

Lesson 9 — Fighter Combat: The Fight Is Won By Whoever Sees First

TA notes for Robert L. Shaw, *Fighter Combat: Tactics and Maneuvering* (Naval Institute Press, 447 pp.)

Draft — not yet published

What you're walking out knowing

1. Air combat is a trade between **angles** and **energy**, and the currency everything is priced in is **sight**.
 2. The three pursuit curves are three different bills: lead, pure, and lag — each buys closure, angle, or energy, never all three.
 3. Nobody fights alone if they can help it: mutual support is a vision system before it is firepower.
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1. The two currencies: angles or energy (20 min)

Every manoeuvre in the book spends one of two things to buy the other. Pick your fighter before the merge, because the right move inverts between them:

- The **angles fighter** trades speed for position *now*. Cash in your energy for one hard turn and end the fight before the bill comes due.
- The **energy fighter** keeps its speed and takes position over *several passes*. Refuse the turn, extend, come back with altitude to spend.

Corner speed is where the trade is cheapest. Minimum turn radius comes from starting the turn at corner speed, pulling maximum available G, and letting the speed decay through the turn. Two traps:

- **Turn rate and turn radius are different goods.** Very slow airspeeds make level turn radius balloon even while turn rate stays usable. Slow is not automatically tight.
- **Altitude taxes the turn.** Below corner speed, both rate and radius degrade with altitude (less lift to work with); above it, structural limits bind instead of aerodynamics.

The energy fighter's optimum is maximum *sustained* turn rate — provided that speed stays above minimum vertical-maneuvring speed. Drop below that and the whole energy advantage evaporates. And Shaw's own moral, worth memorizing: a fighter that generates flight-path separation but lacks the energy for a second vertical move **cannot cash it**. Separation you can't spend is worthless.

2. Pursuit geometry (20 min)

Three pursuit curves, three different bills:

- **Lead** closes fastest but drives angle-off-tail up. It is *self-tightening*: as range closes, the attacker must turn with decreasing radius and increasing rate — eventually out-turning the target just to hold lead. And it has a visibility ceiling: practical maximum lead is limited by over-the-nose visibility. Blind lead turns risk collision and losing the bogey entirely.
- **Pure** closes less but holds angle — and it *hides you*. Nose-on presents the minimum frontal area to the defender, making the attacker harder to see as well as harder to track.
- **Lag** preserves energy and gives up closure. The patient curve.

The single highest-value move in the book is the **lead turn**: turning early against a merging opponent converts a neutral pass into a decisive angular advantage. The reward grows the earlier you turn — and so does the chance of crossing his nose and handing the fight away. Timing is the whole skill.

When the geometry doesn't match, **yo-yos manage the mismatch**: a high yo-yo trades speed for a re-positioned turn circle; the lag roll pulls out of plane rather than bleeding energy in plane.

3. When it goes wrong (15 min)

The **scissors** is a slow-speed trap, and which one you're in is determined by the overshoot that put you there: a fast overshoot makes a *rolling* scissors, a slow overshoot a *flat* scissors. Flat scissors rewards low wing loading — Shaw says less manoeuvrable high-speed fighters should avoid it "like the plague."

Winning a scissors means **getting in phase**: as one fighter gains, the nose-to-nose phase shortens, the lead turn lengthens, and eventually the overshoot stops happening. But remember the price of admission — Shaw counts three passes for the bogey to gain 90° in a nose-low sustained turn, and *each pass is a chance to be shot*.

The deeper lesson: **overshoots create blind periods, and a longer overshoot means a longer one**. Blind time loses fights more reliably than bad geometry does. Which brings us to the book's real thesis.

4. Why two aircraft, not one (10 min)

Hartmann's line is the thesis of the whole section: "*There are no eyes for your backside, no eyes for who is coming from below... if you are single you have too many blind spots.*"

Mutual support is a vision system before it is firepower. Each pilot covers the other's blind cone so an attack can be pressed without checking six. The geometry is explicit, not vague:

- **Combat spread** (line-abreast) gives near-total coverage except one cross-hatched region between the aircraft.
- **Spacing is set by turn radius, not taste** — it varies with speed and altitude because the wingman needs room to turn and point weapons.
- **Vertical splits have a limit**: too large and the low aircraft can't climb to help without arriving slow and useless.

And there's a psychological layer: **mutual support by presence is real**. Knowing a second fighter is in the area makes a bogey less aggressive against either one, before a shot is fired. Shaw even grades doctrines — fighting wing is judged ineffective two-versus-two except against clearly inferior opposition.

5. Worked example (10 min)

Two fighters merge. Fighter A is an angles jet; Fighter B is an energy jet with better thrust-to-weight.

- **A's plan**: unloaded acceleration back to corner speed between turns, then one minimum-radius turn at the lead-turn point. The cue to commit: the bogey showing a 90° aspect view — full planform, hard-turning.
- **B's plan**: refuse the radius fight. B should *not* expect a tracking shot against A's well-flown low-wing-loaded jet — A can generate enough turn to stay out of steady parameters all day. B's tracking shot, when it comes, will be because A's pilot **lost sight or misjudged**, not because B out-flew the airframe.

Same merge, opposite correct answers. That's why Shaw structures everything around *similar versus dissimilar* — the right move inverts.

6. Quick check (5 min)

1. Corner speed gives the cheapest turn — but what makes it "cheap," and what happens if you start the turn slower?
2. Lead pursuit closes fastest. Why not use it all the time?
3. What determines whether an overshoot drops you into a rolling scissors or a flat scissors?
4. Why is mutual support "a vision system before it is firepower"?

(Answers: 1 — minimum radius for the G available; slower means radius balloons even if rate holds. 2 — it's self-tightening and limited by over-the-nose visibility; blind lead risks collision and losing sight. 3 — a fast overshoot makes it rolling, a slow overshoot makes it flat. 4 — each pilot covers the other's blind cone; the historic killer is the unseen attacker, so the second pair of eyes is the weapon.)

TA's honest footnote

Shaw's central claim isn't tactical, it's perceptual: *"the vast majority of fighter pilots lost have been unaware of their attacker until it was too late."* That reframes everything — all the geometry is about arriving where you can see and he cannot. The weapons envelope is downstream of the visual one.

Two honest caveats. First, the evidence base is **experience, not data** — no statistics, no engagement dataset, just a practitioner with diagrams. Second, **the diagrams carry the argument**, and that is a genuine limitation of any text summary including this one: the reasoning is spatial and doesn't survive compression well. Read it with the figures open.

It's also pre-stealth and pre-datalink — the visual-acquisition premise that makes the book coherent is exactly what modern sensors were built to break. What survives: the angles/energy trade (any contest between converting resources into position *now* versus banking them has this structure) and the blind cone (two agents covering each other's unobservable regions beats two individually stronger agents).