



Introduction to Formation Flying

Overview, Safety, Operations



Bonanzas to Oshkosh



Formation Flying

The FAA defines FORMATION FLIGHT .. 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



Safety & Fundamentals

Formation Flight Briefing Worksheet

Aircraft	Operations	Date
Level	Mission	
#1	Route/Area	
#2	Altitude	
#3	Envelope	

Comm Channels					
	Freq	Area		Freq	Area
1					
2					
3					
4					

Engine Start Times: _____

Briefing



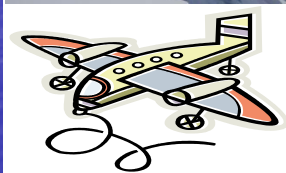
Ground Ops



Take-off



Station Keeping



Maneuvers



Landing



De-Brief

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



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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

Formation Flight Briefing		Flight Call Sign	Date
Aircraft		Operations	
Lead:	N	Mission:	
# 2:	N	Route/Area:	
# 3:	N	Altitude:	
# 4:	N	Enroute:	
Comm Channels			
→	Freq	Area	→ Freq Area
1			5
2			6
3			7
4			8
Engine Start			
Time	Takeoff	Type:	Rwy:
Maneuvers			
	Total Est Flight Time	Total Est Fuel Usage	
# 1:	Time		
# 2:	Time		
# 3:	Time		
# 4:	Time		
# 5:	Time		
# 6:	Time		
# 7:	Time		
Landing			
Entry:	Rwy:		
Weather			
			Altimeter Setting
Notes			



Safety & Fundamentals

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De-Brief

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





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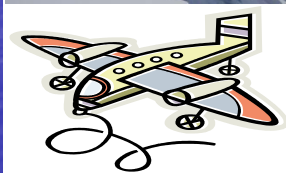
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Station keeping

- Match lead's attitude and velocity at all times
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- Recognize and eliminate PIO
- Be slow/smooth if someone on your wing

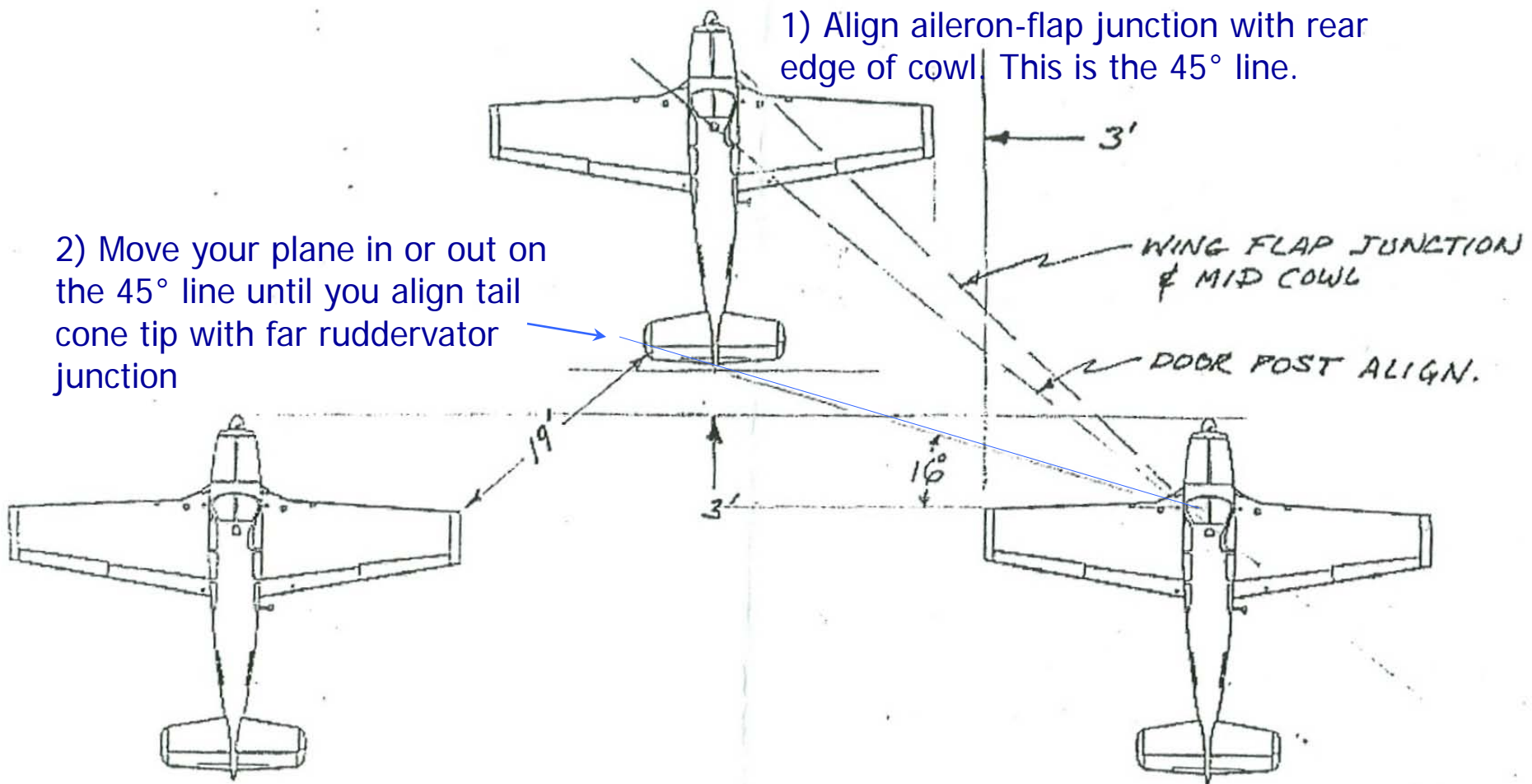
Station Keeping

- 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



Wingman Position – Step Down

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





Safety & Fundamentals

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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



DANGER - #4 TOO HIGH!!!



Good step down and
nice symmetry at Oshkosh

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

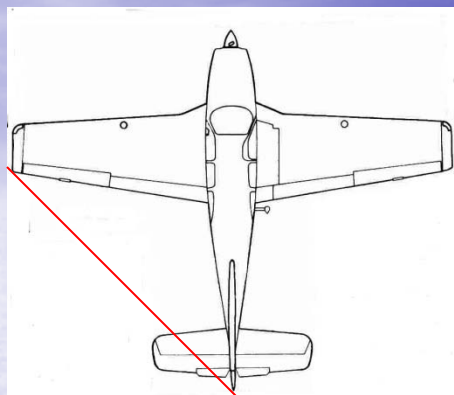
- Lead's signal: circling finger, then # of seconds
- Snappy 45° degree bank
- #2 sets the break interval
- Planes end up in a line 1 mile long

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



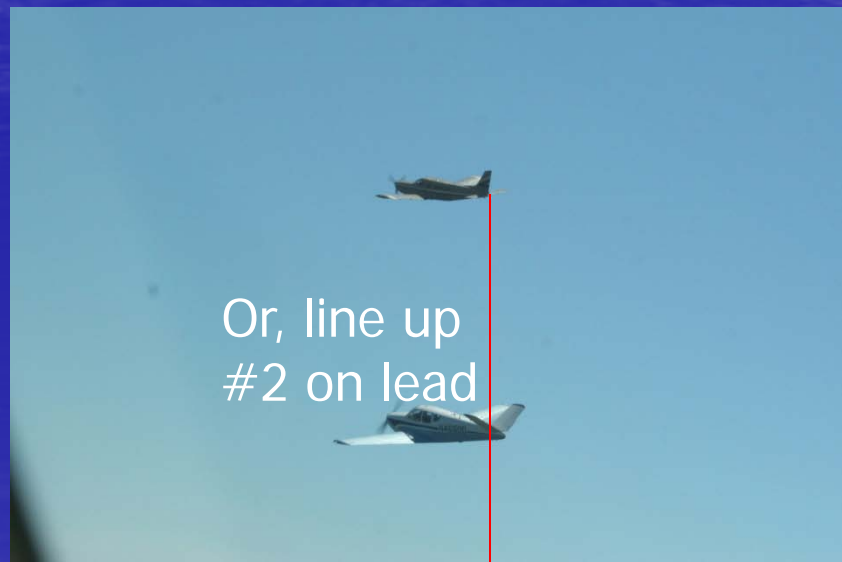
Acute, turn left



Sucked, turn right



Just right. Hold it here



Or, line up
#2 on lead

Rejoins are difficult

An aerial photograph showing four aircraft in a flight maneuver over a green landscape. The aircraft are positioned at different altitudes and angles, illustrating a rejoin scenario. One aircraft is in the upper right, another in the lower left, and two others are further down and to the right.

- #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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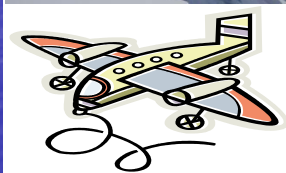
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Overhead Break to Landing



- 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





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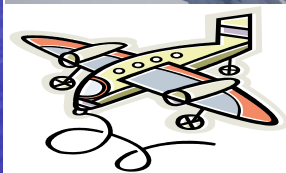
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De-Briefing

- 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



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; echelon turn;
finger-tip; kick-out; rejoin; echelon for initial;
overhead break

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

Landing lights on when "initial" called;
Lights off & flaps up on signal when clear of runway;
Shut-down at 30" or 60" hack, lead calls, turbo respond if not able
Maneuvers at 130 kts;

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

Final Remarks

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