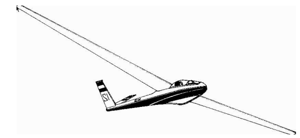
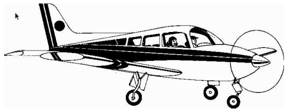
Mountain Flying in Flatland Airplanes



Ed Williams

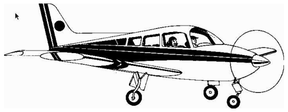
SMXGIG '96

Mountain Flying in Flatland Airplanes: Outline



- High Altitude Aircraft Performance
- Mountain Flying Techniques
- Mountain Weather

Thinner air affects your airplane in two ways:

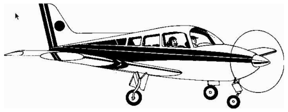


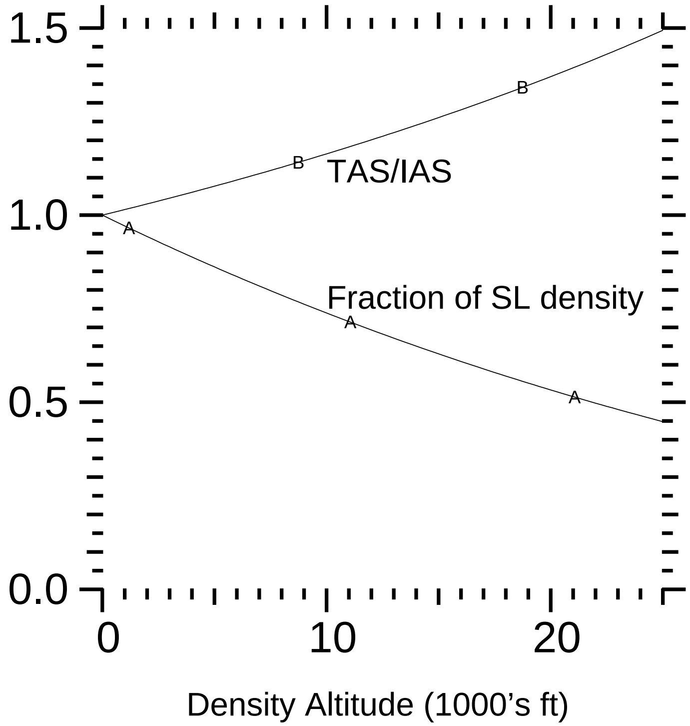
- (1) Reduced air density reduces both lift and drag.

- (2) Reduced air density limits the engine power available.

- Turbocharging addresses (2)

Density Altitude is the measure of air density





- Aerodynamic forces, such as lift and drag, are proportional to ρv^2
- Air density decreases with increasing altitude, increasing temperature, decreasing SL pressure and increasing humidity. *(H)ot, (H)igh or (H)umid!)*
- Density altitude accounts for this.

$$1000' \,\mathrm{DA} \leftrightarrow -1'' \,\mathrm{SLP} \leftrightarrow +15^0\mathrm{F}$$

IAS is the speed the wings care about

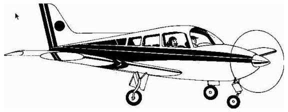
- **I**ndicated **A**ir **S**peed is the speed the airspeed indicator indicates.
- **T**rue **A**ir **S**peed is your actual speed through the air.
- The pitot ram pressure is calibrated at sea-level, i.e.

$$\rho_{SL} v_{IAS}^2 = \rho v_{TAS}^2$$

$$v_{TAS} = v_{IAS} \sqrt{\rho_{SL}/\rho}$$

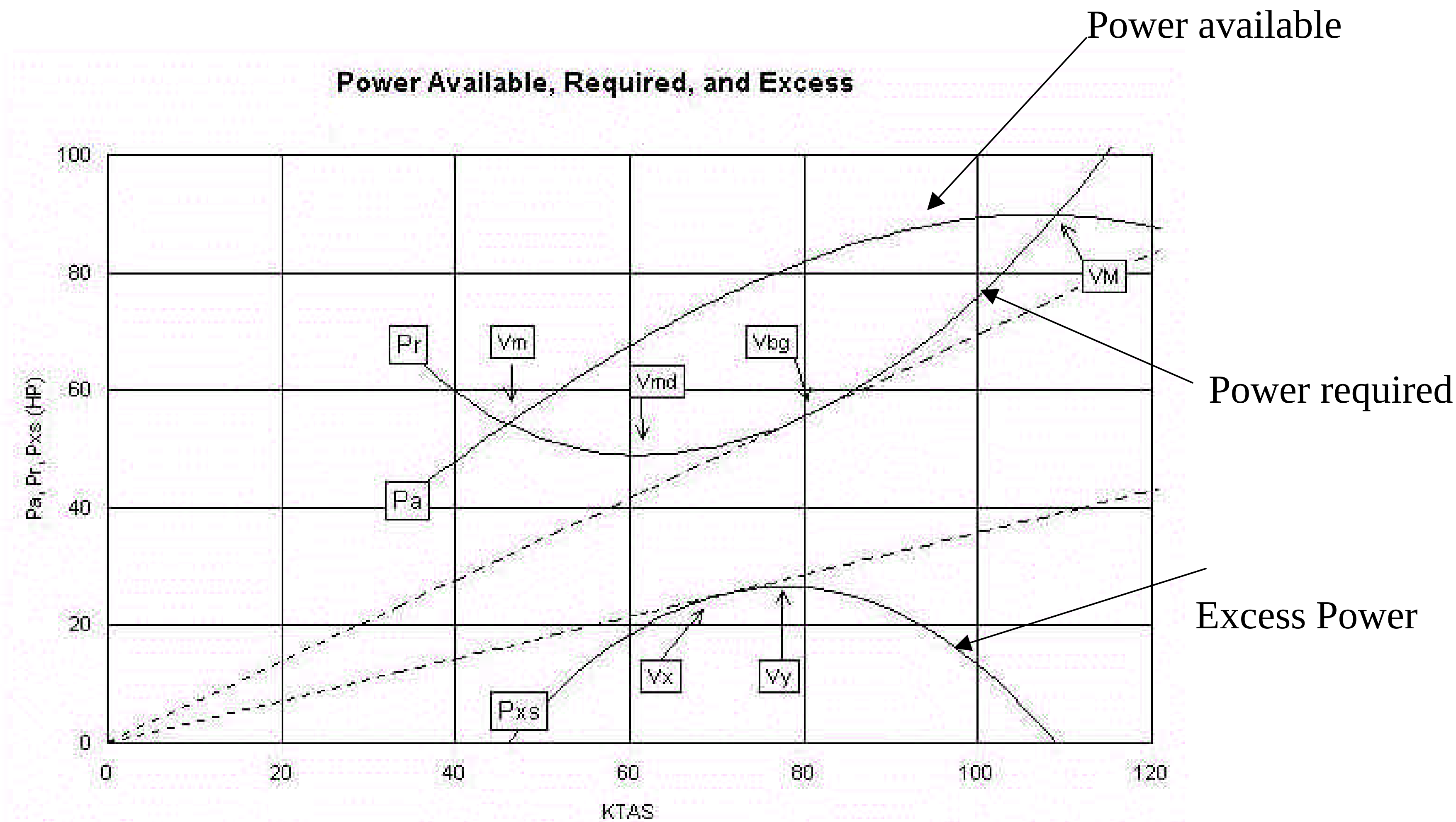
- TAS exceeds IAS by about 1.6% per 1000′
- "Aerodynamic" IAS's (stall, approach, maneuvering, best glide, best range, best endurance) are *independent* of altitude!
- "Engine related" speeds (V_x, V_y) do change with altitude.

Get all the climb performance the manufacturer provided



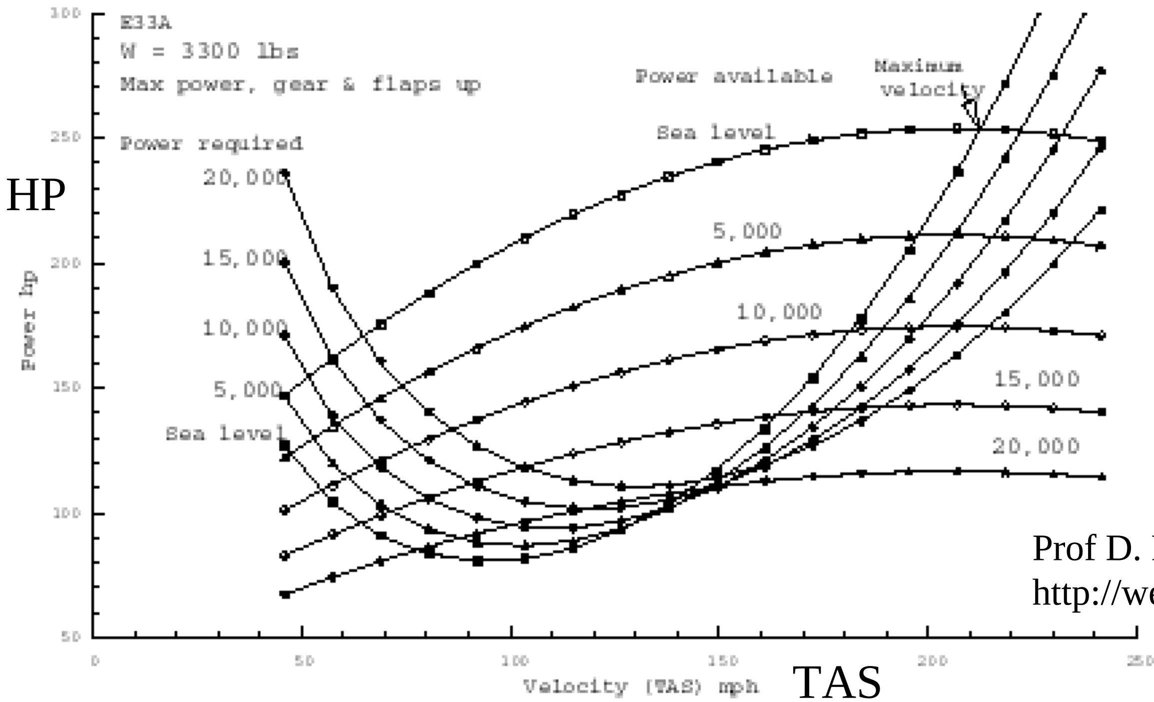
- Use the proper V speed for the altitude.
- Lean properly. (Barry knows how!) Don't use full rich for landing, you might have to go around!
- Center the ball!
- (Partially) close cowl flaps, CHTs permitting?

Many key speeds come from knowing power required/available



Cessna 172 7500ft from John Lowry

ROC is determined by power available minus power required.



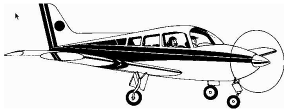
Prof D. F. Rogers
http://web.usna.navy.mil/~dfr/flying/wbs6.html

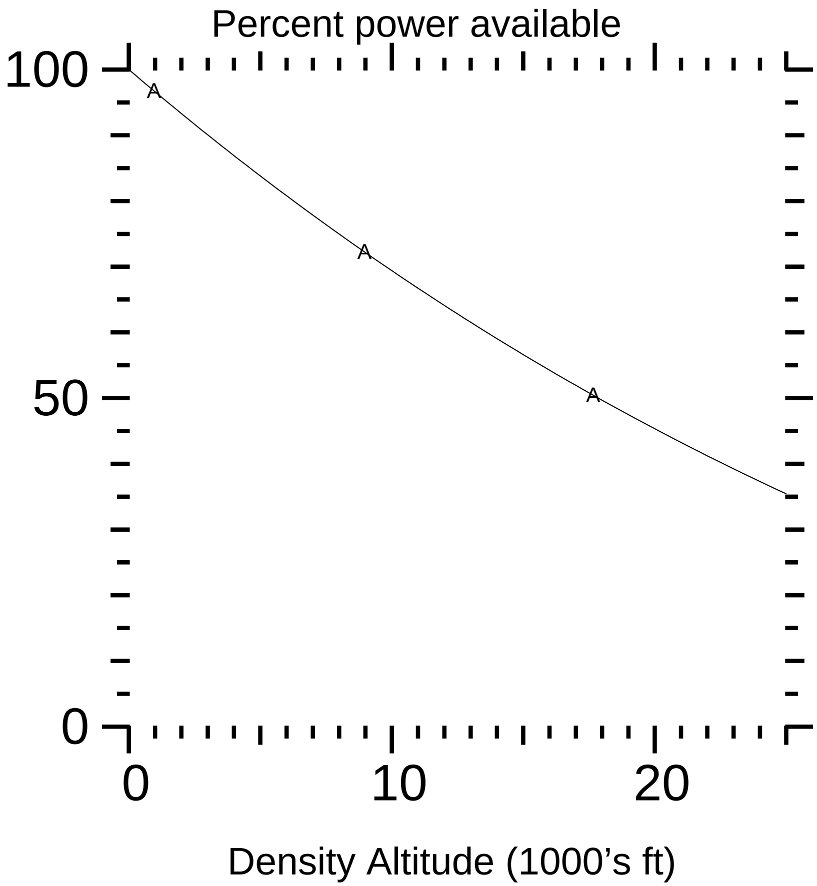
ROC =33000*(Power$_{req}$-Power$_{avail}$)/Weight

With altitude:

- Power available decreases
- Parasite Drag decreases
- Induced drag increases

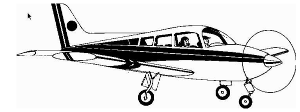
Available engine power falls off with increasing altitude.

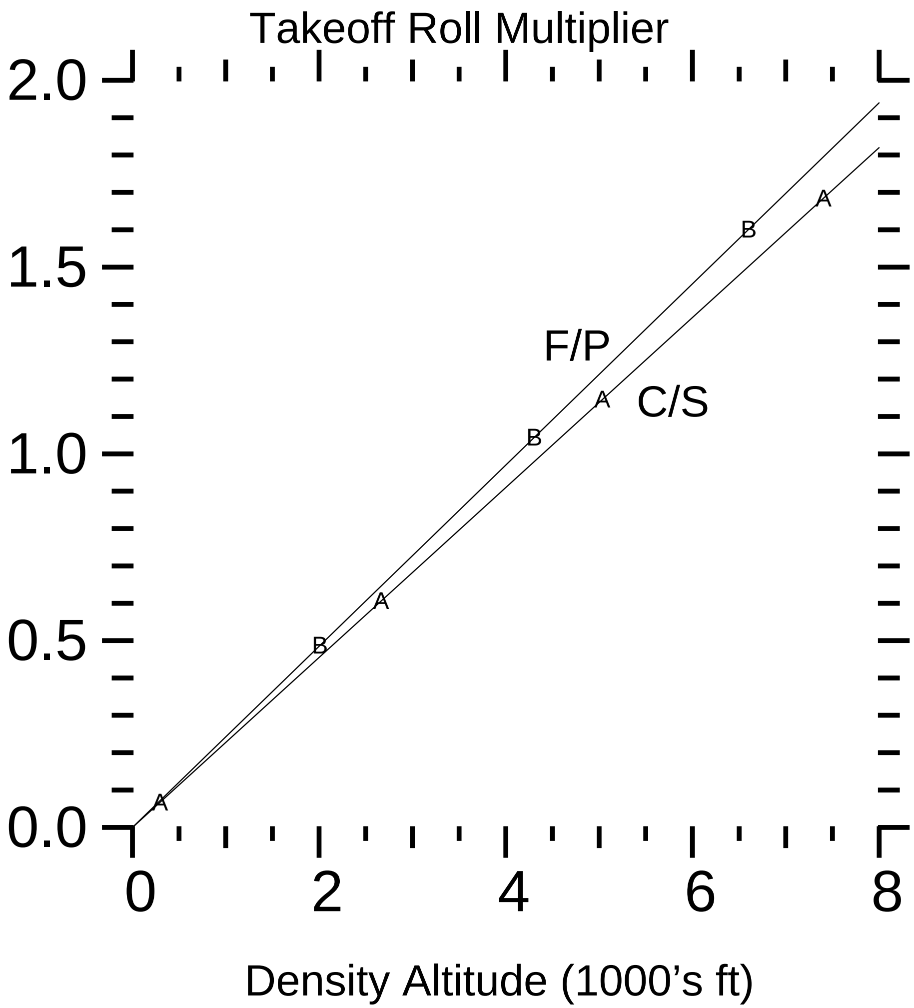




- Engine power is proportional to the outside air density. BUT, a fixed amount is used up in engine friction. So it's worse…
- A turbocharger helps a lot!

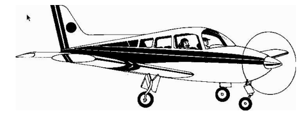
Takeoff performance





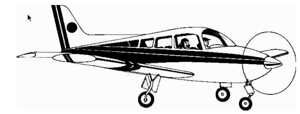
- Refer to the manual, but the old FAA "density altitude computers" tell the story.
- Constant speed props help a little.

Sloping runways?



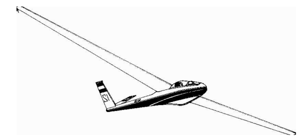
- Many mountain airports have sloping runways. The “FAA” maximum allowable slope (AC150/5300-13/502) is 2%. More than 5% is quite severe.
- Terrain/slope may make airport “one-way” (e.g. ASE), departing downhill, landing uphill.
- If tailwinds exceed 10-15 knots, think twice! Takeoff uphill, if you have the performance. Abort if you don’t have at least 70% of your takeoff speed half-way down the runway. Always be wary of departing towards rising terrain!
- 1% downhill slope reduces takeoff run by $\simeq$ 10%
- On a downhill takeoff, use a soft field technique. Don’t over-rotate!
- For an uphill landing, add $0.1V_{so}$ ($\simeq$ 5 knots) to your approach speed to allow for flare. If you *must* land downhill, use minimum possible approach speed, or you’ll float, float, float…
- Landing, beware of perspective illusions. (Particularly at night!) You’ll tend to approach too low on uphill runways, too high on downhill. Check your VSI.

Enroute: think "high performance sailplane", not "doggy airplane"



- Up and downdrafts are the sailplane pilot's friend. Make them yours! Don't dilly-dally in downdrafts.
- In strong up- and down- drafts (1) (Try to) maintain altitude: BAD (2) Maintain airspeed: BETTER (3) Slow in the updrafts, dive through the downdrafts: BEST.
- Where up? Upwind of ridges, above sunlit slopes, in mountain waves.
- Into the wind, approach ridges at a 45^o angle, to facilitate a turn back to lower terrain, should the downdrafts be overwhelming. Gain altitude prior to the ridge crossing, and cross at higher airspeed. Beware of the "false horizon" stall. 2000 feet of terrain clearance is usually adequate, with experience, probably less.
- Flying up or down a valley, fly on the downwind side, where there should be lift.
- In a canyon, hug the updraft side. This also gives more room for a 180. Don't fly *up* a narrow canyon, unless there is (a) room to turn around, (b) you don't need to climb. Keep extra airspeed for maneuverability.

Some arrival considerations...

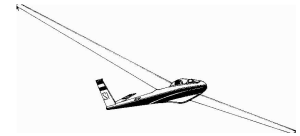


- Do your homework! More planning is needed for mountain airports.

- Look over the strip from aloft? Non standard pattern? Early go-around?

- Evaluate the departure options from the air.

Landing



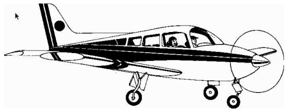
- With a good approach, landing should not be critical. At altitude, one can usually land a lot shorter than one can take off! For a 172, gross weight, 7500' DA, T/O ground roll is 1565', 3855' over 50'. Landing ground roll 650', 1455' over 50'!

- Use IAS.

- For exotic techniques on gravel bars, talk to Fred!

- Beware of late go-arounds!

Reducing weight helps a lot!



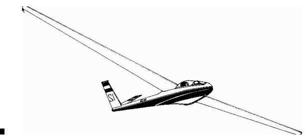
- Reducing weight reduces induced drag, since you need less lift. The same excess power gives a higher ROC. Takeoff acceleration is improved. Liftoff speed is reduced.

- Each one percent decrease in gross weight will give you about a two percent shorter takeoff distance, a one percent decrease in landing distance and more than a one percent increase in your rate of climb!

- Consider staging your passengers/gear through a lower/more suitable airport. Carry only enough fuel to get you out of the mountains. Then fill up…

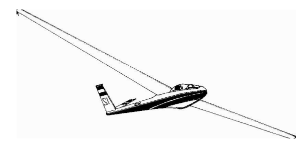
- If departure is problematical with a full load, make a trial takeoff at a lighter weight to check out performance.

Mountain Weather



- Mountains amplify weather. Orographic lifting adds to synoptic effects.
- Observations are more sparse and the weather is more changeable. Remember ceiling heights are above airport (valley) elevations!
- Weather is more limiting, VFR and IFR.
- Altimeter errors: temperature, "precipitous terrain", sparse reporting.

Turbulence



- Convective turbulence below the Cu tops. Fly in the morning! Cu bases = 1000*(Temp-Dewpoint)/4.5

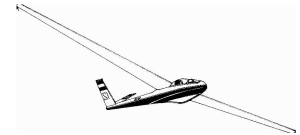
- Mechanical turbulence: it's windy in the mountains. Pretty bumpy if the ridge top winds exceed 35 knots.

- Mountain waves and rotors… ACSL.

- Temperature Inversions.

- Turbulence flying: maintain $\leq V_a$, fly attitude.

Bedtime Reading



- Mountain Flying.

Mountain Flying, Sparky Imeson, Airguide Pub., (Long Beach 1982)
Mountain Flying, Doug Geeting and Steve Woerner, Tab Books (1991)
A Guide to Bush Flying, Fred Potts, ACS Pubs (Tucson, 1993)

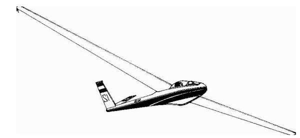
- Aircraft Performance

Aerodynamics for Naval Aviators
The Advanced Pilot's Flight Manual, William Kershner, (Iowa State 1990)
Flying High Performance Singles and Twins, John Eckalbar, (Skyroad 1994)

- Mountain Weather

Turbulence: A new perspective for pilots, Peter Lester, (Jeppesen 1993)

The bottom line.



- Mountain flying is more demanding than flying the flatlands. There's less margin for error. Airplane performance may be marginal. Greater stick and rudder skill is required to extract the required performance. More finely honed judgment is required to separate the difficult from the impossible. The weather is a wild card.

- An airplane is a great way to get to the mountains! With a conservative approach, you can do it safely.