Unconventional WISDOM

The options available following an engine failure

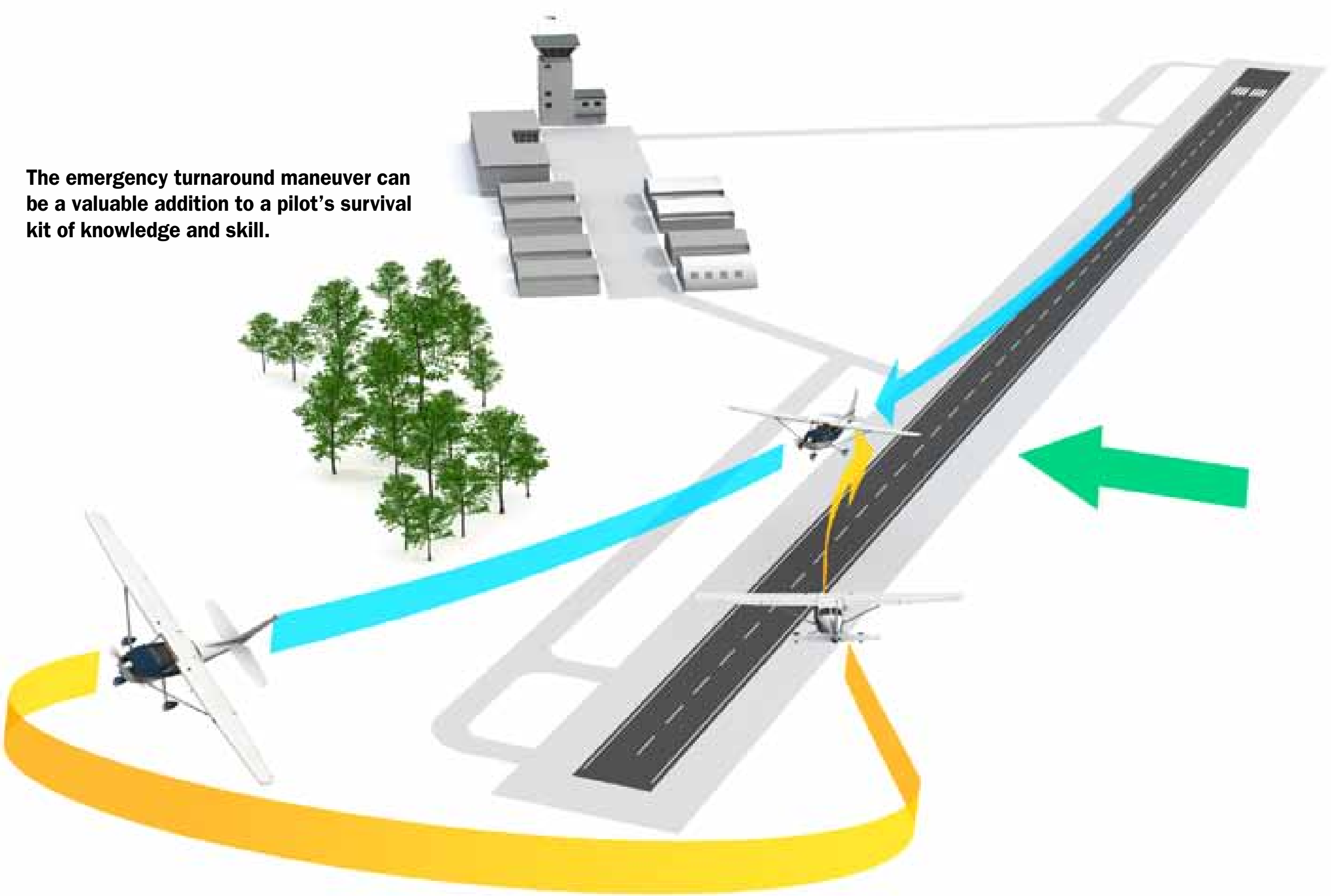
BY BARRY SCHIFF

Three events that pilots fear most are a midair collision, an airborne fire, and an engine failure shortly after takeoff while flying a single-engine airplane. The last of these occurs about twice a day.

Conventional wisdom states that a pilot should land straight ahead following an engine failure occurring shortly after takeoff. I am eternally grateful, however, that I was unaware of this so-called golden rule on April 8, 1957.

Departing California's Santa Monica Airport in a Stinson Voyager (N40156), the Franklin engine threw a rod and my world instantly became frighteningly quiet. Not knowing any better, I whipped the aircraft into a right turn, flared, and landed on a taxiway paralleling the single runway. The landing, though, was hard, and I damaged the right main landing gear.

Plus—Animation of a 180-degree turnback.



The emergency turnaround maneuver can be a valuable addition to a pilot's survival kit of knowledge and skill.

ILLUSTRATION BY JOHN MACNEILL

Following this accident, several experienced pilots told me about the golden rule. They admonished me for turning around and not landing straight ahead. There was something wrong with this conventional wisdom, I thought. Following their advice would have meant trying to thread my way to a crash landing in a congested residential neighborhood. I am convinced that the outcome would have been disastrous.

This seminal event started me on what became a decades-long study of the options available to a pilot following an engine failure that occurs shortly after takeoff. I first wrote about this subject 37 years ago and have been developing ever since a number of thoughts about this subject that you might find worthy of consideration.

The "impossible turn"

When unprepared for such an engine failure, it generally is best to land straight ahead (or somewhat right or left of the runway's extended centerline). NTSB records are replete with accidents resulting from pilots attempting to turn around and land from too low an altitude. The most common result of trying to avoid ground contact before completing the turn is a stall and/or a spin into oblivion. This is why a turn back to the runway is described by some as the "impossible turn," a misleading description of what can be a life-saving maneuver. There are times when attempting to land straight ahead would be extremely hazardous and a less-desirable option.

Records are not kept and do not reflect the many success stories of those who experienced an engine failure, turned around, and landed safely and without incident. Lacking aircraft damage or personal injury, there obviously is no reason to file an accident report. Video of one such event was posted on the Air Safety Institute's website (http://flash.aopa.org/asf/pilotstories/impossibleturn/).

The difference between success and failure is not only having sufficient altitude, but knowing how and when the turnaround maneuver can be performed with relative safety.

For starters, what bank angle should be used? Safety suggests a shallow bank angle. The problem is that a shallow, large-radius turn displaces the airplane so far from the extended runway centerline that a return to the runway becomes less likely. Although a very steep bank angle substantially reduces turn radius and keeps the airplane closer to the runway, the associated rise in stall speed is unacceptable.

The optimum bank angle appears to be a compromise, 45 degrees. This prevents excessive lateral displacement from the extended runway centerline and results in only a 19-percent increase in stall speed (from 55 to 65 knots, for example).

Interestingly, more altitude is lost during a shallow-banked gliding turn than during the same amount of turn using a steep bank. The explanation for this apparent paradox involves time. Although sink rate is greater when turning steeply, rate of turn is so much greater that less time is spent losing altitude than when turning with a shallow bank angle.

Turn direction can be important, too. In the presence of a crosswind, turn into the crosswind (upwind) to prevent drifting away from the runway's extended centerline. A turn away from the wind (downwind) can result in so much drift that returning to the runway might become impossible. If wind is not a consideration, then turn over the lowest obstacles that might be in the departure area. No obstacles and no wind? Turn left because most pilots are more comfortable turning that way.

With respect to airspeed, use the airplane's best glide speed to achieve maximum glide range and to provide a safe airspeed margin above stall. You certainly would not want to fly any faster than this because of the excessive sink rate and angle that would result.

Although maintaining the best glide speed seems logical, David F. Rogers, a professor of aerospace engineering at the U.S. Naval Academy, calculated that the

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minimum altitude loss during a gliding turn occurs when at an airspeed only 5 percent above stall. I winced at this, too, and certainly would not recommend that anyone fly so perilously close to a stall during such a critical maneuver so close to the ground. If a pilot does choose this option, he should resume the speed for best glide after rolling out of the turn.

Another factor is climb speed. Most pilots initially climb after liftoff at either the speed for best angle (V_X) or for best rate (V_Y). The problem is that neither of these speeds best positions the airplane for the possibility of a turnaround. Climbing at V_X places the aircraft in such a nose-high attitude that a pilot must vigorously force the nose down to preserve airspeed following an engine failure. This produces a high initial sink rate, thereby lessening the likelihood of a safe turnaround. Climbing at V_Y in some airplanes can result in such a shallow climb that insufficient altitude is gained while still close enough to the airport to successfully turn around and land. (This, of course, depends on the airplane; a Pitts Special, for example, can climb steeply enough at either airspeed.)

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So how much height above the ground does a pilot need to turn around safely? This depends, of course, on the airplane and the pilot's skill. It can be determined with a relatively simple and interesting flight test at a safe altitude. The first step involves establishing the airplane in a full-power climb halfway between V_X and V_Y while on a cardinal heading (north, east, south, or west). When passing through a cardinal altitude (2,000 or 3,000 feet, for example), pull the throttle closed. Delay doing anything, though, for five seconds. This is typically how long it can take for the average pilot to recognize and react to the shock of an actual engine failure. (Rather than allow the nose to drop, hold the nose in climb attitude for these five seconds because this is what many pilots tend to do following engine failure.)

After the five seconds elapse, simultaneously roll the airplane into a left or right 45-degree bank and lower the nose so as to establish and maintain no more than the best glide speed (or perhaps slightly less, depending on your comfort level with this).

Continue the turn for 270 degrees because reversing course to the runway requires more than a 180-degree turn. A 180 only places the airplane parallel to the runway and displaced to one side. Forty-five degrees of additional turn are needed to return to the runway centerline, and then another 45 degrees to line up with the runway. This means that roughly 270 degrees (180 plus 45 plus 45) are needed to return to the runway.

At the end of the 270-degree turn, roll wings level, initiate a simulated flare to zero the sink rate, and note the amount of altitude lost. Increase this altitude loss by 50 percent to account for other factors. If altitude loss during the 270-degree turn is 400 feet, for example, the minimum turnaround height (above the ground) for your airplane would be 600 feet.

Perform this maneuver a few times. You likely will discover that you can improve on your first attempt and reduce the altitude loss. Rolling into and holding the 45-degree bank while maintaining best glide speed, however, is initially more challenging than you might imagine. The goal is to become familiar, comfortable, and proficient with the maneuver.

There is another important consideration: climb profile. A successful turnaround requires not only reaching the minimum turnaround height, it requires also that you climb to at least two-thirds of that height by the time you pass over the departure end of the runway. This demonstrates that the airplane is capable of reaching the minimum turnaround height while close enough to the airport to have the ability to return. If you are not this high when passing the end of the runway, it means that either the runway is too short or the airplane will be too far from the airport to make a safe return by the time you finally reach the minimum turnaround height.

The likelihood of a successful turnaround diminishes when taking off into a strong wind. Landing downwind with a strong tailwind might make it difficult to stop the aircraft within the confines of the airport. At such a time, a pilot might be better off taking advantage of the headwind to land straight ahead with a much-reduced groundspeed.

Once a pilot opts to turn around and begins the maneuver, he should turn his head and look toward the runway as soon as possible to visually confirm that he really can glide there safely. Consider also that it might be more convenient and safer to land on a long taxiway or another runway. If it does not appear that you can glide safely to the airport, select the softest off-airport landing site ahead of the airplane and land there at the slowest speed possible and while still under control.

Does this discussion imply that I recommend turning back toward the runway following an engine failure after takeoff? No, it does not. The decision to return to the airport rests solely with the pilot in command. Furthermore, it should never be considered unless the risk associated with landing ahead or to the side poses greater risk than turning around. Unfortunately, there are many airports where a straight-ahead landing would be disastrous.

The idea is to be prepared for the possibility of a turnaround. Think about it. Train for it. Otherwise, when the engine fails after takeoff, the mind can turn to tapioca pudding. Time, altitude, and airspeed are wasted while trying to accept the reality of the moment and determine the safest course of action.

Remember, though: Under no circumstances should a turn back to the runway be initiated unless the aircraft has achieved at least two-thirds of the minimum turnaround height (as described) when passing over the departure end of the runway *and* it also has reached at least the minimum turnaround height at the time of engine failure. Even then, there is no assurance of success.

Furthermore, no pilot should attempt such a maneuver unless flying an aircraft for which he has personally determined the minimum turnaround height and is competent to perform such a maneuver during the stress of an emergency.

When previously writing about this subject, I received correspondence from some macho pilots suggesting various other means of turning around. These included wingovers, wifferdills, skidding turns, and other semi-aerobatic maneuvers. None of this maneuvering is recommended when so close to the ground.

Some good news about this subject is that an engine failure after takeoff frequently can be avoided. It most often is caused by fuel mismanagement or attempting to depart with a detectable engine anomaly. Being more attentive and conservative can significantly reduce the possibility that you will be forced to choose between turning around and landing straight ahead. Better news yet is that this likely will never happen to you. After all, such catastrophic events only happen to the other guy. AOPA

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