

Bonanzas to Oshkosh

Formation Flight Practice

Fly Safe – Have Fun

Mandatory Safety Rules

1. Wingmen always keep lead in sight – always.

If you lose sight of lead, go down and away.

1a. Never show your belly to lead. Keep the wing down – uncoordinated flight is common. Use your rudders aggressively when necessary.

2. Maintain clearance in all 3 dimensions. No wingtip overlap, no nose-to-tail overlap, and step down sufficient for your entire Safety Box to pass under lead's Safety Box. The Safety Box is the rectangular prism of space surrounding an airplane. The shoes in 2 shoeboxes can't touch each other if the boxes don't touch.

General Techniques

Watch your reference points for relative movement. Make corrections in 3 step process

- a) stop relative movement of points
- b) move back toward position
- c) stop relative movement of points when they are aligned

This is a constantly occurring procedure.

Anticipate throttle and control inputs. React quickly with small inputs.

Hold the button in on your throttle – vernier action is too casual.

Use mostly rudder to move in and out when within 100 feet (about 3 ship widths).

Move up on lead far enough that you can see his head.

Use highest engine RPM you can.

Preflight Briefing

Refer to the briefing sheet and decide these things before engine start:

Flight Call Sign

Weather: Wind and Altimeter Setting. Everyone sets altimeter to match lead's indicated ALTITUDE, not altimeter setting. Nobody changes altimeter setting for duration of flight.

Positions

Frequencies

Time Hack (synchronize watches)

The thinking man has already taken a hack off his GPS

Planned altitudes

Planned airspeeds

Planned maneuvers

Landing details

Bingo fuel time

Start, Taxi, and Run-up

Lead handles tower communications for the flight. Wingmen monitor.

Taking Runway

Lead takes downwind side. For B2Osh 3 abreast take-off, lead is in middle. It is OK for your wingtips to be well over the grass.

Element Take-off

Lead uses power setting low enough to allow least powerful wingman to keep up.

Lead stays on the ground until at least 80 KIAS.

Leave gear down until landing on remaining runway is impossible – 200 feet AGL is good.

Wingmen rotate when lead rotates.

Wingmen establish step down as soon as safety allows.

Wingmen retract gear when lead retracts gear.

Climb-out & Initial Join-up

Lead climbs out at briefed airspeed and vertical speed – 100 KIAS & 500 FPM will be used in B2Osh.

At SCK we will be doing element take-offs, hence no need for join-up.

For a long climb, Lead will kick you out.

Level Off and Kick-out

Lead will level off and establish briefed cruise airspeed.

Lead will signal a kick-out with a rudder wiggle.

Wingmen will move out to a safe distance to take care of cockpit chores, such as mixture setting, prop setting, cowl flaps, visor positioning, etc.

When moving out, wingmen should move forward to keep sight of lead's head.

Use maximum cruise RPM specified in POH. 2450 – 2500 for IO series engines.

Lead will signal rejoin with a crisp wing rock or radio call.

Station Keeping

Maintain all 3 dimensions of clearance. No overlap and complete step down.

Pay attention to your reference points and react quickly when their relative positions change.

Stop all relative motion. Move back toward your position. Stop relative motion when in position again.

Repeat continuously.

Aggressive throttle movements will be necessary. Hold the button in. You cannot possibly twist the vernier fast enough.

Maneuvering

There are 2 kinds of turns. Finger or Welded Wing and Echelon

Finger Turns

Lead will use bank angle of 20 degrees for Finger turns.

When lead turns into wingman, wingman will match bank angle, reduce throttle immediately, and descend to maintain relative position. Your sight picture of Lead should not change.

When Lead turns away from wingman, wingman will match bank angle, advance throttle immediately, and climb to maintain relative position.

Echelon Turns

Echelon turns can ONLY be made away from wingman.

Lead will use bank angle of 20 to 30 degrees for Echelon turns.

Wingman rolls to same bank angle but does not climb to maintain the same sight picture.

Wingman's sight picture of Lead is much like close trail; wingman keeps Lead slightly above the horizon.

Wingman advances throttle to account for larger turn radius, so that roll-out to wings level ends back at the Finger position.

Descents

Lead will descend at 125 KIAS and 500 FPM. Wingmen will match.

Cross-unders (not done in B2Osh)

At SCK we will do cross-unders in 2 ship so wingmen can do turns into and away on both sides.

Lead will signal cross-under with proper signal (a raised fist) or radio call.

Wingman will reduce throttle and immediately resume original power setting. When wingman has fallen back behind and below lead, wing crosses to other side. Wingman then advances throttle to re-establish position. The trick is to reduce throttle and then immediately advance throttle to the previous position. Then wait a second or 2 and you will be behind your lead. Cross sides smoothly with minimum bank. When across and near your 45 degree line, advance throttle to climb back up and forward to re-establish your position. Your original throttle position held station; that's where it should be when the cross-under is complete.

Breaks (not done in B2Osh)

The formation needs to break up at times. One reason is to land single ship. This is an Overhead Approach or Overhead Break. Another reason is to achieve extended trail so that join-ups can be practiced.

From an Echelon formation, stable at the briefed airspeed, Lead notes his heading and altitude, then makes a 45 degree bank, 180 degree turn without changing his throttle position. Wingman counts off the briefed interval (usually 4 to 6 seconds) and duplicates the turn. If both pilots performed their turns well, wingman will roll out directly behind Lead and in trail by double the break interval (8 to 12 seconds back).

Formation Join-up (not done in B2Osh)

From the extended trail position, Lead indicates a rejoin by rocking his wings.

As a courtesy Lead should first dip the wing to the side to which he will turn.

Lead turns at a 20 degree bank angle, maintains altitude, and holds the turn until the join is complete.

Lead should not change his throttle position.

Without touching his throttle, wingman turns to the inside of the circle & picks out a point in front of Lead.

By heading in front of Lead, wingman flies a smaller radius circle and begins to close distance on Lead.

When wingman sees reference points align, he has found the 45 and needs to turn TOWARD Lead.

As wingman stays on the 45, he or she will "ride" the 45 line into position.

When proper separation has been attained, wingman steps on "inside" rudder to align his fuselage with Lead's, and adjusts throttle to maintain station in the turn.

If Wingman Overshoots:

If wingman overshoots the join-up, wingman will continue underneath Lead to the outside of the turn.

Wingman must wash shorts, but is impressed with the importance of maintaining step down.

Wingman will NOT attempt to turn away from Lead with use of ailerons. Use of ailerons results in lifting of the near wing and blocking view of Lead.

Wingman will NOT attempt to slow down by pulling on the yoke. This results in loss of step down at a critical moment.

Close Trail

Close trail is a highly maneuverable formation that is used when Lead needs the ability to maneuver quickly, for example, descending through a hole in the clouds.

Lead signals close trail with a crisp elevator porpoise or radio call.

Wingman reduces throttle, immediately reapplies throttle and when safely clear of Lead's tail moves in behind Lead. Last guy in calls "In" when everyone is in position.

It is critical that wingman maintain nose-to tail separation and step down, since wingtip overlap is gone. Lead signals move from close trail back to original position with crisp wing rock.

Approach

Lead will kick out the formation for cockpit chores prior to descent.

Lead will descend at 125 KIAS and 500 FPM.

Lead will level off at pattern altitude 5 miles out and establish 90 KIAS approach speed.

Lead will turn on landing lights and signal wingmen so it can be done simultaneously.

Lead will extend gear at the briefed point and wingmen will extend gear when lead does.

Wingmen should know where their gear and light switches are, so they can be operated without looking away from Lead. If you need some room to glance at the switches, ask Lead for a brief kick-out.

If your engine will need cooling air immediately after landing, open cowl flaps when gear goes down because you will NOT be touching anything on roll-out until you have come to a stop off the runway.

Use of flaps should be considered in the pre-flight briefing. If landing with flaps, get them in when the gear goes down. You will need 1 hand on the throttle, 1 hand on the yoke, and 2 eyes on lead.

Landing

In 2 ship element landing, Lead should be on the downwind side, if there is significant crosswind.

Lead will land long, half-way down the runway, abeam the control tower at Oshkosh. At Stockton we will shoot for the point abeam the numbers for 29L.

Lead will NOT aim for the numbers and drag it to midfield. This puts you in the worst wake turbulence.

Wingman will move up acute of the 45 on short final and touch down slightly behind.

Wingman will maintain step down until short final.

Wingman will concentrate attention on lead until just before touchdown.

At OSH and SCK the runways are 150 feet wide. If each pilot lands in the middle of his side there will be 40 feet of wingtip clearance.

Go-Arounds

We will talk about go-around procedures after talking with tower. At OSH all go-arounds are to the right and the turn must be made short of the intersection of Runways 22/4 and 31/13 (just short of the VOR) to remain clear of the pattern for Runway 9/27.

If lead calls for an element go-around, wingman will assume proper position and match lead's performance.

If unable to achieve proper position and performance (highly likely), wingman will turn away from the formation and return to base as a single ship.

Lead will not turn into the formation.

High-Speed Taxi

After landing the formation will taxi to the end of the runway at a high taxi speed to give room to those following. 50 MPH is not too high.

Taxi all the way to the end. High-speed taxi is an important part of this practice.

Do NOT touch anything – not flaps, not cowl flaps, not transponder, not lights, not radios, not windows, not doors, NOTHING – until landing roll has stopped and you have exited the runway! There will be a lot of airplanes in front of, behind, and next to you. Keep your eyes outside!

At OSH we will be taxiing straight off the end of the runway onto the taxiway.

At SCK we will be turning off to the left onto a taxiway. Do NOT cross the path of your wingman. Sit on the runway and wait for him or until he (not Tower or Ground) says you are clear to cross. SCK tower will know this is one of our rules. If they tell you to exit the runway sooner, say, "unable." After exiting the runway, lead will stop so the flight can clean up the cockpits before taxiing in.

After Flight Debriefing

Safety is our primary goal and fun is our secondary goal.

Criticism during the after flight debriefings will be constructive and honest.

This is no place for either thin skin or mean spirits.

Pilots will use the debriefing sheets to assess their own performance.

Safety observers will use separate sheets to assess each pilot in the formation.

All members of the flight will then discuss the sheets with the goal of improvement.

You will learn what you did well, which increases safety by increasing confidence.

You will learn where there is room for improvement (there is always room for improvement)

Four Ship Formations

Finger Tip

Hold up your right hand with the back of the hand toward your face. Your tips of your fingers describe the positions of a Finger Tip Strong Right formation.

Lead is your middle finger tip.

#2 is the index finger tip and is Lead's wingman. #2's position sets the separation distance for the flight.

#3 is the ring finger tip and is also called Deputy Lead.

#4 is the pinky tip and is Deputy Lead's wingman.

#1 and #2 comprise one element and #3 and #4 comprise another element.

There is also Finger Tip Strong Left.

All turns in Finger are Finger turns (Welded Wing)

Diamond

Start with a Finger Tip formation and put #4 in close trail behind Lead.

This is a Diamond formation.

Echelon

Echelon is characterized by all 3 wingmen on the 45 degree line to the same side of Lead.

When in echelon, turns are Echelon Turns and can ONLY be made away from the echelon.

This is the least maneuverable formation, but is required for a proper break-up, i.e. an Overhead Approach.

Close Trail

We have already discussed Close Trail. It's the same for 4 ships as for 2. It's just a longer trail

Four Ship Maneuvers

Configuration Changes

All formation configuration changes either start out in Finger or end in Finger. A Break-up is the only exception.

Crossing Lead's wingman (#2) results in an Echelon.

Crossing the element also results in an Echelon.

From Echelon, crossing either the wingman or the element results in a Finger.

From Finger, Lead may put #4 in the slot to create a Diamond.

A wing rock tells #4 to go back into Finger.

From Finger, Lead may put the formation into Close Trail.

A wing rock tells the formation to go back into the previous Finger.

Four Ship Breaks

Performed the same as a 2 ship break, only sequentially with the same interval.

#2 sets the interval. #3 and #4 match that interval no matter how poorly #2 counts.

Done correctly, #4 should roll out on heading directly on the line of aircraft.

Four Ship Join-up

From extended trail, Lead starts his 20 degree bank turn.

#2 joins the same as in a 2 ship join-up.

#3 waits until #2 has started his join-up turn and turn inside to find the 45 off Lead

#3 must be careful to stay "sucked" of the 45 until #2 is on the line.

When #2 has joined, #3 rides the 45 until about on #2's wing then crosses under to join on Lead's outside.

#4 has to be even more patient before following #3 up the line.

When #3 crosses under, #4 also crosses under to join on #3's outside wing.

This is the hardest maneuver we do.

Considerations for B2Osh Element Leaders

Accordion Effect

The B2Osh flight is nothing more than 3 ship elements in extended trail from each other. Those who have made the B2Osh flight would all agree that the “weakest link” in our flight has been the control of fore and aft relative movement and separation of elements. This is called “accordion effect.” It is probably safe to say that most pilots have been more comfortable with separation from the members of their own element than they have been with the separation between elements. There are 2 aspects to this. 1) Some wingmen have fallen so far behind their element as to pose a hazard to the element following. And, 2) Element leaders have difficulty detecting relative motion of the element leader ahead. The solution to problem #1 is simple. Wingmen should get enough practice keeping station to be able to stay with their element. The closer in a wingman can comfortably fly the easier it is to keep up on the outside of a turn and the easier it is to stay back when on the inside of a turn. This is what everybody practices and as a result station keeping has been pretty good on the B2Osh flights – at least for the pilots who do the required practice, which fortunately, is nearly of us. Problem #2 is not as easy to deal with. It is difficult to detect relative motion from 3000 feet behind another aircraft. Here is some advice for element leaders to consider for improving their ability to control accordion effect.

- 1) **Fly the briefed airspeeds.** We take off with the same interval we want for arrival. Do not try to catch up except to maintain visual contact with the element(s) ahead. Going like hell to catch the element ahead results in a sudden need to throw out the brakes when you finally do catch up. It is hard for you and your wingmen and it is really hard for the element behind you. Going slow to let others catch you does way more harm than good. If they expect 125 KIAS when they catch you and you are doing 115 or 110, you just added 10 or 15 knots to the closing speed they anticipated.
- 2) **Take advantage of turns.** Cutting corners a little can close a lot of distance without a big speed difference. But, do not to the opposite. If you’re a little close, do NOT pass the designated turn points to create space. More about this below.
- 3) **Offset slightly when appropriate.** On the long straight run, if you find the gap in front of you has decreased, gently move wide and slow down gently. Do not pull out a wad of throttle. If the guy ahead of you goes a little wide for no apparent reason he is probably getting too close and is slowing a little. If your separation is good or too close, offset to the other side a little. If you are too far back, go straight.
- 4) **Try to look 2 or 3 elements ahead.** Anticipate what the guy ahead of you is going to do. If he really puts on the skids and throws out his gear, just pull out to the side. The rest of the formation is following you. Try to dampen unwanted effects and try not to amplify them. When the guy ahead stabilizes you can move back in behind him.
- 5) **Look for signs of turbulence in the elements ahead.** When closer than 3000 feet the wake turbulence of the aircraft ahead will become noticeable. If the guy ahead starts getting bounced around he has probably gotten a little closer than briefed and will soon be slowing down.
- 6) **If you can see shadows on the ground, use them.** We want 15 second intervals. Counting the time between shadows is a good job for passengers.
- 7) **Find an unused runway with fixed distance markers.** They are 1000 feet apart. Line up behind a Bonanza 3000 feet away and try to learn the sight picture.

Snake Effect

Snake effect occurs when an element passes the point where the previous element turned. In order to not cut off the spacing, the next element has to follow and go past the designated turn point also. As succeeding elements do likewise, the snake eventually turns back on itself. Not good! Snake effect serves a beneficial purpose. As the snake grows it creates a longer path for succeeding elements, thus increasing the space between elements. This happens most notably at the turn onto final approach as Element Leaders try to put more space in front of them. We need path control. We need to avoid the Ripon/Fisk general arrival, so the turn prior to the last turn MUST be accurately flown by the entire B2OSH formation. We've been pretty good at that turn the last few years. We also need to manage the snake at the final turn point – POBER on the charts. If the snake goes to the lake shore, our formation gets close to Warbird Island, the main reporting point for traffic going into Oshkosh from Fon du Lac. There is a special procedure for FLD-OSH that does not require using the Ripon/Fisk procedure.

A significant crosswind can create snake effect as well. If the guy ahead of you is crabbed into the wind (as he should be), and you line up behind his tail, you are downwind of the correct course line.

Snake and accordion go hand in hand. If spacing is good, there is less tendency & need to fly past the designated turn points.

So, Element Leaders, in addition to the points above:

- 1) **Turn at the designated waypoints.** Do not fly past them and turn late. Formation flight is a visual exercise, but the guys behind you expect you to be on the “pink line”. Looking out the window is absolutely required, but you still have to fly the route accurately.
- 2) **Don't let the snake grow.** If the element ahead goes past, you may have no choice but to also go past. But, if able, try to restore the proper turn point by turning earlier than the preceding element.
- 3) **Be the mongoose.** If a snake is developing and there is excess space between you and the preceding element, turn at the correct point and re-establish the correct path.
- 4) **Think about what's happening behind you.** Final point, relevant to handling both accordion and snake effects: Always be aware of what your actions will do to the flight behind you and be aware that the flight behind you expects you to follow the briefed procedures and fly the briefed numbers. So, do your best to nail airspeeds, altitudes, climb & descent rates, and fly the route accurately.