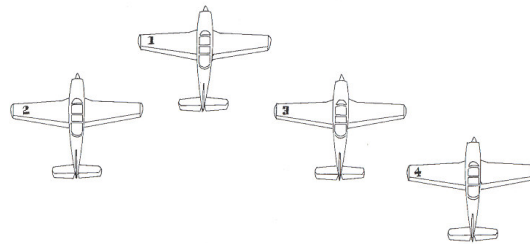


assume his position as tail-end Charlie, the last aircraft in the flight, on the new side in the same relative position that he occupied in the previous formation. (This occurs when the formation goes from fingertip strong right (or left) to fingertip strong left (or right), or when the formation goes from fingertip to echelon on the side opposite the second section.)

360 OVERHEAD APPROACH/BREAK

The overhead break entry to an airdrome traffic pattern is the fastest, most efficient method of handling a large volume of air traffic. It is also the safest way to keep aircraft from becoming entangled with one another over the airport. With this type of pattern entry all aircraft approaching the field for landing cross an initial point at a specified distance out on the extended centerline of the landing runway. When they cross this point they are at a specified altitude and headed straight in towards the runway. Usually this altitude is higher than traffic pattern altitude. This allows the flight leader to set his power at cruise so that the other members of the flight have plenty of power reserve with which to maintain good formation and still carry sufficiently high airspeed to the field. A respectably high airspeed in the break makes for a good-looking flight breakup overhead just in case anyone is watching. (They will be!) At the designated position, the lead makes his break 180 degrees to downwind. (The preferred



Fingertip Four Strong Right

method is a brisk roll to the break bank angle, followed by an equally brisk pull. This will result in noticeable G, which bleeds off airspeed to gear-down speed.) Other members of the flight follow suit at the briefed interval. In addition to the level break described above, a pitch up to pattern altitude may be used, in which case the leader should have plenty of "smash" coming down initial to allow for a snappy pull up.

Still another method of breaking is the fan break. The "Fan Break" signal is the same as any other break, but with zero time (e.g. closed fist) indicated for the break interval. It is executed from either left or right echelon, with all aircraft rolling into the break simultaneously. Lead must roll smoothly into a steep bank. All aircraft roll simultaneously with Lead, but each allows the preceding airplane to gain separation, while flying in the same plane. All aircraft roll level on the downwind leg in a giant stretched out echelon. Number Two establishes the geometry of the echelon by lining up behind the Lead with only enough lateral offset to clear his wake. Longitudinal spacing may be close at this time, but additional spacing for landing can be generated during the turn from downwind to final.

LINE ASTERN PATTERN ENTRY

Is used in the rare instance of a flight leader wishing to enter the pattern just like all the other grandmothers and bomber pilots. He configures his flight in the tail chase formation, spaced for landing. He then enters the pattern in the normal 45 degree to downwind leg method.

THE DOWNWIND BREAKUP

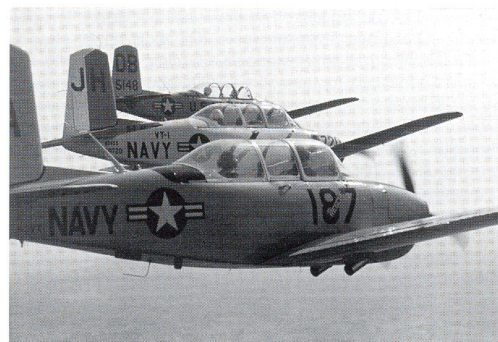
May be used when the 45 degree entry to downwind leg is necessary. The lead configures the flight in echelon away from the runway. Lead will kiss off the flight as he enters base leg, with other members of the flight taking their interval as they turn base. Very cumbersome and not recommended for more than three aircraft. Gear and flaps should be lowered on downwind leg.

FORMATION TAKEOFF

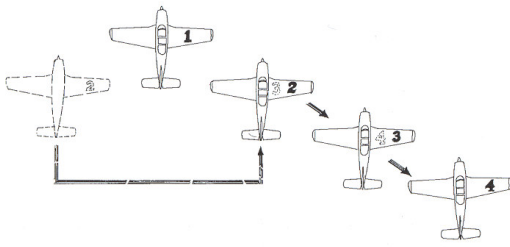
The formation takeoff eliminates the need for join-up after takeoff. Normal operational procedure will be to launch by section or element, assuming adequate runway width. In the case of an airshow appearance, three or four ship formation takeoffs may be made, if adequate runway width permits. Adequate runway width required assumes wingtip clearance. Normal formation takeoff procedure is for the lead to line up on the downwind side of the runway, ensuring that his propwash does not affect the wingman. This has the added beneficial effect of pointing the wingman's aircraft away the leader if he "weathervanes" into the wind. The wingman will line up well forward of the normal 45 degree angle-off position. (This assures that the wingman will quickly clear the leader if the leader aborts or has a tire failure which would cause him to veer to one side.) When all aircraft are in position, lead will give the signal to run up engines. He will give a head nod to signal brake release. All aircraft then roll in unison. Additional power is added smoothly,



The ideal sight picture for a wingman has the aileron-flap junction on the trailing edge of the wing lined up with the last cowl latch, indicating a 45° angle-off from the lead aircraft. Both top and bottom of the wing are visible, indicating proper step-down. (Lou Drendel)



A nearly perfect echelon, with uniform step-down and angle off. (Lou Drendel)



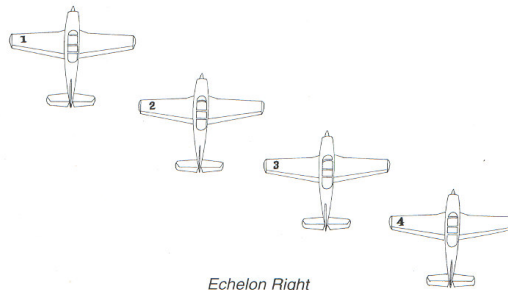
Fingertip to Echelon

with lead using less than METO power in order to provide margin for the wingmen. Lead will hold his aircraft on the ground slightly above takeoff speed. The wingman concentrates solely on the lead. If he stays in position on the leader, he will stay on the runway. Wingtip separation and the acute wing position should be maintained during takeoff, in the event that lead is forced to abort. If it becomes necessary for lead to abort, he will pass the lead to his wingman, and broadcast "aborting" on the radio. If he deems it necessary for the entire flight to abort, he will signal so by broadcasting "flight abort", while applying brakes smoothly. Once off the ground, the lead will establish positive rate of climb, then signal gear up to his wingmen. (Thumbs up, with head nod for execution. This may also be shortened to a head nod only, if pre-briefed.) In the case of multiple element takeoffs, the leader(s) of following element(s) will wait until the element in front of them has lifted off before beginning their takeoff roll. The same rule applies to single ship takeoffs. This margin allows for safe abort if the airplane(s) in front of you have to abort on the runway. Any advantage gained in starting your takeoff roll sooner is not worth the risk of overrunning the aborting aircraft in front of you!

FORMATION LANDING

The leader will signal gear down and flaps down on downwind leg. In the case of a two ship landing, the leader will move the wingman to the outside of all turns in the landing pattern, and will allow enough room for the wingman to cross under on final (if necessary) to get on the upwind side of the formation. All turns in the landing pattern will be made smoothly and with the minimum bank angle. The wingman should assume the same acute position as he did for the formation takeoff, for the same reasons. On short final, the wingman will have to divide his attention between the leader and the runway lineup, always assuring adequate wingtip clearance with the lead aircraft. The wingman should stack level with the leader for the landing so that he lands at the same time as the lead. This will enable him to maintain his acute position during roll-out until lead has slowed enough to allow for safe in-trail taxi operation.

The formation takeoff and landing procedures have been written for nose-wheel type aircraft. Tailwheel airplanes present a whole new set of problems and challenges which must be addressed by flight leaders within those formations.



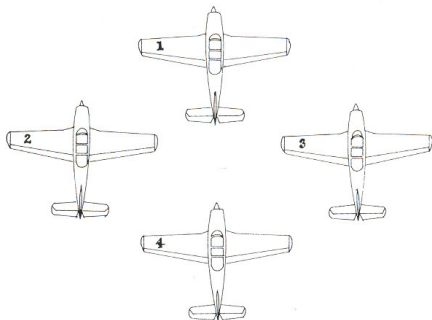
Echelon Right

STANDARD 4-SHIP FORMATION RULES



Gear Down (To be executed on head nod.)

The basic 4-ship configuration for maneuvering and the formation from which all other 4-ship formations will originate is the "fingertip four", so named because in plan view it resembles the position of your fingertips when your hand is extended. Positions in the fingertip are as follows: #1 = Lead, #2 = Lead's wingman, #3 = Section or element lead, #4 = Section leaders wingman. Number two is always the leader's wingman, and is always on the weak side of the fingertip formation. The fingertip formation will be designated "strong right" or "strong left", depending upon which side the element (# 3 & #4) are flying.



Diamond

For the purposes of standardization and communication by hand or aircraft signals only, the 4-ship flight will always return to the basic fingertip configuration (strong right or left, as designated by flight lead) prior to reforming from any non-fingertip formation to any other non-fingertip formation. For example, if the lead wishes to configure from echelon right to diamond, he would signal number two to cross under to his left wing (single arm pump). Number's three and four close the gap to make the formation fingertip strong right. Lead then signals number four to move to the slot position. **Remember:** Any 4-ship formation change from any non-standard formation to another non-standard formation will always entail two moves. First to fingertip, then to the new formation. The following formation configuration change signals assume a standard strong right fingertip formation. They are applicable to a strong left configuration, with a change of hands.

1. **Fingertip right to echelon right:** Lead's left arm bent ninety degrees, fist clenched. In order to accomplish this, # 3 moves his element out and back to allow #2 room to cross over to lead's right wing.



Cross Under (Motionless for wingman, double pump for element.)



#4 to Slot

2. **Fingertip right to echelon left:** Lead's right arm bent ninety degrees, fist clenched, two arm pumps. #3 and #4 move as an element to #2's left wing. #4 crosses under #3 as the element is crossing under #2.
3. **Echelon right to fingertip right:** Lead's right arm bent ninety degrees, fist clenched. #2 passes this signal to #3, who moves his element out to allow #2 room to maneuver over to lead's left wing. #3 moves his element back into position on lead's right wing.
4. **Echelon left to fingertip right:** Lead's left arm bent ninety degrees, fist clenched, two arm pumps. #3 and #4 move, as an element, to lead's right wing, with #4 moving to #3's right wing.
5. **Fingertip right to diamond:** Lead's arm bent ninety degrees, fist clenched, four fingers extended, then closed with thumb pointing rearward, motions aft. #3 relays this to #4, who moves into the slot position. When #4 is in position, #3 signals "thumbs up" to lead.
6. **Diamond to fingertip:** Lead will gently rock his wings several times. #4 will move to his element lead's (#3) wing.
7. **Fingertip to trail:** Lead gently porpoises his airplane several times. #2 slides back and behind lead. #3 moves behind #2, #4 moves behind #3. As each wingman slides into position he will call "Two's in", "Three's in", etc. on the flight discreet radio frequency.
8. **Trail to fingertip:** Lead rocks his wings several times, then starts a shallow turn. #2 moves forward, joining on lead's inside wing. #3 and #4 form as an element, then join on lead's outside wing. Note that #2 always joins on lead's inside wing.

In addition to moving the formation to different configurations, hand and arm signals are also used for basic aircraft to aircraft communications. They should always be used during airshows to keep the radio clear for more necessary communications. It is a good idea to practice them at all times, just so you aren't left with your face hanging out when they **have** to be used.



Flap Actuation



Fuel State Inquiry



"Seven"



Climb



"Two"



Inflight Problem (To be followed by HEFOE code.)



Pitot Heat



Landing Lights On



Landing Lights Off



Speed Brakes



Rotating Beacon



"Choke the Parrot" -- Stop Squawk

ADDITIONAL HAND SIGNALS

GO TO PRE-BRIEFED RADIO FREQUENCY: Tap ear with index finger, extend index finger. (Variations on this have been used, for example, the common signal for the T-34 frequency is an extended middle finger. It is advisable to pre-brief this signal to avoid unpleasant post-flight confrontations.)

CAN'T HEAR: Move open palm of hand past ear, back and forth.

CAN'T TRANSMIT: Move open palm of hand past mouth, back and forth.

EXTEND LANDING GEAR: Clenched fist, thumb down, downward motion, head back against headrest (viz), nod forward to execute.

RAISE LANDING GEAR: Clenched fist, thumb up, upward motion, head back against headrest, nod forward to execute.

FLAP ACTUATION: Thumb and fingers together, opening and closing.

REDUCE POWER: Palm open, facing rearward, motion to rear.

ADD POWER: Clenched fist, arm in forward motion.

FUEL STATE INQUIRY: Clenched fist, thumb extended to mouth.

INFLIGHT EMERGENCY: Clenched fist up to forehead, land as soon as possible. If radio does not work, the following number (by raised finger(s)) indicate the nature of the emergency:

1. Hydraulic
2. Electrical
3. Fuel
4. Oxygen
5. Engine

These signals are often referred to with the acronym; "HEFOE"

O.K. OR READY TO GO, IF ON GROUND: Thumbs up

LEVEL OFF: Palm flat, moved back and forth in horizontal.

WINGMAN TO CROSS UNDER: Arm bent ninety degrees, fist clenched.

ELEMENT TO CROSS UNDER: Arm bent ninety degrees, fist clenched, two arm pumps.

ENGINE RUNUP: Clenched fist, index finger extended and rotated.

BREAKUP SIGNAL: Clenched fist, with index finger rotated. Break interval signaled with number of fingers extended after rotation.

FLIGHT TO GO TO ENROUTE OR COMBAT SPREAD: Lead yaws his aircraft.

FLIGHT TO CLOSE UP TO PARADE FORMATION: Lead rocks wings smartly.

STACK DOWN IN FORMATION: Lead extends palm of hand downward, with downward motion.

STACK UP IN FORMATION: Lead extends palm of hand upward, with upward motion.

LEAD CHANGE: Lead points to aircraft he wants to assume lead, then points to front. Pilot so designated should acknowledge this signal by patting the top of his head and pointing forward.

In all cases, the wingman should acknowledge receipt and understanding of any signal by nodding his head.

SPEED BRAKES: (T-28s) Hand up, palm forward, with head nod for execution.

"IN-TRAIL" FORMATIONS

by Bill Cherwin

"IN-TRAIL" is used for ground maneuvering, and interval depends on taxi speed. Pre-briefing, or team familiarity with techniques can reduce the interval to perhaps 10 feet nose-to-tail. Some very impressive "FLANK" maneuvers (simultaneous turns) can be executed while taxiing "IN-TRAIL."

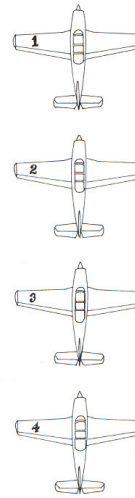
In flight, the "IN-TRAIL" formation might be used to maneuver several airplanes through some tight conditions where a large spread formation would be unable to execute faster roll rates.

"IN-TRAIL" interval can vary from one to several plane lengths, with only enough "stack-down" to avoid wake turbulence. An important point to remember is that the aircraft you are following is at twelve o'clock only when flying straight and level. When in a turn, the plane you are following should be offset in your windscreen proportionate to the amount of turn. "Tail-end-Charlie" should feel like he is in the caboose of a train rounding a curve, and should view everyone as if they were the cars and the engine. If you keep the aircraft ahead of you at twelve o'clock while in a turn, you are cutting him off and closing the gap. Conversely, the interval can be readily increased by "widening-out" your turn, allowing the aircraft ahead to increase the gap. Adjusting interval while flying straight is tricky, and can induce an accordion affect if done with anything but small power changes.

"SECTION-TRAIL" is a practical way to build or disassemble larger formations. The sections can be two, three, or four airplanes in "vics," diamonds, or echelon. For example, to "break-up" a twelve ship formation in a diamond of four "vics," the lead would first call for "SECTION-TRAIL." Bravo, Charlie, and Delta Leads would then maneuver their sections in-trail with enough longitudinal separation to allow the preceding section enough room to reconfigure. If runway width is adequate, the flight can break and land in sections. If not, the lead will call "SECTION-TRAIL, ECHELON RIGHT (or left)," and each aircraft can break and land individually.

TAXI AND SHUT-DOWN PROCEDURES

Where parking space allows, the leader will try to park his flight on the same line. He will taxi at a rate that allows his wingmen to maintain the same interval, and if possible will allow for a 90 or 45 degree "flank turn" into parking position. After all aircraft are aligned, the leader will call for, "1000 RPM, hand on mixture", (brief pause), "cut.....now!". Precision conduct on the ground during taxi, parking, and shut-down, demonstrates discipline, and will build confidence and pride in the formation and engender respect from onlookers.



Trail Formation

RADIO PROCEDURES

The most important thing that can be said about formation radio procedures is; the less said, the better. The primary reason for using hand and arm signals is to avoid the confusion of several people talking on the radio simultaneously. Sage advice from leaders to their wingmen: The only thing I want to hear from you is; "Two" or "Lead, you're on fire!"

During the formation briefing, the leader will brief the radio frequencies to be used, assigning a "channel" number to each. (viz: 122.9 = Channel One, 123.45 = Channel Two, etc.) He will call for check-in on the startup frequency by transmitting; "Red flight, radio check....one." Flight members should answer with their number **only**. There is nothing more impressive than a quick check-in that goes; "...one.", "two", "three", "four".

Frequency changes will be signaled using prearranged hand signals for the frequency. A check-in on the new frequency will be called after a suitable interval. The thinking wingman will have his radios set up with the known frequencies before takeoff to make switching quick and easy, enabling him to hold his position in the formation.

When the leader has to transmit special procedures on the radio, the wingmen will acknowledge receipt and understanding of those instructions by transmitting their number **only** after the leaders transmission is complete. (Note that it is most important for the #2 man to be aware of this and transmit quickly. Failure to do so may result in the #3 or #4 man transmitting first, in which case the #2 man may be liable to buy drinks for the rest of the flight.)

DISSIMILAR AIRCRAFT FORMATION

by John Ellis

Flying aircraft of different types in the same formation presents special concern relating to procedures, technique, and safety of flight. When this concern is addressed, dissimilar formation can be accomplished safely and present unique opportunities for air show activities, photography, etc.

Dissimilar aircraft formation is not recommended in the takeoff or the approach and landing phase of flight. Acceleration and deceleration rates, plus aerodynamic differences (particularly during configuration changes) add unnecessarily to pilot workload during these critical phases of flight operations. Dissimilar flight formations should plan a three to five second interval for brake release of individual aircraft on takeoff, and utilize the 360 degree break procedure for individual landings.

BRIEFING AND PLANNING THE FORMATION

Aircraft performance and aerodynamics are both major concerns when placing dissimilar aircraft in the same formation. For example, a modern, swept wing jet fighter can safely fly formation on its World War II propeller driven ancestor by placing the jet fighter in the formation on the outside of the leaders turns. Accordingly, power-limited aircraft should be placed on the inside of planned turns. These formations are usually flown for Airshow activities or for photographic purposes, and the flight path is normally planned prior to takeoff.

LEADER CONCERNS FOR DISSIMILAR AIRCRAFT

In order to safely lead a formation flight of dissimilar aircraft, it is imperative that the flight leader have a thorough understanding and knowledge of the performance characteristics, aerodynamic envelope, and operating limitations of each aircraft in the formation. The flight leader will use this knowledge to establish airspeeds for climb, cruise and descent, rates of climb and descent, turn radius and turn rates, as well as mission planning,