and relative altitude are correct, fix the roundout point on the runway in your windscreens. If it goes low, add power; if it goes high, reduce power.
The Anatomy of a Good Landing

**Roundout** – The roundout is the action of stopping the descent and transitioning the airplane into level flight, just a few feet above the runway surface. All art, but easy to judge. The FAA’s definition of the roundout equates it with the entire process of stopping the descent, slowing to flare speed, and flaring. We will break these apart into discrete steps. We will *not* use the FAA definition. Our roundout begins when the nose is raised to stop the descent and ends once a zero feet/minute descent rate is attained.

**Float** – After the roundout, the airplane will float down the runway centerline. Your goal is to maintain altitude while slowing the airplane. You literally hold the airplane off the runway while waiting for the airspeed to dissipate. Depending on your model, you will probably have the power reduced to idle. As the airplane slows, extremely subtle increases in pitch are required to keep it from descending. Be patient! Too much pitch and you get a “balloon”. There is no time to look at numbers on your gages. You do this all by visual estimates, based on your view of the runway well ahead of you. Note that better landings will exhibit shorter amounts of time in the float phase. The length of time spent in the float is directly proportional to the amount of excess airspeed the aircraft carries into the roundout.

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**Roundout or Flare?**

One of the most imprecise terms in primary training surely must be the word *roundout*. Considered by many CFIs to be a separate phase from the flare event, it is considered by the FAA to be synonymous with *flare*. In the Private Pilot Practical Test Standards (2006), the word flare never appears.

*From Airplane Flying Handbook (FAA-H-8083-3A)*

**ROUNDOUT (FLARE)**
The roundout is a slow, smooth transition from a normal approach attitude to a landing attitude, gradually rounding out the flightpath to one that is parallel with, and within a very few inches above, the runway. When the airplane, in a normal descent, approaches within what appears to be 10 to 20 feet above the ground, the roundout or flare should be started, and once started should be a continuous process until the airplane touches down on the ground.
Flare – At some point during the float, the airspeed will slow to that magic speed that feels right. It’s right above the stall speed. Maybe you’ll even hear the stall horn chirping. It is the speed that your artistic mind has selected as the touchdown speed. Allow the airplane to descend those final few inches with a slight pitch up at the last instant to soften the contact with the runway.

Touchdown – The mains are on the pavement and you are holding the nose up. As your speed decelerates, you allow the nosewheel to gently drop to the surface.

Rollout - Stay on the centerline until your aircraft has slowed to taxi speed and you are ready to turn off. Surprisingly, most landing accidents probably occur during this phase. Especially with student pilots, loss of control occurs here simply because they assumed the job was complete and failed to continue “flying” the airplane.

From these descriptions, you can see that we start out with fixed rules, fixed airspeeds, and fixed power settings. All science; technical details that we adhere to precisely. But as we get closer to the touchdown, our actions become more artistic. We start to pay less attention to our readings of airspeed and rpm, and more attention to the way the ground and runway look. It is this perfect mixture of art and science that produces the perfect landing.

The most common overall mistake that pilots make is failure to grasp the complete details of each step in the landing process. Your first objective must be to learn and commit to memory the nuances for every one of these steps.

After learning the general landing profile we just discussed, your second goal is to learn and use the specific settings that will achieve the profile requirements. Most single-engine training airplanes will use similar settings.

Please view the lesson at [www.betterlandings.com/multimedia](http://www.betterlandings.com/multimedia) entitled: The Anatomy of the Traffic Pattern
The final stages of a landing begin with the **Descent** on final. A reduction of power and increase in pitch should have set your approach airspeed. Maintain the aiming point (probably the runway numbers) at a fixed position in the windscreen.

At approximately 20 feet above the pavement, raise the nose to begin the **Roundout**. As your pitch attitude flattens you will lose view of your aiming point. During the roundout process, a decreasing rate of descent will occur until level flight is reached at 2-4 feet above the surface.

After the roundout is completed, you enter the **Float** phase. Your goal here is to remain in level flight with little to no loss of altitude as the aircraft’s speed decays. A slow, steady increase in pitch will be required, adding lift to offset the lift lost due to decreased airspeed.

When airspeed has slowed to the minimum (and pitch has risen to the maximum), **Flare** the airplane by allowing it to slowly descend the remaining inches to the runway surface. Just before **Touchdown**, apply slight backpressure to momentarily increase lift, thus softening the impact.
Landing Profile Settings/Actions for a Cessna 172

| Downwind Leg | • Power to 2100 rpms.  
• Trim for level flight at TPA.  
• This will yield an airspeed of approximately 85 knots. |
|--------------|-------------------------------------------------|
| Abeam Point  | • Reduce power to 1700 rpms. (1500 rpms on a cold, dry day)  
• Carburetor heat on.  
• Add first notch of flaps.  
• Nose up (maintain TPA) until target airspeed of 70 knots.  
• Trim for 70 knots and allow the airplane to descend. |
| Base Leg     | • Continue descent at 70 knots. (control airspeed with pitch)  
• Evaluate altitude and optionally add 2nd notch of flaps.  
• Ideal descent rate is 400-500 feet per minute. |
| Final        | • Fix the roundout point in the windscreen.  
• Maintain the extended centerline.  
• Evaluate altitude and distance to roundout point - add/remove power as needed to adjust this “relative altitude”.  
• Decelerate steadily so that 60 knots is reached at the roundout point (pitch up and reduce power).  
• Begin a slow, steady reduction of power timed so that the power is at idle when the roundout point is reached. |
| Roundout     | • Transition from descending flight to level flight at approximately 3 feet above the surface.  
• Power should be at idle unless your altitude was too low on final.  
• Confirm that power is at idle. |
| Float        | • Objective is to lose airspeed while remaining in level flight.  
• Absent a crosswind, keep wings level with aileron (yoke) and aim the nose with the rudder pedals to maintain the centerline.  
• The lower your airspeed at the roundout, the shorter your float (in both distance and length of time).  
• Maintain altitude with extremely subtle increases in back pressure.  
• Be patient! Don’t give up the float until all excess airspeed is gone. |
## The Anatomy of a Good Landing

<table>
<thead>
<tr>
<th>Flare</th>
<th>Touchdown</th>
<th>Rollout</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Stop increases in backpressure and maintain constant pressure on yoke; this allows a descent to occur.</td>
<td>• Mains touch the pavement.</td>
<td>• Maintain the centerline – keep your feet active.</td>
</tr>
<tr>
<td>• Just prior to the main landing gear touching the surface, add slight backpressure to slow the descent rate again.</td>
<td>• Maintain backpressure momentarily.</td>
<td>• Turn the yoke into the wind, keeping the upwind wing from lifting up. Very important, even in light crosswind conditions.</td>
</tr>
<tr>
<td>• Maintain backpressure and ensure that the nose is high.</td>
<td>• Allow the nose to drop gently to the surface.</td>
<td>• Allow the airplane to slow before applying brakes.</td>
</tr>
<tr>
<td>• Use rudder pedals to ensure that the nose lines up with the centerline.</td>
<td></td>
<td>• At the taxiway, brake first, then turn.</td>
</tr>
</tbody>
</table>

Note that the power settings and airspeeds shown in this chart are for a generic Cessna 172. They may be slightly different in other single engine airplanes.
The FAA *Airplane Flying Handbook*, defines the roundout/flare as a single entity and describes the pilot actions needed in a mere two sentences. Since these final few seconds of the landing process traditionally contain the most difficult control issues for new students, an abbreviated breakdown in two sentences is less than helpful.

A study published in *The International Journal of Aviation Psychology* in 2005 recognized that “Transitioning . . . from the approach attitude to the landing attitude is one of the first obstacles that confront new students.” The study indicated that the process is “poorly understood and underreported.”

Depending on the source, the final phases of flight are often listed:

- Descent, Roundout/Flare
- Descent, Roundout, Flare
- Descent, Leveloff, Roundout, Flare
- Descent, Roundout, Float, Flare
- Descent, Roundout, Holdoff, Flare
- Descent, Flare

There is no consensus about the exact definitions of “roundout” and “flare”. Talk to three pilots and you’ll likely get three explanations of where the roundout ends and the flare begins.

During interviews for this book, one pilot commented, “The problem is that you are looking for names for discrete parts of the landing process. In actuality, it is one continuous process where each of your ‘parts’ blends into the next with no finite boundary. It is one continuous slow pull on the yoke.”

The *IJAP* study found that pilots regarded the roundout (*their definition*) to be more difficult when presented with a diagram and less difficult when presented with a textual definition. The study went on to conclude that “60% of expert pilots attributed roundout difficulty to difficulty in perceiving altitude AGL. This difficulty is symptomatic of the leveloff, not the roundout.” The more likely conclusion is that the pilots were unclear of the definitions begin used.

This problem of definition is indicative of the wider problem – too much emphasis is put on the indeterminate art of landing. Pilots and instructors have not developed a standard model of the landing process.
Consistently good landings share important commonalities. If you’re greasing a Stearman in every time, listening to the wind whistle through the wires, you have mastered the art to the point where you need pay little attention to the science. But in that case, you probably have a lot more experience than the rest of the readers bending the pages of this book. So, for all the rest of us, let’s identify the fundamentals commonly found to exist in every good landing.

For any given position in the traffic pattern, there is a configuration resulting in an ideal:

- Airspeed
- Altitude
- Descent Rate

These ideals are:

- Controllable by you
- Quantifiably specific
- Impact the successive steps in the landing profile

As pilots, and therefore intelligent human beings, we can identify and learn these ideal configurations. That’s the science. If we fail to maintain any of these ideals, the next step in the landing process will be thrown out of sync. On the downwind leg, for example, we should have leveled off at TPA (traffic pattern altitude) and stayed precisely on that altitude. The descent we were planning to initiate at the abeam point assumes that it begins at traffic pattern altitude. So, if we allow ourselves to lose altitude on the downwind, the configuration change we planned to make at the abeam point (for the descent) will cause us to remain too low for the remainder of the approach. Lose 200 feet on the downwind, and you’ll carry it all the way to the crash site unless you make additional configuration changes midstream.

In an example like this, making unplanned configuration changes may certainly solve the problem. Add some power, maybe pitch the nose up, regain the altitude. But they also throw off your timing for subsequent configuration changes.

Varying from our ideal airspeed, altitude, and/or descent rate at any point in the pattern will adversely affect the remainder of our approach. You will experience an increase in workload as you’re forced to make extra decisions.
Small mistakes in the pattern are cumulative unless corrected early. There is much truth to the old axiom that “a good approach makes for a good landing.” And a good approach is dependent on your understanding of these fundamental factors:

**Rectangular Pattern**

One the most important fundamentals of flying a good approach is to make your traffic pattern rectangular in shape. Keep the legs 90 degrees to each other and make sure that the ground track on the downwind leg is parallel to the runway. Seems so easy doesn’t it? Obvious, too. Yet, this simple thing is one of the most common fundamentals that pilots discard once they get airborne.

A non-rectangular leg will guarantee that the subsequent leg is either longer or shorter than originally planned. That will have a huge impact on your timing.

**Lift**

Forget Newton. Forget Bernoulli. As far as we’re concerned, lift is controlled by two factors: angle of attack and airspeed. Reduce either and the aircraft descends. Increase either and it climbs. At least momentarily.

*We have two controls for modulating lift: the throttle and the yoke (or stick).*

*Therefore, we have two means for increasing lift:*

1. *Increase power and more air flows over the wings, increasing lift.*
2. *Pull back on the yoke and the angle of attack is increased, increasing lift.*

Getting a firm mental grasp on the regulation of lift is critical to your ability to make good landings. Memorize these relationships now.

**Balance**

Airspeed and altitude are controlled by a careful balance of pitch and power. One can argue that we’re really talking about thrust, drag, and angle of attack. But the easiest, most Zen-full way of envisioning it is via pitch and power. We have controls for both in the airplane. Power is controlled with the throttle and pitch is controlled with the stick or yoke.
This correlation of pitch and power is always confusing to student pilots. It takes a while to get the hang of it.

**Airspeed**

In the landing profile we are going to control altitude with power, and airspeed with pitch. But that just seems so backwards at first. And it is very easy to demonstrate that a pitch up of the nose does cause a climb, not just a reduction in airspeed. Does this refute the prior claim about pitch and power? No. The reason why has to do with the longer-term tendency.

In a car, we always add power (foot on the gas pedal) to make it go faster. We equate power with speed. But a car has no option of changing altitude. The tires are going to remain on the asphalt no matter what we do, short of rolling it over in the ditch. Lift is zero and no amount of power is going to change that.

In an airplane, if we push the throttle in to add power, we increase the airflow over the wings, thereby increasing lift. Instead of accelerating, the airplane goes into a shallow climb at roughly the same airspeed. Reduce the power and the opposite occurs, a descent at roughly the same airspeed.

The proper method of changing airspeed in an airplane is to alter the pitch. Whatever short-term change in altitude is experienced is then damped with a change in power.

*Increase pitch to decrease speed, and simultaneously reduce power to prevent a climb.*

*Reduce pitch to increase airspeed and add power to reverse the subsequently developing descent, thus maintaining constant altitude.*

Imagine that we’re somewhere in the pattern, and at that position there is an ideal airspeed. We know what that airspeed is. The artful method of reaching that airspeed is to jiggle the power in and out, pitching as necessary to maintain altitude, and tweaking it all until the desired airspeed is reached.

The scientific approach is much easier. Through earlier test flights, or from information provided to us by some other source, we realize that a specific power setting will yield our target airspeed if we’ll just set it and trim for level flight. It is easy and it always works the same (we’ll talk about density altitude considerations later).

Let’s reiterate.

*In situations of level flight or where the fine control of descent rate is not critical, the easiest way to achieve a target airspeed is to set the power to a known setting and pitch to achieve the desired airspeed.*

Set the power, then pitch and trim for your target airspeed. Quick, easy, and results in a minimal workload. Make a note of this.
Altitude

An airplane trimmed for level flight at a constant airspeed will, absent of gusts and thermals, tend to stay at that altitude. Add a little power to increase lift and a climb results. Remove power and lift is lost resulting in a descent. The airspeed remains essentially unchanged. *Power controls altitude (and VSI rate).*

Now again, we can consider that experiment that we did for altitude. Pitch the nose up and the airplane climbs – in the short term. During the climb, however, airspeed is bleeding away. Loss of airspeed equates to loss of lift. And what do we get when lift is reduced? Loss of climb. So, changing the pitch of the nose without changing power will result in a temporary change in altitude, but the longer-term effect is to return to level flight, but at a different airspeed.

Fine Control

Fine control is most critical during the float and flare stages of the landing. This is where your art really kicks in. But setting the airplane up scientifically, prior to this final portion of your flight, will give you more time and require fewer gross corrections.

Art is most effective when you set up for it scientifically. Tune your guitar before you start playing it.

Timing

We started by discussing they way that non-rectangular legs destroy your timing. We started with it and we’ll end with it. *Timing is crucial to a good landing.*

Imagine that the traffic pattern is a rectangular string of dominoes. In an ideal situation, you push one end, and the wave of tumbling blocks propagates steadily through to the predicted finish. This describes a pattern flown with perfect timing.

Imperfect timing could be demonstrated with the dominoes by holding one back somewhere on the downwind leg. The wave tumbles to that point and then stops. When you release it and allow the wave to continue, it sequences on to its final disposition, but not at the originally chosen time.

When something happens in the traffic pattern that causes a planned change in configuration to occur too early or too late, the rest of the planned events are impacted. It forces us to make unplanned decisions and increases our workload. This can only have a detrimental effect on our final touchdown.
Failures in timing are almost always due to pilot error. Either the pilot has become distracted, or has taken too long on a previous task, or has simply forgotten something. *We can all learn to be masters of timing. It just requires a little self-discipline and practice.*

Without question, one of the best things you can do to improve your landings is to learn your procedures and execute them on time. I cannot stress enough the importance of this. By remaining on time in terms of procedures accomplished at every point in the pattern, your workload will be minimized. Minimize your workload, adhere to the proper settings, maintain proper relative altitude and airspeed. If you do these things you are guaranteed to reduce your task of touching down softly on the centerline to the bare minimum effort.
Believe it or not, we have now discussed everything you need to know to make consistently good landings in calm air. No crosswinds yet. We’ll master the airplane under the default conditions first. That is calm or negligible winds.

We know and believe these things:

For any given position in the traffic pattern, there is a configuration resulting in an ideal:

- Airspeed
- Altitude
- Descent Rate (VSI rate)

These ideals are:

- Controllable by the pilot (with pitch and power)
- Quantifiably specific
- Impact the successive steps in the landing profile

We accept these fundamental facts about control:

Rectangular Pattern – all legs must be squared off

Lift – we modulate lift with pitch and power

Airspeed – our primary control for airspeed is pitch

Altitude – our primary control for altitude (and VSI rate) is power

Fine Control – is most important after the roundout

Timing – each event in the approach should happen at a specific time (if one event is delayed, the effects are passed on)
To define your perfect landing profile, you will need two sheets of paper. This is where you will identify and note every action involved.

Divide the first page into four sections. Label them:

- **Downwind Leg**
- **Abeam Point**
- **Base Leg**
- **Final Approach**

Divide the second page into five sections. Label them:

- **Roundout**
- **Float**
- **Flare**
- **Touchdown**
- **Rollout**

Now, go through each of the sections and write down your actions and the events that occur, in order, during that time period. Don’t leave anything out. Use the example for the Cessna 172 on pages 18 and 19 as a guide. Once you have completed this, you have a precise checklist for a perfect landing.

These two pages, as great as they are for study, are totally useless in the airplane. I’m sure you realize that there is just no way that you can read off and comply with these items in the busy environment of a traffic pattern. Yet, you need to do every one of these actions at the time indicated to get your airplane onto the ground as smoothly as possible.

You have one choice: you have to learn it. There is no way around it. Make this a two step process. Study and attempt to memorize your two pages. Give it your best effort to really learn it well.

Next, place a chair facing a blank wall, eight-ten feet away. In front of that chair, place a card table or TV-stand. On the tabletop, place a banana on the left, a screwdriver on the right, and your two pages neatly spread in the center. Prop the pages up at an angle so you can read them more easily. Congratulations. You have just built your first procedures trainer.

**Arm Chair Flight**

All right, have a seat in your cockpit. In the real airplane you fly, where is the trim wheel? In a Cessna 172, it will be on the center console, just beside your right knee. In a Piper Warrior, it will be on the floor to your right. Now hold that thought for a moment.
Take the banana in your left hand. That’s your yoke. Pretty handy if you get hungry, too. The screwdriver will be your throttle. Hold it as you would hold the throttle control in your real airplane. You will move them just as you would manipulate the real controls they represent.

During trim changes, you will need to lay the screwdriver momentarily in your lap or on the tabletop. For a Cessna-style trim, hold your right-hand thumb and index fingers together and brush the side of your knee with the back of your thumb, simulating turns of the wheel. If Piper is your style, make a similar motion, but brush the side of your right hip to represent the turning of the trim wheel.

This probably isn’t going to work very well if you have spectators so I would recommend you schedule some quality time with just yourself. Block off about twenty minutes and put everything else out of your mind. You are going to fly this dad-gummed chair around the traffic pattern, you are going to do it exactly as you’ve written on your pages, and heck, you might even have some fun doing it. It’s okay to make airplane sounds with your mouth if you like.

Your goal is to make consistently good landings, right? To apply techniques consistently, a requirement for consistently good landings, you have to first learn them. Flying your armchair with a banana in your hand may feel a bit foolish, but it will work.

Psyche yourself up. Imagine that you really are flying the traffic pattern. Make your power and trim corrections. Say your altitude out loud. If you do this for twenty minutes a day, three days in a row, and allow zero tolerance for missed checklist items, you will learn them.

It is a very small effort really. And your guaranteed reward will be more confidence and less stress in the cockpit during your next flight. It will give you command of the science, leaving you less distracted and more capable of discovering and mastering the art.

Summary

The act of landing truly does begin on the downwind leg. Your objective is to lose altitude and airspeed in a carefully timed sequence of events.

Starting on the downwind, you have a series of configuration changes you must enact at specific points in the pattern. This is your landing profile. You must memorize it. Each configuration change is precise. Any mistake in a configuration change must be corrected prior to touchdown (and causes an increase in your workload). Along with aircraft-specific configuration changes (e.g. flaps, carburetor heat, props, and pumps) you control your landing profile by managing the altitude and airspeed with power and pitch. That is about as concise as we can make it.
Chapter 6

How an Airplane Lands

It may seem a bit odd to you, just now getting to the explanation of how an airplane transitions from flight to ground operations. We’ve been talking about airspeeds and descent rates and bananas for quite a few pages already. I waited because I wanted you to learn the easy stuff first. The rote material. This volume of knowledge is now, hopefully, reflex for you. You can call on it without any effort. Otherwise, trying to implement it in the air will become a self-created distraction. There you are, trying to remember the throttle settings, and oh, heck! you forgot the carb heat. Meanwhile, you’ve lost three hundred feet and your airspeed is 20 knots too fast. All that because of the cumulative effects of one or two distractions.

Flying has a lot of busy work to it. Learn all the little items thoroughly so that you don’t have to expend any brainpower to implement them. Keep your mind free for the artistic decisions you’ll have to make.

Lift Modulation

An airplane remains in level flight when its lift vector, the upward force generated by the wings, is equal to the gravity vector, the downward force of the airplane’s weight. When the lift vector is greater than the gravity vector, the airplane goes into a climb. When the lift vector is less, it enters a descent.

We can control the lift vector. The gravity vector, however, is a constant. We cannot do a single thing about it. So, to fly our aircraft, we’ll have to settle with being in control of the force of lift.

As pilots, we modulate lift with the throttle and the yoke.

If we increase power with the throttle, the airflow over the wings increases and that increases the lift vector.

If we pull back on the stick or yoke, the elevators force the tail down and the nose up. This changes the angle of attack, the angle between the wing’s chord line and the relative wind. As angle of attack is increased, lift is increased – up to a point.

During the landing profile, we transition through various stages of level flight and descending flight. We control this by manipulating the lift vector with the throttle and yoke. The only trick is learning which is the more appropriate control at any given instant.

During unaccelerated flight, that is flight at a constant airspeed, the throttle is the primary control for lift modulation. Reduce the throttle slightly and
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we reduce the lift vector. The nose subsequently drops, the aircraft descends, but the airspeed remains relatively unchanged.

Larger and more sudden decreases in power will allow an excessive pitch-down of the nose. Airspeed may tend to increase in these cases. But as it increases, more air races over the wings, the lift vector grows, and the nose will again begin to pitch up. As it pitches up, the airspeed will tend to move back toward its original value. This type of operation will frequently set up a series of oscillations that may take some amount of time to damp out. But the point to note is that a reduction of power, when the airplane is trimmed for a constant airspeed, results in a loss of lift (and a descent) without a meaningful increase in that airspeed.

The yoke also allows us to modulate the lift vector. If we push the stick forward we force the nose down, thus reducing the angle of attack. When angle of attack is reduced, the lift vector is reduced. But something else also happens in this example.

We’ve pushed the nose down without making any change to the throttle. Lift is lost, a descent begins, and the airspeed climbs. Remember, we didn’t touch the power so now we’re in a power-on descent.

As airspeed builds, more air rushes over the wings, the lift vector starts to grow again and the airplane wants to pull out of the dive. The only way to keep it there is to either hold the yoke forcefully forward or reduce the power to lower the growing lift vector. If you let go of the yoke, the airplane’s nose rises as it seeks its previous airspeed.

During a descent to a landing, we won’t normally wish to dive the airplane. We’ll be looking for more gentle descent rates, ones that give us plenty of time to respond and do other things. The more flexible tool for fine-control of descents is the throttle. Certainly there will be times when we change the pitch, but the general rule of pitch for airspeed, power for altitude (and thus, descent rate) gives us the most Zen-like answer to our questions of lift management and descent rates in a landing profile.

Final Approach

To get the airplane from the final approach onto the runway pavement requires some significant changes in the airplane’s state. Three things in particular must occur:

(1) The airplane must lose altitude.
(2) The airplane must lose airspeed.
(3) The lift vector must be gracefully reduced to zero.
Ignoring all the requirements like maintaining the centerline and clearing obstructions, we are talking about a very precise balancing act between pitch and power. On short final our goal is to keep a smooth 3° (approximate) glideslope while allowing a subtle but steady decrease in airspeed. We want to continue that all the way to the roundout, timing it so that our power is as low as possible when we lift the nose to stop the descent.

Two common problems on short final are being either too high or too low. We could also be too fast or too slow, but let’s keep it simple for the moment.

Assuming that the airspeed is correct but the airplane is too low, the natural reflex is to pull back on the yoke, raising the nose. Wrong answer. Raising the nose will slow the descent rate (your obvious goal when you find yourself too low) but only in the short term. Raising the nose also causes a loss of airspeed. And what do we get when we reduce airspeed? Loss of lift.

So, in an effort to increase lift to reduce the descent rate, our response of pulling the nose up had the ultimate effect of losing lift. Exactly opposite of what we wanted. Down in the weeds we go.

The proper response when we find ourselves low on final is to add a little power. It probably won’t take much. Maybe just 50-100 rpms. A little power causes a little increase in the lift vector. A little increase in the lift vector causes a little reduction in our descent rate. And that means we will go further before hitting ground zero.

If we are high on final a similar situation exists. Our innate response is to push the nose down to lose altitude. But what happens when we push the nose down without reducing power? Answer: airspeed increases along with the lift vector. The end result would be finding ourselves with elbows locked, forcing the yoke forward as the airspeed goes through the roof. We’d get down all right, but with a large excess of airspeed.

The proper response when we find ourselves high on final is to reduce power. Again, it probably won’t take much. Remove 100-200 rpms and our descent rate will increase nicely without impacting our airspeed. If we find that we are still too high, a forward push of the yoke coupled with another reduction in power (maybe all the way to idle) will probably do the trick.

Another way of viewing these two cases (too low or too high) is to imagine that you are too far out from the runway or too close in. Consider that you are 200 feet above the ground and runway is still nearly a mile away. You may have the perception that the distance to the runway is the problem. But really, there is nothing wrong with being a mile out. The real issue is being there at only 200 feet AGL.

Regardless of how you look at it - whether you imagine that you are too low or too far out - add power to solve the problem. Increase the lift vector with power to reduce the descent rate while leaving the airspeed constant.
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Roundout

The roundout is where the descent ends. It is the point where you raise the nose to produce a zero reading on the vertical speed indicator. True, you could add power to increase the lift vector, but that would not give you the result you wanted. The roundout is a transition from descending flight to level flight. Adding power would cause the airplane to climb again. Or, if you forced it to stay level, the additional power would be manifested as increased airspeed. In both cases, not at all the intended result.

Changing from the descent to level flight is done with pitch at the roundout. Not a difficult decision. It seems pretty obvious when you see the runway numbers coming at you. You should start this process 10-20 above the ground. The smooth pitch up should place you in level flight about 2 feet above the runway surface.

Float

After transitioning to level flight, your next goal is to just stay at that altitude (anywhere from six inches to two feet above the runway surface) and patiently wait for the airspeed to decay. This phase is probably the most difficult part of the landing profile to master. It is all art and requires the most extremely precise control.

As the airspeed bleeds away, lift is lost and the airplane wants to descend. But you don’t want that – not quite yet. Your goal is lose all excess airspeed before allowing it to descend those last few inches. So, your lift vector management skills are called on for peak performance after the roundout.

After the roundout, you “hold the airplane off” while it continues to slow. In the face of decreasing airspeed, the only way to keep the lift vector constant is to increase pitch. Subtle increases in yoke backpressure are thus required until you feel the magic moment when the pitch is maximized and the airspeed is minimized.

Note that the amount of time you spend floating along in ground effect is a function of airspeed. If you come in a little faster than normal, you should expect to float along in this phase for a few extra seconds. This will place your touchdown point further down the runway. Be patient and don’t try to force the airplane to the pavement early.
Touchdown!

You and the airplane are just seconds away from touching Earth and leaving the world of flight. Your goal is to begin another descent, but an exceedingly slow one of just a few inches. The lift vector is still greater than zero, but you allow it to shrink by discontinuance of further backpressure. Decreasing airspeed with a constant angle of attack = loss of lift.

It is all art at this point. The split second before the rubber touches, the slightest amount of additional backpressure causes a tiny spike in the lift vector, stopping the descent at the exact instant when the main gear meets the runway.

Once the main gear is on the ground, a rapid unloading of the wings occurs. The lift vector is less than the gravity vector at this point, but it is still not zero. The wings are supporting some amount of the airplane’s weight, although most of the weight is on the two main gear tires.

As the airplane continues to slow, the lift vector becomes negligible and the elevator becomes incapable of holding the nose up. With a gentle “plop,” the nose gear drops to the tarmac.
Chapter 7  Ten Tips for Better Landings

Just as all good landing have the same characteristics, pilots fail at one or more issues from a common bank of mistakes on landings that aren’t so good. They are easy to identify because the same issues have been cropping up since Wilbur and Orville taught themselves to fly.

While much of landing prowess is more art than science, there are things we can do to consistently stack the deck in our favor. In fact, there are ten specific issues that can be addressed. You might consider them ten mistakes to avoid, or ten points to get right. But these ten issues combine to form the perfect landing profile.

It doesn’t take all ten to make your landings better. Improvement in a single one of these issues will translate into better timing and control. Quite simply, if you will pick just one and apply it in the air, your landings will improve. Master it and you will see results.

1 - Setup on the Downwind

Whether you are climbing into the downwind from a touch-and-go or descending into it at your destination airport, the downwind leg marks the beginning of your landing profile. Your goal on the downwind is to transition to a specific power setting while maintaining traffic pattern altitude (TPA). The power setting, usually the bottom of the green arc on the tachometer, will result in a relatively slow airspeed. That is exactly what you want since any excess airspeed must be disposed of. The object of your desire is that specific power setting and level flight.

A climb into the downwind will likely be at full power. But full power in level flight produces entirely too much airspeed. Thus, climbing into the downwind requires that you pitch the nose down and reduce power at TPA. You want to attain level flight, at pattern altitude, at your new speed. This power reduction is the first of three that you will perform prior to landing.

If you are descending into the traffic pattern, your power will probably already be reduced. Upon reaching the downwind at TPA, your goal remains the same. Set the power to that magic setting, the same one you use every time, and adjust the pitch to attain level flight.
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Perform this setup smoothly and quickly and the rest of your approach will be considerably easier. If you are too high or too fast, all of the remaining timing in the approach will be thrown off.

2 – Rushing on the Downwind

Students learning to land think the downwind leg is just too short. They have so many things to do, yet so little time to get them done. With practice, the downwind leg does appear to grow in length because the student learns his or her tasks and performs them more quickly. More time, less stress.

But even after getting comfortable setting the power and pitch, doing prelanding GUMP checks, and talking on the radio, there are going to be times when you find yourself rushing.

The reasons for rushing on the downwind are simple. Either you are waiting too late to get started or you haven’t learned the procedures well enough. One or the other, and you can learn to avoid either mistake.

Waiting too late is usually caused by distraction. Let’s just say that it will take you 45 seconds to reach the abeam-the-numbers point from your intercept of TPA on the downwind. That gives you 45 seconds to set your power, get it trimmed, do your prelanding checklist, and talk on the radio. Sounds like plenty of time, doesn’t it? So you reduce your power to the bottom of the green arc, hold the nose to level, then tweak the pressure off of the yoke with the trim wheel. It’s a beautiful day and you smile confidently at your passenger. The runway looks cool down there. This is just about the time that the tower clears someone to land, but you’re not sure of the callsign. You’ll be abeam the numbers in just 10 more seconds and now you’re having to ask the grumpy controller to “say again”. You dread making the call. And heck, there was that GUMP check you should have already done.

The result is a compressed timeline. You have too much to do, and not enough time to do it. Had you simply gotten right to your downwind tasks and completed them without interruption, handling the radio call would have been a non-event. Now you’re going to be stressed and behind schedule as you pass the abeam point where the next phase of preparation is scheduled to begin.

Learning the tasks required on downwind isn’t really that difficult. Think about what you have to do: pitch, power, altimeter, tachometer, trim, altimeter, GUMP, talk. Not really that much if you’ll be honest. In the air, however, all tasks
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become more complicated – they haven’t changed, but you have. Even a small amount of stress reduces your cognitive abilities. So, just being in the air flying an airplane will make these tasks slightly more difficult. To offset this, simply learn them exceedingly well. In fact, get so good with them that they become reflex. You don’t want to have to stop and think about them.

3 – Setup at the Abeam Point

Your arrival at the abeam-the-numbers point marks the real beginning of your landing. Up until now, you were maintaining altitude. At the abeam point, you begin your descent.

At the abeam point, your goals are to slow the airplane (your second power reduction), configure it for landing, and start your descent. When you see the approach end numbers off of your wingtip, you reduce power, probably add one notch of flaps, and possibly add carburetor heat. The trick is to do these things without any initial loss of altitude. Yes, you do want to descend, but not until you have slowed the airplane to its target airspeed. Next to the actual flare, this seems to give student pilots the most trouble. Let’s talk about that.

What happens if you reduce power, but do not raise the pitch? Think about it. If you simply reduce power, the airplane will start a descent, but with an approximately unchanging airspeed. Reduce the power but leave the pitch and trim alone and you get a constant speed descent. Not at all what you wanted. Instead of slowing the airplane, you end up too low and too fast.

Reminisce for a moment about slow flight. As you reduced power, you had to raise the nose to maintain altitude. Since your goal was to slow the airplane, you couldn’t allow a descent to creep in. The descent would prevent the slower airspeed you sought.

The same fundamental of aerodynamics applies at the abeam point. To slow the airplane, you must reduce power while smoothly increasing pitch. Once you have slowed to your target airspeed, then and only then do you allow the descent to begin. Trim for the target airspeed and you will have navigated one of the more touchy transitions in the landing profile.

At the abeam point you have to do your chores quickly and precisely. This is where armchair practice will pay you huge dividends. Get it right at the abeam point and you may be astonished at how easy the landing becomes.
4 – Maintain a Rectangular Pattern

The maintenance of a rectangular ground track in the traffic pattern is one of the simplest things you can do to help improve your landings. This one is so easy and the payoff so great that you must not underestimate its importance. If you fail to keep your traffic pattern squared off, the length of the individual legs will vary from their normal lengths. When that happens you can throw all of your timing out the window. Great landings are difficult enough. Don’t make them more difficult with the inclusion of new variables. Keep your legs square, keep your timing consistent, and do it the same way every time.

In a no-wind situation, use the lateral axis of the airplane to judge your ground track with relation to the runway.

A crab for crosswinds removes the ability to use a lateral line through the wing to judge your performance, but a rectangular ground track still must be maintained. Otherwise, legs will be shortened or lengthened.

If you accept the fact that timing is extremely important in making consistently good landings, you must strive to fly a rectangular traffic pattern. Imagine your ground track, perpendicular or parallel to the runway, and fly it perfectly.
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5 – Squeezing

One of the most common mistakes made in the pattern is a ground reference problem called squeezing. This is a big favorite of almost everyone. And again, it is one that is so easy to correct, I can’t imagine why pilots continue to do it.

Everything is fine on the downwind. The pilot flies the leg reasonably parallel to the runway. After passing the abeam point, however, the runway slides behind, lost from his peripheral view. The pilot looks back and subconsciously applies a slight turn, inward toward the final. Not realizing it, he has departed the parallel track and begins to squeeze in to keep the runway visible in the periphery.

The result of squeezing is a shortened base leg and too much altitude, both of which throw his timing off.

When a pilot finds himself in this situation he recognizes that he is closer to the final than planned. In some cases, the pilot just gives up on the idea of a base leg altogether and continues the egg-shaped turn toward the final increasing his relative altitude (ratio of altitude and remaining distance to the runway) even more. A tight spiral can develop; this has its own problems.
Up at altitude, a steep spiral is pretty much a non-issue. Level the wings to redirect the lift vector and the airplane will seek level flight on its own. This does, however, take a few seconds to occur. Close to the ground, those few seconds may represent the amount of time it takes to impact the earth. Plenty of pilots will succumb to the urge to pull back on the yoke when they see the ground coming up at them unexpectedly fast. This can be a recipe for disaster. Increasing backpressure on the yoke increases load factor which, in turn, increases the stall speed. Already flying at a reduced airspeed, the increased load factor may put the airplane into a stall/spin configuration with just too little altitude to recover.

At other times, the hypothetical pilot might “square up” his base leg, but because it was shorter than planned, fly right through the final approach. That complicates matters because of the requisite S-turns to get back onto the runway centerline.

In either case, squeezing will change the length of the base leg and your timing, and it will probably cause you to be high on final. These are relatively minor problems, but they do have to be fixed. And the resulting increase in workload comes at a very inopportune time. Things are happening more quickly, the touchdown zone is getting closer, and you are already plenty busy. Messing around with course and altitude corrections is something you don’t need.

Avoid squeezing first by being aware of it. Most pilots don’t even realize they’re doing it. While parallel on the downwind, pick a landmark directly off the nose. Keep it there even after the runway has disappeared from your peripheral view. Ensure that you maintain a parallel track all the way until you turn to your base leg. An innate temptation to squeeze will stay with you as long as you allow it to. Take charge and drill this one in – “I will not squeeze on the downwind!”
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6 – Wind Correction

Crosswind takeoffs and landings have their own technique. But general corrections for winds in the pattern are needed to keep that square ground track we’ve been talking about. On windy days you must be proactive and apply needed corrections, anticipating in advance what the winds will do to your ground track.

Headwinds

Taking off into a headwind requires that you must crab into the wind on the crosswind and base legs. Failure to do so will change your rectangular pattern into a trapezoid. The downwind will likely be shortened while the final will be lengthened.

Inadequate wind correction skews the ground track and introduces errors in timing and altitude. These, in turn, increase pilot workload.

Changing the lengths of the legs alters your timing. Additionally, because you are further from the runway when you make the base-to-final turn, your relative altitude will be too low. This requires an increase in power to slow (or temporarily stop) the descent - an obvious increase in workload that you want to avoid.
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Crosswinds

If you take off into a crosswind, you must crab into the wind as you climb out on the departure leg to maintain the departing runway centerline. But it doesn’t stop there. On both the downwind leg and the final you must apply drift correction into the wind to keep your pattern square and your timing intact.

Students frequently underestimate the affects of crosswinds when they turn onto the base leg. In this example, the crosswind becomes a tailwind once the airplane enters the turn. When the pilot completes the turn and brings the wings level, the airplane has already traveled halfway through the base leg and is moving at a faster-than-anticipated ground speed. These two factors cause the pilot to overshoot the turn to final.

Overshooting the final approach leg creates a new set of problems. If the pilot chooses to make a sharp S-turn to regain the runway’s extended centerline, he may inadvertently overbank the airplane. Overbanking at a low airspeed can cause a spin if too much backpressure is applied on the yoke. And at such a low altitude, this can easily become a disaster.

Even if the centerline is safely regained, the pilot is confronted with a much shorter-than-normal final approach leg. Timing is compressed, configuration changes must be quickly made, and the landing attempt is overburdened with excess problems.

Remember to correct for crosswinds in the pattern, not just during the takeoff and landing.
7 – Extended Centerline

On final, it is particularly important that you intercept and track the runway’s extended centerline as far out as possible. Imagine that you’re driving a monorail, sliding down this white line that slopes upward to greet you. Even without winds, it is just too easy to get sloppy and fail to track it precisely.

Now, granted, it can be difficult to tell exactly where the extended centerline is when you’re a mile out on final. It takes some practice to be able to discern slightly right or slightly left. The trick is to look at the entire runway in two dimensions. See it as a bilaterally symmetric trapezoid. When the angles formed by the runway sides and the threshold are mirror images of each other, you are on the centerline. The departure end threshold will appear narrower than the (closer) approach end threshold and should be centered.

Staying on the centerline all the way down keeps you on track for a good landing. It helps to minimize last minute corrections and reduces workload. Let me stress this simple fact by stating it another way: Failure to maintain the extended centerline will add significantly to your workload by requiring a series of last minute corrections. So, get on the centerline and stay there. Do it early and make it easy. Easy is good.
Ten Tips for Better Landings

8 – Trim on Final

Being smooth in the roundout and flare requires advance fine-tuning in terms of pitch. You will have the most fine-motor control if your arm muscles are relaxed. Trim the airplane for neutral pitch pressure at your approach airspeed on short final. This can dramatically improve your ability to apply subtle corrections. In addition to improving your finesse, this will allow the airplane to maintain the glidepath even if a distraction causes you to relax your pressure on the yoke.

Short final is a busy time. As simple as this sounds, you have to really think about this one. Forgetting to trim the airplane on final is a very common oversight. Practice it on the ground and do it in the air.

9 – Rudder After Roundout

If a student pilot is asked to recite one phrase heard most often from the instructor it would probably be, “Right Rudder!” While heard more often on takeoff, it is still a common command given during landing.

Prior to the touchdown it is imperative that the airplane’s longitudinal axis is aligned with the runway centerline. Translated from FAA-speak, this says that you better land with the nose straight. Touch down with it one side or the other and you’ll feel the side-loaded jerk as the airplane tries to line up the tail with the runway-induced ground track. It’s uncomfortable to passengers and hard on the airplane’s structure.

As the airplane slows in ground effect, you apply small increases in pitch to keep it off of the ground. Remember, you’re still trying to slow it to touchdown speed. Subtle pitch increases are required to keep it in the air as the airspeed bleeds off. As the pitch comes up and the airspeed goes down, the nose is likely to drift from the centerline. This is when the instructor pipes in with the command to give it some rudder. The most common mistake at this point is to apply the appropriate rudder correction, but keeping it in for too long. The nose swings to the opposite side as a result and you have the same problem, just going the other way.

While slowing to your touchdown speed, be aware of the nose’s angle to the centerline. If it is off to one side, give it a little rudder to swing it straight. But then remember to release the rudder correction. Put the rudder in, straighten the nose, then take the rudder back out. Repeat as needed.
Ten Tips for Better Landings

10 - Patience

Patience is a true virtue when landing an airplane. It also falls quickly by the wayside when your timing is off. You’ve gotten all the way through the pattern. You’ve rounded out right above the runway. Now, why screw it all up by becoming impatient?

Your goal after the roundout is to slow the airplane and wait. That’s right, wait for the airplane to decelerate to your appropriate touchdown speed. Then and only then should you allow the airplane to descend those last few inches.

Here’s the problem scenario: You turn in on final either just a little high or a little fast. You swoop down to the roundout and bring the nose up level, but with just a tad too much residual airspeed. This vestigial momentum has to be reduced before you touch down. So you float along and wait. After a few seconds, your subconscious starts chattering. “Shouldn’t you be down already? Look how far you’ve floated.”

The impatient pilot tries to solve the problem by lowering the nose. It’s ever so slight, but that subtle loss of lift is just enough to smack the airplane down upon the pavement. It makes him marvel that the engineers could design such a robust undercarriage.

Now the patient pilot hears the same questions from his subconscious. “Wow, we’re still in the air.” His response, however, is different. Hold the nose up, let the plane slow. As long as there is plenty of runway remaining, patiently waiting for the airspeed to dissipate is the true key to a soft landing.

Summary

There are no simple answers to mastery of a complicated system of events such as landing an airplane. But there are multiple steps that, applied incrementally, will improve your performance. Such are these ten tips. Ultimately, you need to master them all. But for now, just pick one or two. Master those and you will see positive results. Guaranteed.

Please view the lesson at www.betterlandings.com/multimedia entitled: Ten Tips for Better Landings
The techniques and practices we’ve developed up until now work just fine on a calm, standard temperature day. We needed these constants in order to define a baseline for our landing model. But circumstances do not always adhere to standards. Strong headwinds, gusts, varying density altitudes, and topographic factors influence our landing profiles.

Pilots must be ready to modify portions of their approaches based on non-standard conditions.

**Strong Headwinds**

A headwind, right on the nose, can be a blessing in many ways. Assuming that it doesn’t include a significant crosswind component, a headwind will slow your ground speed. At touchdown, the rubber meets the road at a lower speed, generally resulting in a softer contact. But a headwind does require modifications to the standard landing profile.

An airplane sitting still in the takeoff position experiencing a 15-knot headwind really isn’t sitting still at all. At least in terms of the airmass. The airplane’s wings think they are moving through the air with an airspeed of 15 knots before the pilot ever touches the throttle. When the power goes in and the airplane starts its takeoff roll, the airspeed will exceed the groundspeed by 15 knots. If the airplane rotates at 60 knots, a look out the window would give the illusion that the aircraft and its passengers are trundling along at only 45 knots. Thus, the airplane would become airborne with less runway and in less time than is normal.

Likewise, the climb would seem steeper although the time to climb would be unaffected.

In relation to the ground, it would appear that the airplane is performing better than on a calm day. It would launch more quickly, and would reach the turnout altitude closer to the departure end of the runway. Yet the airplane itself, in relation to the airmass, would be flying just as it normally does. The only thing that would change would be its status (in terms of timing and altitude) over the normal ground track.

Landing into a steady headwind also presents differences in the airplane’s status.
Problem: On a calm day, the normal geographical spot where a pilot turns base to final would produce a steady, stabilized descent to the touchdown zone. In a hypothetical Cessna 172, the airplane might be sliding down the glidepath with an airspeed of 65 knots and a groundspeed of 65 knots.

With a 15-knot headwind, however, the same airspeed would produce a groundspeed of only 50 knots (65 minus 15). And because of this, it would have a steeper descent profile. The normal power and pitch settings would cause the airplane to land short of the runway.

In other words, with a 65-knot groundspeed, an airplane would travel the necessary distance (d) in a given amount of time (t). That is the length of time it takes the airplane to descend to the surface. By decreasing the groundspeed, the airplane would travel less distance in the same amount of time. Less distance equates to coming up short.

Distance to touchdown zone: 1 mile
Descent Rate: 500 feet/minute
Starting Altitude: 500 feet
Ending Altitude: 0 feet

<table>
<thead>
<tr>
<th>Winds: Calm</th>
<th>Winds: 15 Knots on the nose</th>
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<tbody>
<tr>
<td>Airspeed: 65 knots</td>
<td>Airspeed: 65 knots</td>
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<tr>
<td>Groundspeed: 65 knots</td>
<td>Groundspeed: 50 knots</td>
</tr>
<tr>
<td>Time Enroute: 1 minute</td>
<td>Time Enroute: 1 minute</td>
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<tr>
<td>Distance Traveled: 1 mile</td>
<td>Distance Traveled: 3/4 mile</td>
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Solution: In order to reach the runway when faced with a headwind one of three things must occur if the airplane is to reach the runway: (1) increase the groundspeed, (2) decrease the descent rate, or (3) decrease the distance.

(1) To increase the groundspeed, increase the airspeed. Increasing the airspeed is accomplished with added power and reduced pitch. To offset a 15-knot headwind, an airspeed of 80 knots would be required.

(2) To decrease the descent rate, add power. If a descent rate of 500 feet/minute will place you on the ground in one minute, you simply need more time. Perhaps a descent rate of 200 feet/minute will do it.

(3) Decreasing the distance is one of the easiest ways to solve this problem. Simply make your turn from downwind to base earlier than normal. This will produce a final approach that is shorter in terms of distance, but more normal in terms of transit time.
Changing the Plan

Gusts

Gusts provide a garden variety of problems for a landing airplane. They may be more likely during certain seasons and may be common with passing fronts and nearby storm activity. Gusts can create particularly dangerous situations and should not be trifled with. Always be prepared to execute a go-around when landing in gusty conditions.

Problem: Gusts from the side.

Solution: Gusts from the side will frequently lift the upwind wing, exacerbating the problem. With a wing up, more surface area is offered to the offending gusts. Be prepared to quickly lower any raised wing while yawing with the rudder pedals to maintain coordinated flight with a centered ball. Close to the ground this becomes even more critical. Extensive practice in crosswind technique with a talented instructor should be mandatory before you attempt gusty landings.

Problem: Gusts on the nose or tail.

Solution: First recognize that gusts affect an airplane when they hit as well as when they abate. Imagine a gust of wind as a ball of air impacting the airplane. When the ball hits, an increase in indicated airspeed (but not groundspeed) is felt by the airplane as well as the pilot. Once the airplane has exited this bolus of air, another bump will be felt, this time from the sudden decrease in indicated airspeed. In either case, an abrupt change in airspeed will occur. As airspeed changes, lift changes.

To protect yourself from a potentially sudden decrease in airspeed due to a gust, carry extra airspeed during takeoff and landing. This implies a flatter climb/descent gradient. Typically, pilots subtract the gust speed from the steady state wind speed to produce a gust factor. Then, half of that factor (in terms of knots) is added to takeoff and landing speeds.
Density Altitude

By definition, density altitude is pressure altitude corrected for non-standard temperature. Does that help much? No, I didn’t think it would. How about this: Density altitude is used to express the density of air in terms of a volume of standard air existing at some altitude on a standard day. Is that any better? No? I can’t say I am surprised. This concept of density altitude remains one of the most confusing issues to pilots of all experience levels.

Density altitude is a measure of air density, nothing more. Think of it this way: high density altitude describes low density air. When we ascend, the ambient air pressure (which is another way to describe its density) is decreased. The air density we expect at high altitudes is less than the air density experienced at lower altitudes. High density altitude = low density air.

Air density is a function of its temperature and its relative humidity. High values of either lower the air density. Hot air is less dense than cold air. Damp air is less dense than dry air.

Expect a high density altitude on hot and humid days.
Humid + Hot = High Density Altitude = Low Density Air.

Density altitude is important to pilots because airfoils and air-breathing engines are less efficient in lower density air. We can expect poorer-than-normal performance in both the takeoff and the landing on a day with a relatively high density altitude.

Why does air density vary with temperature and humidity?

Air density is a function of its temperature and its relative humidity. High values of either lower the air density. Hot air is less dense than cold air. Damp air is less dense than dry air. Here’s why:

The molecules of hot air are more excited and exhibit more movement. Banging around against each other, fewer of them can squeeze into a given volume of space. Hot air = fewer molecules = lower density.

Humid air is less dense for a completely different reason. Air is made up primarily of oxygen and nitrogen. In humid air, some of these elements are replaced by water vapor. The molecular weight of H₂O is less than the molecular weight of the molecules replaced. Thus, damp air contains less molecular mass than an identical volume of relatively dry air.
Changing the Plan

**Problem:** Airplane tends to sink more when density altitude is high.

**Solution:** Consider the abeam-point settings we described for a Cessna 172. We typically use 1700 rpms, one notch of flaps, and expect to descend at approximately 500 feet/minute. On a particularly hot and humid day, however, your normal settings might produce a greater descent rate. The answer is obvious: on a high density altitude day, expect to add extra rpms to all the “normal” power settings. Usually, 100-200 rpms is sufficient.

This increased sink rate can also be noticed in the flare. The precise amount of backpressure you are accustomed to using on a cooler, drier day may result in more pronounced drop to the touchdown. Be prepared to add a tiny bit of power at the last minute. The resulting extra lift might just get you that soft touchdown you want.

**Problem:** Airplane doesn’t want to descend when density altitude is low.

**Solution:** Exactly opposite the example given above. The air is more dense on a low density altitude day. At 1700 rpms, your airplane might not descend at all. Try a lower power setting. Again, a reduction in power of 100-200 rpms will probably be plenty.
Unfamiliar Airports

Most of us learned to land over a series of lessons at one or two airports. We became very familiar with their geography and naturally picked out landmarks on the ground. We used these landmarks to know how far out our parallel downwind leg ran, where to perform power reductions, and where to turn onto the base and final legs. A very normal result of operating in familiar surroundings.

Using landmarks as a crutch in the initial stages of learning to land can be very helpful, and all because of the timing issue I have stressed so much throughout this book.

Learning to land is all about timing and workload management. Workload requires less effort once we improve our understanding of the tasks. Another way to look at this would be to say that work takes less time after we master a task. We don’t have to expend a lot of extra effort just remembering what to do and where to do it. The result of this is that we have more time to devote to the tasks that follow.

When first learning to land, a student hasn’t mastered much of anything. Thus, anything he or she can do to make the process easier – any crutch that can be employed – will have a positive effective in the ultimate outcome.

Crutches, though, eventually must be discarded. As a student becomes more skilled, a crutch becomes more of a hindrance. And landing at a new airport where you know nothing of the positions of local landmarks illustrates this point perfectly. If you have made landmarks a crucial part of your traffic pattern operations, you will find yourself in a heap of it the first time you go to an airport with which you are unfamiliar.
Changing the Plan

**Problem:** You enter the traffic pattern at an airport that is new to you and are unsure where make your turns.

**Answer:** Forgive me if this comes off as sarcastic, but the real answer to this issue is don’t rely on landmarks to identify points in the pattern to begin with. Develop a different method. The only landmark you should use is the runway itself.

The downwind leg is generally flown approximately ½ mile from the runway in light single engine airplanes. But don’t get too stressed if you are not precisely separated from the runway off your wingtip. True, being the same distance away on the downwind leg on every landing will help keep your timing intact. But it is not critical to be exceedingly precise. Use your best judgement. Pick a distance that looks right; it does not have to be exact. If there are other airplanes in the pattern, follow the path they are using. Once you are established on the downwind, put it any needed wind correction, then *pick a point out in the distance along your line of flight and fly towards that*. Done effectively, this will keep you on a course parallel to the runway.

The abeam point is where you do your second power reduction and prepare the airplane for its descent. The abeam point, that spot on the downwind leg when you are adjacent to your roundout point (generally the runway numbers), is the same for every airstrip. No problem here. Just wait until it is off your wingtip.

Next, where to turn base? Most instructors will teach that the turn is made when you intercept a 45-degree imaginary line that extends from the runway threshold out to the extended downwind leg. This is a good reference to get used to. But remember what we discovered in Chapter 3? If you are right on your numbers and everything is perfect at the abeam point, descend 200 feet (100 feet if the TPA is only 800 feet above ground) and you are ready to turn to the base leg. *(Important caveat: this only works in relatively calm air. A headwind or tailwind may place you geographically at a point too short or too long after descending 200 feet below pattern altitude. Be aware of what the wind is doing to you.)*
No pilot trying to improve his or her landings need ever feel alone. Every one of us has been there, and many of us still are. The internet provides a place where more and more pilots go, everyday, to share their joys and frustrations. In this growing virtual community, you can find people just like yourself having the same problems and asking the same questions.

Following are questions I have excerpted from some of the popular online forums. I have chosen ones that I believe express the most commonly felt issues.

**Question:** I have been introduced to all the maneuvers and I have a little over twelve hours in. I seem to come in high most of the time, but the thing I struggle with the most is the flare. I am flaring too early! I have about 25 landings to date and my CFI says I am close to solo. Am I being too critical?

**Answer:** Too critical? Of course you are being too critical. Landing an airplane is a skill that only the tiniest percentage of the human population has ever mastered. To become a member of this elite society takes time. Twelve hours and twenty five landings and you are coming in too high and having trouble with the flare? Well of course you are! That is completely normal.

Now one advantage that you, the reader, has over this student is that you understand how to correct his problems. Too high on final – clearly the result of inadequate management of relative altitude. This could have started as early as the downwind leg. If he simply paid more attention to altitude sooner he would not have to struggle with it at the last minute. There is nothing easier to correct than an altitude problem. Nail the TPA on the downwind, keep it there as you slow the airplane at the abeam point, make your base and final turns at the right spots and you are unlikely to find yourself high on final.

As far as flaring too early, wow, this is another one that is so easily corrected. Remember #10 in the Ten Tips for Better Landings? That is the one where I extolled the virtues of patience. Flaring too early? Well, stop doing that. Be patient. Let the airplane slow down and accept a longer float if necessary.
The Real World

Question: I’ve been stuck on landings for several lessons now. For whatever reasons, I can usually get it into the flare, but I don’t have a good feel for the amount of backpressure to apply as the airplane sinks. If I apply too much, we balloon. If I don’t apply enough, we land hard.

Answer: This is probably the most difficult technique to learn (and possibly even more difficult to teach). Although understanding the operation of the lift vector in conditions of decreasing airspeed and increasing angle of attack are required, when you are in this phase of a landing, you have darn little extra brain power available to analyze the physics. Things are happening quickly and your number of options are decreasing.

Chances for success in the final moments of flare are improved by adhering to the timing and procedures that start on the downwind leg. But remember, this ultimate event, touching tires to pavement, has the smallest performance envelope of any part of a flight. It consists of a precision balance of airspeed and descent rate, modulated primarily by angle of attack. I know, sounds pretty abstract. All the more reason to lean heavily on your artistic skills during this event.

While the flare and touchdown will improve with practice, you can definitely speed up the process by flying the airplane to that point using proper procedure. This allows you to enter the flare phase of the landing under the best possible circumstances. You have probably heard that a good landing begins on the downwind. That quaint aphorism is completely true.

Ballooning in either the float or flare phases is generally the result of carrying too much airspeed during final. If you get your airspeed correct early, it is easier to keep it correct than to apply extra correction at the last moment. Slow the airplane down and your chances of ballooning will be minimized.

Ballooning can also result from flaring too early, that is, flaring before the airplane has slowed sufficiently. This is usually the result of impatience. Wait a bit longer, increase backpressure just enough to prevent further descent. Let the airspeed dissipate prior to that last descent to the pavement.

Every student smacks it in more than a few times learning to touch down. Learning to apply enough backpressure without applying too much seems like an impossible task, but it is one you will master with practice. Slowing the airplane as much as possible, sitting high in the seat, and looking far down the runway will help. And if things just are not coming together, put the power in and
execute a go around. Don’t try to salvage an approach that is getting worse by the millisecond. Make ten go arounds if needed. Do not touch the tires to the runway unless everything is going perfectly.

**Question:** I keep dropping it in hard and my instructor says “Don’t try to land the airplane, try NOT to land it.” I just don’t get that.

**Answer:** A common admonition and one that can be confusing. What the instructor means is that you need to exhibit more patience, keep the airplane in the air a bit longer, and bleed off more airspeed. Your goal is to land it as slowly as possible. Holding it in the air for what seems like an inordinate period of time, however, can feel very uncomfortable for many students.

Imagine yourself to be a pre-solo cadet. Maybe you are and maybe you have 300 hours. It doesn’t really matter. Understanding the psychology at work may help you get a better grip on your own landings. So there you are, rounded out and floating down the runway. You came in just slightly faster than normal, perhaps by only a couple of knots. Nonetheless, this extra speed is something you need to lose prior to flaring the airplane.

“Hold it off! Don’t let it land!” your instructor instructs. You hold the yoke back trying to keep the airplane aloft. Time ticks by and you’re still in the air. And that is when you get this nagging feeling. It is not really a conscious thought, but you have this sense that you have been floating down the runway for too long. You can almost hear the little voice in your head saying, “Shouldn’t you be on the ground by now?” By telling you to “hold it off” your instructor is trying to tell you to ignore that little voice and keep the airplane flying so that more airspeed can be lost before settling to the asphalt.

Unfortunately, the little voice has a backup plan if he cannot convince you that you have been in the air too long. He tells you to concentrate on your arm muscles. “See? Feel that? That can’t be right – you are having to pull too hard!” Doubt creeps in and you want to succumb. “Don’t let it land.” You hear the words in your headset. It’s the same thing as before. Be patient, continue to hold the needed backpressure and let the airplane decelerate.

To sum it up, yes, you do want the airplane to land. But you do NOT want it to land until you have slowed it adequately. And what is adequate? Absent significant winds or other special problems, you want the airplane to fly as slow as you can get it while maintaining directional control. Next time you practice slow flight, concentrate on the amount of control you retain at various airspeeds.
Question: I have 32 hours and still haven’t soloed. I am having a real problem keeping the airplane the level over the runway. I feel like I’m bouncing up and down, ballooning and descending like a rollercoaster. Any ideas on how to correct this? I need help!

Answer: You can hear the frustration in this student’s lament. The hours are building in his logbook to an embarrassing level and still no solo. As if learning to land wasn’t hard enough by itself, this poor guy is adding stress to the mix.

Handling the yoke, especially in terms of elevator control, is a very precise affair during the roundout and flare. Your goal, to keep the airplane skimming just inches over the surface, is momentarily defeated by the slightest over correction.

Remember that the yoke is controlled by the muscles of your arm. You expect them to give you fine motor control in order to make tiny corrections in pitch. If you expect them to conform, you have to allow them to relax. Try this experiment.

Take a pen or pencil in your hand and flex your biceps muscle in your upper arm. Now, holding it as tightly as you can, write your name on a piece of paper. Next, totally relax your arm and sign your name again. Big difference. You clearly have better muscular control when your arm muscles are more relaxed.

Understanding this, it should be obvious that we can control the yoke or stick in an airplane with more precision if our muscles are already relaxed. So how do we do that and still maintain backpressure? Another one that is so easy, you’ll wonder how you could overlook it. The trim wheel.

Trim the airplane for neutral during short final. Let go of the yoke and your airspeed should not budge. Now, when you perform the roundout, it will take very little strength to hold the yoke back. You will maintain fine control and the little voice won’t start questioning you about pulling back too hard.

If you find yourself in an extended float, don’t be afraid to turn in a little more nose-up trim. Having the airplane trimmed properly means its natural tendency will be to fly relatively level. It will require only the slightest effort from you to fine tune it and maintain level flight while the last of your airspeed bleeds away.
The Real World

**Question:** I’ve already soloed, but my landings are still pretty sloppy. A consistent problem I’ve developed is bouncing. I can see why it happens when I drop it in a little hard, but even when I’m slow, I can rarely stick it to the pavement. I’m getting tired of logging three landings on every trip around the pattern.

**Answer:** Bouncing is almost universally the result of touching down with too much airspeed. But it is more complicated than simply that. A good, experienced pilot can land an airplane at significantly higher airspeeds without bouncing, but that pilot is managing his lift vector with a precision that a student is unlikely to match. In fact, this technique of landing at faster speed can be a requirement under certain wind conditions or when trying to land an ice-laden airplane.

For the less experienced pilot landing in good conditions, there is no reason to carry any excess airspeed onto short final.

When an airplane drops to the pavement too hard, much of the downward energy is redirected upwards upon impact. The airplane arcs back into the air, but at a decreased airspeed. The inexperienced pilot pushes the nose down to limit the ascent. This reduces the angle of attack. So now the airplane is in a condition of decreasing lift for two reasons: reduced angle of attack and reduced airflow over the wings. The result is a second impact, frequently harder than the first. And if the pilot allows the nose to drop enough that the nose wheel touches first, loss of control and structural damage are very possible results.

The best option for an inexperienced pilot is to add full power immediately after the first bounce and execute a go around. Salvaging a soft landing instead of a second impact requires skillful application of power and backpressure. Because there is very little margin for error in this situation, a go around is the more prudent choice.

Bouncing can also be the result of flaring too high. This is another one of those artistic determinations. The pilot flares too high and the airplane has a chance to accelerate because it has further to travel from the flare point down to the pavement. Gritting your teeth and squeezing the yoke won’t help. If you find yourself too high with an airspeed decaying to flare speed, either add power and land further down the runway, or better yet, go around.
Question: I have completed all my requirements and am getting ready for my checkride. I seem to make all my landings soft enough but I consistently drift off to the left of the centerline. Any hints for keeping it in the middle?

Answer: This is another extremely common problem. With a wide runway and no crosswind, it is not necessarily a safety issue. But limit the lateral width of asphalt available and you will quickly see the value of landing on the centerline.

Solving this problem is a two step affair. First, master tracking of the extended centerline on your final approach. It is not difficult and most students fail to do it very well not for lack of ability, but simply because they are not paying enough attention to it.

Once the ability to stay on the extended centerline on final approach is mastered, the second part of the problem must be addressed. And this one involves that left-turning tendency that pilots learn about in the books, but rarely give thought to when they are actually in the air.

On final approach, an airplane is descending at a speed and pitch attitude which is very stable. The airplane’s nose and tail retain the tendency to follow the same track. But after the roundout, speed decreases and pitch increases. Torque effects are allowed to perform their function of swinging the nose ever so slightly to the left. Because students tend to under-utilize their feet on the rudder pedals, nothing is done to counter the leftward yaw.

Small, short rudder corrections are required to keep the airplane tracking straight down the runway centerline. Add enough to straighten the nose, then take half of that back out. Be conscious of the painted centerline and use it to gauge your line of travel.

Remember that if you put in enough rudder correction to swing the nose from the left to the center, that swing will continue if you don’t reduce the rudder deflection you added. Next thing you know, the airplane is now on the other side of the centerline. Add only enough rudder correction to line up the nose and tail and to stop continued drift to the side.
Epilog

Consistent success with smooth landings is a skill that anyone can acquire. I suspect the way you would like to differentiate yourself is to acquire or improve that skill in the quickest fashion. No reason to hang around at the University of Hard Knocks any longer than necessary, right?

A good landing is much more than the touchdown, that instant of contact where rubber touches pavement. But that single moment is the test, marked by either a smooth deceleration, a sudden bump that jars an unspoken expletive from your lips, or something in between. You score represents your performance in this fleeting window of time that opens and closes in less than three seconds.

That moment of touchdown is the culmination of a series of events that started on the downwind leg. You maximize your chances for a happy ending by performing well at all the checkpoints that lead to the final event. By doing so, you fly through that open window with every advantage you can possibly have.

Good Flying!

Please view the lesson at www.betterlandings.com/multimedia entitled:
Of Space and Time