

Random Shallow Approaches

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Background

In Southeast Asia, C-130 LZ operations were conducted predominately in what could be called a Low-Threat Environment. (Low threat is when they are shooting at someone besides me.) The most common weapons were small arms, .51 cal (12.7 mm) and the SA-7. The most effective tactic against these threats was to maintain altitude until over the airfield, then spiral down. Once called a variable pattern entry, this tactic is now well known as the Random Steep Approach.

When the techniques used for random steps are still valid in many parts of the world, a study of the threat in a European environment will convince us that other tactics will probably be required when operating in close proximity to a Soviet, Warsaw Pact or Soviet-equipped/trained force. In fact, we can deduce that if we fly at high altitude within a few miles of the FEBA, we're very likely to get our TUSH shot off. This leads us to a low level ingress to the LZ. Further study of the problem indicates that if more than one aircraft is involved, approaches from more than one direction may be desirable. In addition, the threat, prevailing winds and geography may dictate approaches from other than normal positions. Hence, the random shallow approach.

Theory

Breaking the problem down further, we find three major areas of concern for this type of

approach: Tactical Considerations, Energy Management and Terrain Avoidance. Tactical considerations dictate this type of approach in the first place. If there is no threat or no danger related to detection, there aren't many reasons to fly this type of approach. The key is to remain outside the DRCPB's weapons envelope. That may force an approach from only one side of the field, or from behind a ridge. It may, on the other hand, dictate a high speed, low altitude approach until over the airfield. A relatively static conventional warfare scenario may allow only one or possibly several avenues of approach. A very fluid tactical arena will probably push us toward maintaining our ingress posture (low altitude and combat cruise airspeed) until the last possible moment, slowing as quickly as possible while configuring for landing. The keys are threat analysis, planning and flexibility.

Threat analysis is needed to determine the advantages and disadvantages of various approaches. Capitalize on as many advantages as you can; give away as few disadvantages as possible. As in any kind of discussion concerning tactics, past solutions may or may not give you an acceptable answer. Anticipate the enemy's moves and counter before they are effective. For example, weapons are seldom deployed singly. If a gun is reported in the area, expect a whole battery; missiles are usually defended by AAA. Accurate intel is absolutely essential.

Planning cannot be overemphasized. Approach the airfield from an IP, just like a drop or extraction. Your slowdown, pattern entry and traffic pattern must be planned to ensure that

you get the airplane slowed, configured and positioned for a successful landing. That's on speed and in the zone; running off the end of the runway is an inconvenience at best, a class A mishap (fatal) at worst. Analysis of the airspace available should include the areas denied by enemy weapons envelopes, friendly artillery and terra firma. Plan your approach around these restrictions, leaving adequate margins in all directions. I'll say it now and you'll hear it again: make the approach good on the first try. Save the closed patterns for the home drome.

Flexibility is what's left after your threat analysis or planning didn't work quite as anticipated. This factor can be reduced quite a bit by good planning that allows for alternate courses of action if things go awry. Items in this category are things like your decision points, emergency escape plan and alternate approaches. Decision points are times or positions where you must commit to one course of action or the other. You may require a certain piece of equipment to continue i.e., RADAR for an ARA, or anti skid for an assault landing. Determining in advance where you will either commit to the approach or landing or abort the mission will make your decision process easier in the confusion of the battle area. An emergency escape plan is essential in combat, where a climb to the ESA and turn for a direct RTB will most likely compound your problems. Performance data is critical, especially in high or mountainous terrain. It's entirely possible that if you have a non-jettisonable load; you could find yourself in a position that you don't have the power to fly out of. A bailout plan could save your crew in that case. Alternate approaches may be required for a number of reasons. Changes in the tactical situation, a shift in the wind or your arrival from a direction other than initially

planned will require different approaches. It may sound like flexibility is part of planning, but it is more than that. Flexibility is being constantly aware of potential problems and your options so that you can pick the best, survive and complete the mission.

The energy management problem inherent to random shallow approaches is not quite as obvious as the tactical considerations, but is every bit as important for a successful approach and landing. There are probably very few of us who haven't sped past a DZ with the doors closed, unable to slow down enough to get them open. This is a classic example of poor energy management. Random shallow approaches complicate the energy problem because you are working in one plane: climbing to dissipate airspeed isn't usually recommended.

When dissipating energy, we can pretty well assume that the throttles will be set at zero torque (flight idle more or less). That leaves us about three ways to ensure that we get configured in time to make a successful landing without doing it too soon: form drag, induced drag and track distance.

Form drag is the force trying to slow the aircraft as it bludgeons its way through the atmosphere. Even a sleek, high performance airplane like a C-130 is affected by form drag. Clever pilot that you are, you can control the aircraft drag configuration mainly in three ways. First, wing flaps increase drag in any position except up. As an added bonus, you probably want them down for landing. Two pretty good reasons to get them down promptly. Remember: There are intermediate speed limits and flap settings between 50% (180 kts) and 100% (145 kts). Getting the flaps down on speed will reduce the time and distance required to slow down.

Second, the landing gear significantly increases form drag, and again is required for a graceful landing. This is particularly true if you want to taxi after landing, make a subsequent takeoff or continue to collect flight pay. NOTE: Trying to move the landing gear and flaps simultaneously can result in overtaxing the utility hydraulic system, resulting in low pressure lights and cardiac arrest in the flight engineer. In most cases, it is recommended that you move the gear and flaps independently. The third way to increase form drag is by use of uncoordinated flight. Slips or skids can help you dissipate energy quickly or tighten up a turn dramatically. But this method is not without drawbacks. There are warnings in the DASH-1 about extended uncoordinated flight possibly flaming engines out from fuel starvation. Unlikely during the brief maneuvering in the traffic pattern, but a consideration nonetheless. Uncoordinated flight increases airframe structural loads significantly, as well as increasing the loads on the cargo and passenger. Abrupt control inputs are particularly hard on the airframe and can, in some instances, exceed the design limits. Further, stall margin is reduced and while the resultant increase in induced drag may slow you down even more, an inadvertent approach to stall in an uncoordinated configuration can result in an abrupt departure from controlled flight. For these reasons, I recommend using uncoordinated configurations sparingly, not planning on the added turn rate or drag, but rather using it to improve your situation when required. By keeping it in your “bag of tricks” but not normally depending on it, this technique improves your margin, and may allow you to make good an approach that for some reasons didn’t start out just right.

Induced drag is drag incidental to the lift produced by the wing. As the angle of attack increases to produce more lift, the induced drag goes up as the Sine of that angle. If you don’t think induced drag is a factor in C-130 operations, see how long you can turn at 2 g’s with the power back at idle. Comparing the rate of airspeed decay with a straight ahead wings level slowdown will show a significant difference. On a random shallow approach, there is basically one way to increase angle of attack: Turning. The more bank, the more “g” required to maintain level flight, resulting in increased drag. This, in turn, slows the airplane, which means more AOA and (amazingly enough) yet more induced drag. And so it goes.

Turning during our approach is helpful in more than one way. It allows our random approaches to be from more than one direction (random), giving us a tactical advantage. It allows us to dissipate energy quicker and at the same time keeps our pattern in close proximity to the airfield which is presumable under friendly control. All this is not without draw backs. The same AOA that slows you down puts you closer to stall. It is entirely possible to put a relatively heavy C-130 into a accelerated stall during aggressive maneuvering even at fairly high airspeed. It’s also entirely possible to put yourself on a downwind too tight to make a successful turn to final. Low altitudes and airspeeds are not the best envelope to work on your stall recovery procedures, and a go-around in a combat area could jeopardize your relationship with your crew.

For a normal approach, track distance is easily controlled. You either extend or widen your downwind so that you can make the turn to final. A random shallow may not give you either of these options. Prior planning and crew

coordination are essential to a successful approach. Plan so that you know where you're going to start dissipating energy, and what ground track you want to fly. Crew coordination is required to ensure you get there with the intended entry parameters: Position, speed and heading. A variance in any of these will necessarily effect the approach. You can vary the form and induced drag to a point, but if you haven't got enough track distance, you won't be able to get the airplane configured and slowed to the speed required for a successful landing in time. Again, go-arounds in combat aren't the best way to operate. The opposite error (slowing too early) gives Ivan his shots on the way in. Remember, the whole idea of these approaches is to maintain your tactical posture as long as possible, and do your maneuvering in the relatively low risk area near the friendly airfield.

The third major consideration for this type of approach is terrain avoidance. It should be intuitively obvious why this is important. Regardless, I'll say it again: The ground has a PK very close to 1.0. If you ever forget that, you are a likely casualty.

That emphasized, we must also say that the ground is our ally from a tactical point of view. That ridge that will kill you if you impact it can also shield you from ground fire or radar detection. Like any low level event, operate with adequate margin. Be especially mindful of the extra ground clearance required while maneuvering; at 60° of bank, the wingtip is more than 50 feet lower than the cockpit. In flat terrain, the key is to stay in that narrow gray area: Low enough to minimize the threat, yet high enough to ensure you don't hit the ground. In hilly terrain, you'll want to approach from a direction that allows you a tactical

advantage; if you can't be detected, you're a lousy target. But check your terrain clearance closely. If your turn radius exceeds the airspace available between you and the ridge you will either (a) pop up into the weapons envelope (bad) or (b) impact with the ridge (worse). An LZ in a bowl is a different problem. Your pattern may look more like a random steep, but in close proximity to the ground. Suffice to say that this problem is by far the most complex of the lot. Your energy management problem is three dimensional, and in some cases your probability of go-around isn't very good. This case indicates very conservative planning to ensure you don't become an accident statistic.

Practical Applications

"OK," sez you, "So how do we make this work?" Well, after some pondering, study and experimentation, I'm willing to go out on a limb and talk about flying these approaches. A couple of caveats:

1. These are not procedures. They are my techniques and opinions.
2. Our experimentation has been with relatively light aircraft (100-110,000 gross). Aircraft operating at 125-140,000 lbs. will certainly need more space to maneuver, and probably more time to slow down. The disclaimers out of the way, we'll look at the few different types of random shallow approaches. Most other variations on one or the other or a combination of segments from different types. The four types of approaches that we'll discuss are the Straight-In, the Teardrop, the Beam Approach and the Spiral.

The Straight-In

The approach (see Fig. 1 and Fig. 2) appears at first glance to be the simplest, but may in practice be the most difficult to execute consistently. The lack of turns means that your energy dissipation problem is one dimensional. You're committed to a given track distance once you start the approach, and you're unable to significantly effect the induced drag because of lack of turns. Form drag is all you've got. The keys to a successful approach are starting it at the right time and getting configured on speed. Entry airspeed is critical. Since energy is proportional to the square of velocity, a small increase in entry airspeed can make the difference between a landing and a go-around. It will take at least three nautical miles to slow from 220 knots indicated. From 250 knots, plan on 4.5 to 5 nm. That is a bare minimum. Tail winds or increased gross weights will probably dictate an even earlier slow down.

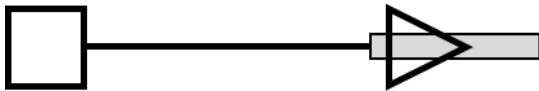


Figure 1: Straight-In Approach

ADVANTAGES: No maneuvering required at low level. LZ acquisition generally easier.

DISADVANTAGES: Slowdown initiated further from airfield than other approaches. Slowdown timing/entry parameters critical. Navigation critical since the LZ is only 60 feet wide from head-on.

VARIATIONS: You won't always be able to approach on a direct line to final approach, but an angling final, dog leg or even an entry to base will require basically the same techniques as the straight-in.

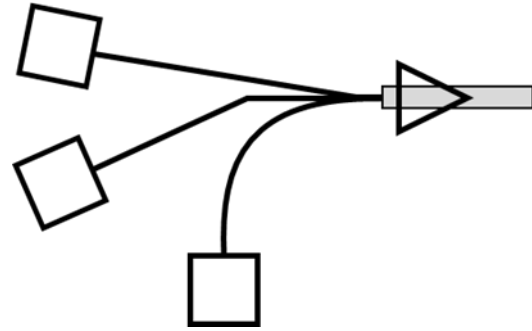


Figure 2: Straight-In Approach

The Teardrop

This approach (see Fig. 3 and Fig. 4) is familiar to most Air Force pilots from their instrument checkrides. It is very similar to a circling approach to the opposing runway, the primary difference being that the random shallow is entered at en route airspeed rather than fully configured. So you are dissipating energy throughout the approach. Also, a 300 foot pattern altitude is somewhat lower than most circling approaches. Start slowing about 1 nm from the approach end, with 30 degrees displacement from the runway axis. Turn base when even with the landing threshold. It will probably require a continuous turn to final. The key reference point for this approach is 160 kts, flaps 50% and landing gear in transit before starting the base turn. This will ensure that you can get configured in time to land.

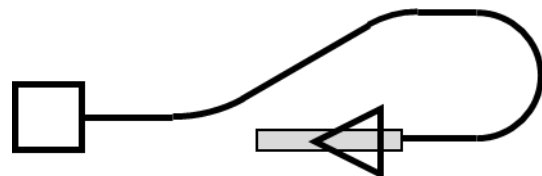


Figure 3: Teardrop Approach

ADVANTAGES: Pattern is flexible enough to allow adjustments to manage your energy and still stay within a close proximity of the airfield; allows you to convert from a straight-in to the opposite runway. You maintain ingress airspeed until close proximity to the airfield. LZ acquisition about the same as a straight-in, but less precision needed due to more flexible pattern.

DISADVANTAGES: Maneuvering at low altitude and airspeed. Unusual “picture” likely to result in a too tight pattern and overshoot.

VARIATIONS: A normal entry to downwind will set you up for the same base turn used on the teardrop approach. A turning or straight ahead slowdown may be used to establish the proper configuration and position to enter the base turn.

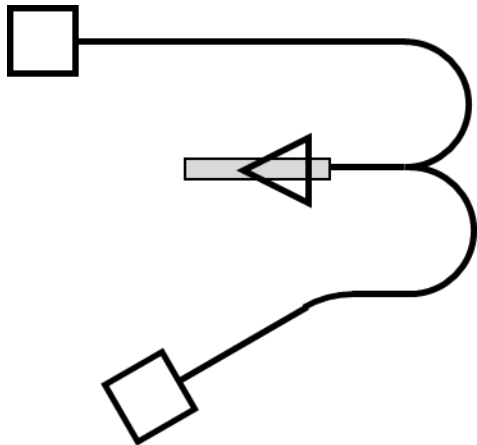


Figure 4: Teardrop Approach Variations

The Beam

This may be the most elegant of these approaches (see Fig. 5). It offers a good degree of flexibility, and keeps you as close to the field as any of the approaches. The approach from abeam the runway sets you up for landing in either direction and allows some RECCE of the

field as you fly over. The key reference points to shoot for: Field crossing at 220 kts, initiate base turn at not more than 150 kts, flaps 50% and landing gear in transit. If you enter with more than 220 kts, you'll probably have to extend your downwind. If you turn final with less than the recommended configuration, it is likely that you'll end up in a go-around.

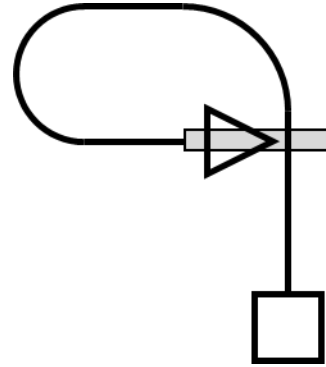


Figure 5: Beam Approach

ADVANTAGES: Ingress airspeed maintained until over the airfield. Easily adapted to landing either direction. Constant turning degrades you as a target. The airfield is at least a half mile wide when approached from the beam, reducing the precision required for navigation.

DISADVANTAGES: LZ acquisition more difficult particularly for dirt strips or austere fields without a lot of buildings around them to make them stand out. Considerable maneuvering in close proximity to the ground and with decaying airspeed. Possible loss of position awareness while making turn to downwind you loses tall passing the runway.

The primary VARIATION on the Beam Approach is the Spiral.

The Spiral

The approach (see Fig. 6) allows pattern entry at maximum airspeed, but requires planning to

ensure that your entry is within the required parameters. The pattern is a continuous energy decay maneuver, and you'll notice that each of the previous patterns is included in the spiral. The pattern allows you to deplete your energy and land in the absolute minimum time. The key points for this approach are one nautical mile abeam the touchdown zone at 250 kts; crossing the runway at 90 degrees, 220 kts; and 150 kts, flaps 50% and gear in transit before starting the base turn.

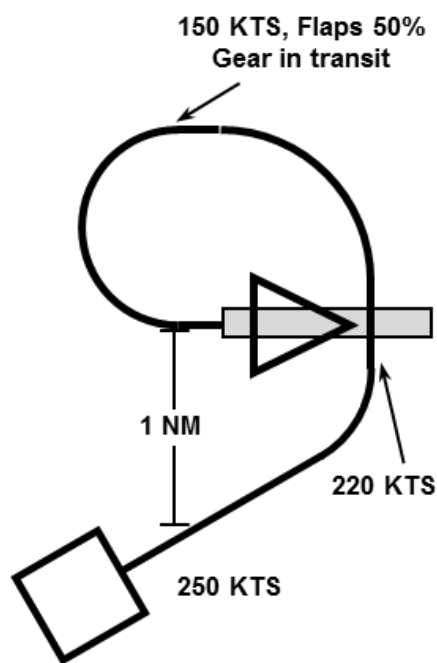


Figure 6: Spiral Approach

ADVANTAGES: Maintains higher airspeed until very close to the airport. Constant turning while changing airspeed and configuration degrades you as a target. Pretty good flexibility for energy management.

DISADVANTAGES: Lots of turning close to the ground. Again, possible loss of position awareness as the runway passes to 6 o'clock. More critical on crew coordination since the pattern entry point is more sensitive than some of the other approaches.

A few notes on this approach:

1. The entry, abeam the touchdown zone at 250 kts will work from a variety of approach angles. Generally, the closer to the runway heading, the more bank required. Use these as starting points:
 - a. PARALLEL: 60 degrees BANK UNTIL RUNWAY CROSSING.
 - b. 30° OFF: 45 degrees BANK UNTIL RUNWAY CROSSING.
 - c. 45° OFF: 30 degrees BANK UNTIL RUNWAY CROSSING.
2. The spiral can be extended to allow pattern entry at even higher airspeeds. The line is extended on the 60 degree bank turn radius to the desired entry airspeed. This may be useful in some special cases, and I don't think it should generally be a factor. Note that the radius of a turn is constantly changing as the airspeed decays.
3. All the approaches we've discussed can be analyzed as variations of this approach. All of the approaches pick up the spiral approach and follows it to landing. (see Fig. 7)
4. The most common mistake made on these approaches is for the pilot to fixate on the word "SHALLOW" in the name and drag in the approach. There is no need to descend until on a normal glidepath for the landing. Fly a normal approach path on final. FAILURE TO PERCEIVE THE GLIDEPATH CAN RESULT IN A SHORT LANDING.

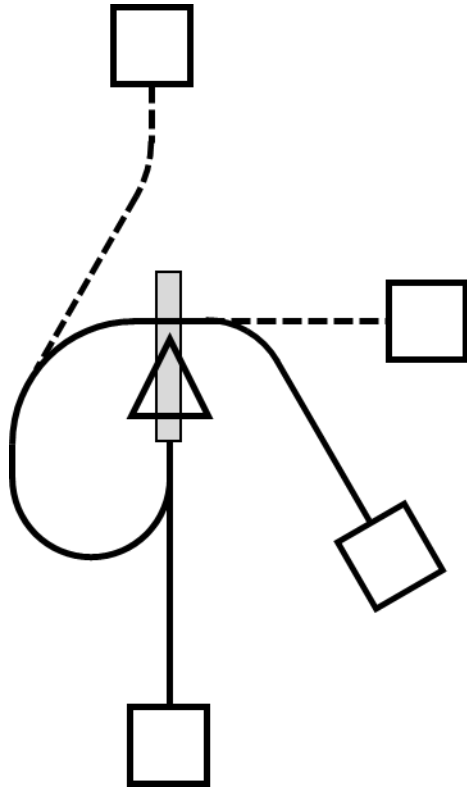


Figure 7

Conclusion

I hope this article gives you a start at understanding these approaches. There isn't anything magic about them, but like any tactical low-level event it behooves you to study, ponder and consider how to do them before you get in the airplane. Your understanding of tactical considerations, energy management and terrain avoidance will directly relate to your success in either the training environment or actual combat. However, there isn't any good way to develop proficiency without getting out there and practicing. Remember that courage isn't a requirement for Random Shallow Approaches in training. A conservative, step by step method of learning these approaches will ensure that you develop your skills and habit patterns without undue risk to your airplane, pilot's wings or life insurance policy.