

Piston Twin

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- When both engines spinning: easier to fly than a single (less right rudder)
- Training and rating are all about how to fly on one engine
- Six power levers
- Maybe cowl flaps that add drag
- No required climb rate on one engine, even if everything done perfectly



Eisenhower's Air Force One

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Your trainer: Piper Seminole

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Where the problems happen

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Piston Twin Engine Failure

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- Push all six levers forward (throttle, prop, mixture)
- Dead foot, dead engine
- Verify dead engine by pulling back that throttle
- Feather dead engine's prop by pulling back that prop lever
- Close cowl flaps
- Now the second engine can take you to the scene of the accident!

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Within Human Capability?

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- World War II pilots did this all the time
- But they also got it wrong
 - [Louis Zamperini was in a four-engine B-24 bomber](#)
 - One engine quit
 - Flight engineer feathered the prop on the same-side good engine
 - Floated in raft for 47 days then imprisoned in Japan for two years
- Cape Air does it when necessary
- Most of us don't, which is why capable twins are almost free to buy and expensive to insure

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Baron vs Bonanza Insurance

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- 1,000 hour commercial, instrument rated 45 year old pilot with 250 hours in type
- \$200,000 hull value
- \$1M smooth liability

Bonanza: \$2,521/year (planeinsurance.com)

Baron: \$3,762/year (50 percent more)

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Limits to piston engine power?

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Question for the class: *What stops us from getting as much power as we want from a piston engine?*

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Frank Whittle

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- Cadet at Royal Air Force College
- Filed patent in 1930 at age 23: Adapt gas turbine (John Barber, 1791), with one spinning component, to airplane propulsion
- Volume of air burned no longer limited by volume of pistons
- Struggled with funding; first flight in 1941
- Don't be too early: Whittle died in 1996 in relative obscurity.

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The Science is Settled

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National Academy of Sciences, Committee on Gas Turbines (June 1940):

“In its present state ... the gas turbine engine could hardly be considered a feasible application to airplanes mainly because of the difficulty in complying with stringent weight requirements imposed by aeronautics.”

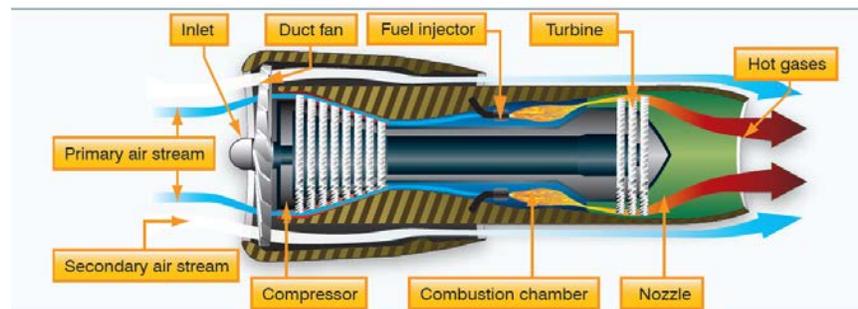
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Turbofan (“Turbojet”)

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Source: Public Domain

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Twin Turbojets

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- Engine failure:
 - press on rudder to rectify any yaw (if yaw damper has not dealt with automatically)
 - push both thrust levers forward
 - plane will keep climbing nicely (FAA certification regulations)
 - once at safe altitude, start running checklist
- No propeller to drag back a wing
- Engines often close to fuselage
- Cardinal rule of flying jets: “If you see a switch with dust on it, don’t touch it.”

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Pilot Requirements

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- Turbojet-powered: requires a type rating on pilot certificate
- Most turbojets require two pilots (but Captain Sully was alone in the Airbus A320!)
- FAR 91.5 says that PIC of a two-pilot aircraft must get an annual proficiency check under FAR 61.58
- FAR 61.58 says the check also required for single-pilot turbojets (aligns with insurance requirements)

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Turbojets that you might own

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- Single-pilot business jet pioneered by Cessna in the 1970s
- “Very light jets” introduced starting 2006:
 - Cessna Mustang ->
 - Eclipse
 - Embraer Phenom 100
 - HondaJet

All business failures!



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Phenom 300 = smallest practical

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- Fixed costs of jet ownership are high:
 - Hangar can be \$40,000 per year
 - Sim training for two pilots, \$50,000
 - Insurance: \$30,000
 - Flight planning, landing fees, etc.

Nobody has ever made money with a plane smaller than a Phenom 300 (Cessna CJ3, Pilatus PC-24 are comparable)

\$9 million new; \$3-5 million used.





Single-engine jets

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- F-16 and eject if there is a bird strike
- Cirrus SF50 Vision Jet; pull parachute if necessary

(don't forget your noise-canceling headset; note the engine right over your head and the composite fuselage acting as a resonator!)



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Twin Turboprops

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- [Beech King Air](#) (1964-present) best-known example
- Prop enables short takeoff and landing
- Better tolerance for dirt and grass
- Bird Cuisine
- May have auto-feather after engine failure (not a panacea; [TransAsia 235](#) had this on their new ATR 72-600)

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Single Turboprops

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- Unpressurized: Cessna Caravan
- Pressurized: Piper Meridian↓, TBM, Pilatus PC-12

More expensive to purchase than twin-turboprop, but cheaper per hour to run.

Useful when your friends are sea turtles ([story](#)).



Jet Maintenance

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- Most generic FAA repair guidance and regulations superseded by FAA-approved manufacturer's maintenance manual
- Intervals may be as long as 600 hours
- Annual inspection costs of \$50,000 or \$100,000 are common
- Illegal to operate after reaching hour or cycle limit due to stress on pressure vessel

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Fun: B737 or A320 type rating

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- Nearly 10,000 Boeing 737s have been built
- Nearly 8,000 Airbus A320s are flying
- Sims for these planes are thus the most numerous
- \$10,000 gets you a type rating (compare to \$25,000 to \$50,000 for bizjets)
- Great for proficiency!

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Summary

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- Multi-engine rating is a good challenge
- Piston multi-engine rating is a typical step toward flying a twin-engine jet
- Engine failure in piston multi usually handled well by people who fly every day or two
- For personal flying, a well-maintained single is just as safe statistically
- Nervous? Get a single-engine plane with a ballistic parachute as the backup!

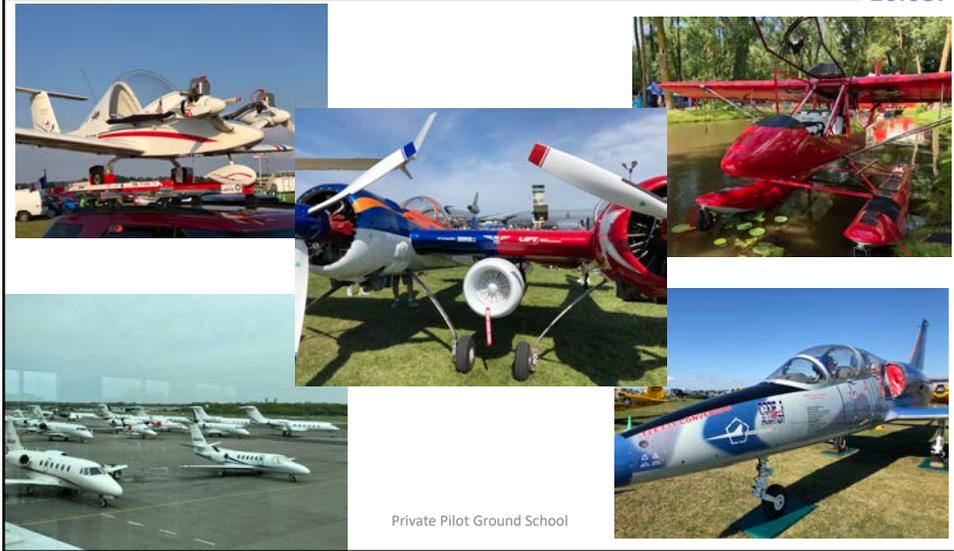
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Questions?

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