Introduction to Formation Flying
Overview, Safety, Operations
Bonanzas to Oshkosh
The FAA defines FORMATION FLIGHT as more than one aircraft which, by prior arrangement between pilots, operate as a single aircraft with regard to navigation and position reporting. A standard formation is one in which a proximity of no more than 1 mile laterally or longitudinally and within 100 ft vertically from the flight leader is maintained by each wingman.
Formation Flying Proficiency

• 1. Fly B2Osh Flight Safely & Professionally
• 2. Fly Basic 2-Ship Formation Safely
• 3. Fly Four Ship Formations Safely
• 4. Qualify for a FFI Card
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Formation Study Materials

- Proposed National Formation Manual
- T-34 Formation Flight Manual
- Bonanza Type Specific Addendum
- Darton Formation ‘The Art’ Video
- www.b2osh.org training pages
- FFI Program Manual
- No formal instruction available in GA
Caution:

• Formation flight is risky – people can get killed
• Be responsible, be safe
• Study and know the material first
• First flights with experienced formation safety pilots
Start simple... the pro’s get fancy
Emergency Escapes

- **Military**
  - Ejection seat
  - Parachute

- **War bird**
  - Parachute

- **Most GA**
  - No escape
  - No parachute
  - Nonprofessional pilots
  - Requires extra safety margins
Safety Starts with You

- You are the PIC, be safe
- Fully understand before flying
- Poor execution, spontaneity cause accidents
- Know your vision, skill, and experience limits
- Maintain a sterile cockpit
- NEVER take eyes off of lead in close formation
Keeping the Group Safe (1)

- Keep everyone comfortable – no pressure
- Make a big change in one small step per flight
- Avoid macho unsafe attitudes
- Don’t fly too close
- Avoid idle chatter
- Use an experienced formation safety pilot with a new formation pilot
Keeping the Group Safe (2)

- Master 2-ship skills before attempting 4-ship
- Do not fly larger than 4-ship unless experienced and with experts
- Do something new with an experienced lead
- Know and avoid your collision threats
- Make moves slowly
- Be considerate of your blind side
Safe Technique

- Always have multiple degrees of safety
- Don’t rush.
- Be calm and cool
- Maintain checklist discipline
- Keep adequate spacing in the traffic pattern, especially on final
Weather Safety

- In bumpy air, accept unstable step down and leave extra step out and step back
- Don’t fly formation if there are restrictions to visibility
- Keep WAY clear of clouds
GA Formation Pilots Died from:

- IMC
- Flying towards someone you just lost sight of
- Wingman looking down in the cockpit
- Doing maneuvers with fewer degrees of safety
- Flying up a box canyon
- Undisciplined and/or confused landing/takeoff
- Wake vortex encounter close to ground
- Others are possible and likely
Duties of Lead

• Invites each pilot to fly
• Plans and conducts a safe flight
• Knows capabilities of each pilot
• Maintains control from brief to debrief
• Maintains communications with ATC and flight
• Navigates and clears traffic
• Coaches as needed
How to Fly Lead

- Fly smoothly
- Slow changes in parade formation (roll, pitch)
- Think 18-wheeler, not ferrari
Duties of Wingman

- **MAINTAIN SEPARATION FROM LEAD/OTHERS 100% OF TIME**
- **LOOK AT YOUR REFERENCE PLANE(s) 100% OF TIME WHEN CLOSE**
- Be safe
- Follow lead’s commands
- Maintain flight and radio discipline
- Request a kickout if you need to look away
How to Fly Wing

- Match lead’s attitude and velocity at all times
- Be slow/smooth if someone on your wing
- Maintain station by reference point alignment
- Start correcting the moment you diverge
- Come back TO (not through) reference point
- Recognize and eliminate PIO
Safety & Fundamentals

Briefing

Ground Ops

Take-off

Station Keeping

Maneuvers

Landing

De-Brief
Briefing

• Lead runs the briefing
• Lead covers planned operations, nonstandard procedures, safety issues, emergency procedures
• Wingmen take notes, PAY ATTENTION
• #2 talks next, then #3, then #4
• Hold questions, comments, and requests until your turn
• Discipline = quality and safety
Safety & Fundamentals

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Start Up

- Start time set at end of briefing
- Perform check lists: preflight, prestart, post-start
- Lead checks in flight on radio
Taxi Out
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Take Off (Tricycle Gear Only)

- Taxi on to runway with lead down wind
- Wingman (if element TO) pulls up wing abreast to wing aligned w/ empennage
- Lead gives run up signal (2000 rpm)
- Then head nod release brakes
- Gradually push in 75% power for take off
Station keeping

• Match lead’s attitude and velocity at all times
• Maintain station by reference point alignment
• Start correcting the moment you diverge
• Come back TO (not through) reference point
• Recognize and eliminate PIO
• Be slow/smooth if someone on your wing
Station Keeping

- Farther out -- Line up the door posts
- In close – line up the back cowling to the aileron/flap gap junction
Wingman Position - Top View

- 3’ step out, 3’ step back happens when reference points are simultaneously aligned at cowl and empennage.

1) Align aileron-flap junction with rear edge of cowl. This is the 45° line.

2) Move your plane in or out on the 45° line until you align tail cone tip with far ruddervator junction.
Wingman Position – Step Down

- In parade formation, top edge of near wing should be barely visible or barely not visible.
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Standard Formation Turn

- Maintain sight picture
- Add power and go up for outside
- Reduce power and go down for inside
- 1 to 3 kts speed difference in close formation
- 54’ vertical spread at 30° bank in fingertip
- Lead’s slow roll rate allows wingmen to maintain welded wing
Echelon Turns

- Maintain same altitude (not welded wing)
- Keep adjacent plane’s lower wingtip on horizon
- Roll out should be in position
- Plane #2 shown is high
- Lead rolls out slowly to avoid collision hazard
Cross Under

- Beginning formation move
- Reduce power
- Move down
- Move back
- Slide under walking speed
- Power up
- Move up into position
Fingertip 4 Ship Position

- Can be strong right or left
- Turns welded wing
- All maneuvers start and end with fingertip
- Lead rolls slowly in and out
Close Trail

- Extra step down and step back (no step out)
- See little or no wing walk
- Extra step down – engine out safety
- Turn as lead turns
- Lock on lead, avoid plane ahead
Diamond Position

- #4 is in trail & step down with #2 and #3
- All turns standard
- 4 calls in
Flying the Slot in Diamond

• #4 has a collision hazard on three planes
  – Keep them all in sight
  – Maintain step down and step back on 2 and 3
  – Maintain step down for lead’s engine-out
Echelon

- Least maneuverable
- Used for overhead break
- Never turn into an echelon. Only turn away
Pitchout Procedure

Break from echelon with 180° turn

- Lead’s signal: circling finger, then # of seconds
- Snappy 45° degree bank
- #2 sets the break interval
- Planes end up in a line 1 mile long
Rejoin

- Join up safely on lead
- Same speed as lead
- Stepped down 10’ to 20’ from plane in front
- Find the 45° join line and stay on it
- Your “Out” is down, behind, and outside the plane in front
- NEVER go belly up to plane in front
- Always see and avoid all planes in front
- Lead rocks wings l/r/l (or r/l/r) then banks 17 degrees to l (r)
- 2 joins to inside, 3 and 4 to outside in fingertip
Flying the 45° Join Line

• Your CDI - lead’s tail cone alignment with far wing tip
• Turn your plane as needed to hold join line
• Drop as necessary to keep planes ahead in sight over glare screen

Acute, turn left

Sucked, turn right

Just right. Hold it here

Or, line up #2 on lead
Rejoins are difficult

- #2 is low and acute
- #3 is on the 45 but a little above #2
- #4 has lead on horizon but risks a safety hazard being above #3 and #2. He must not lose them under glare screen or be unable to fly under and behind them
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Overhead Break to Landing

- Formation arrives in echelon
- Overhead numbers, lead sharply breaks 45 degrees of bank at pattern altitude
- Each wing breaks at count
Element Landing

- Break in pairs
- More difficult, less safe
- Extra in-trail spacing
- Lead signals gear, flaps
- Lead lands with power
- Wingman is slightly acute
- Tricycle gear only
Sturdy Landing

- 5 second break, single ships
- Land center
- Move to cold side (exit side) as soon as stable
- Plane with overrun problem has other side (hot side) clear

WARNING – All landing/takeoff info applies to Tricycle Gear only
Taxi Back

- Lead taxi to end of runway, regroup at taxi way just like run-up
- Lead signals for clean up, #4 passes back thumbs up
- Shutdown on lead’s briefed signal
- Write debriefing notes before exiting cockpit
De-Briefing

- Lead goes first and then in order
- Lead goes through each segment of flight
- #2, #3, #4 cover things left out
- First call “safety’s” on yourself
- Then critique the rest of the flight
- Don’t leave any significant thing unsaid

NOTES: Standard T-34/Bonanza specific unless otherwise briefed.

Maneuvers: Est. fit time: ___  Est. fuel usage: ___ gal
Fly to enroute position, when called join in position finger; diamond with #5 trail; diamond lazy-8; finger close trail; close trail lazy-8; finger; diamond w/#5 trail; diamond lazy-8; finger-tip echelon; break & rejoin; opposite echelon; break & rejoin; echelon turn; finger-tip kick-out; rejoin; echelon for initial; overhead break

SAR: el wing/lead goes with ship 1000 ft above all times com 121.5

Emergency Procs: On take off abort, call "# aborting" others fly normal; In flight 1 up, 2 away and up, 3 down, 4 up, 5 away (Break, Break, Break!) Single ship emergency - pull up
Final Remarks

• Be safe
• First flights with experienced formation safety pilot
• If you don’t understand, ask!
• Have fun!