Performance

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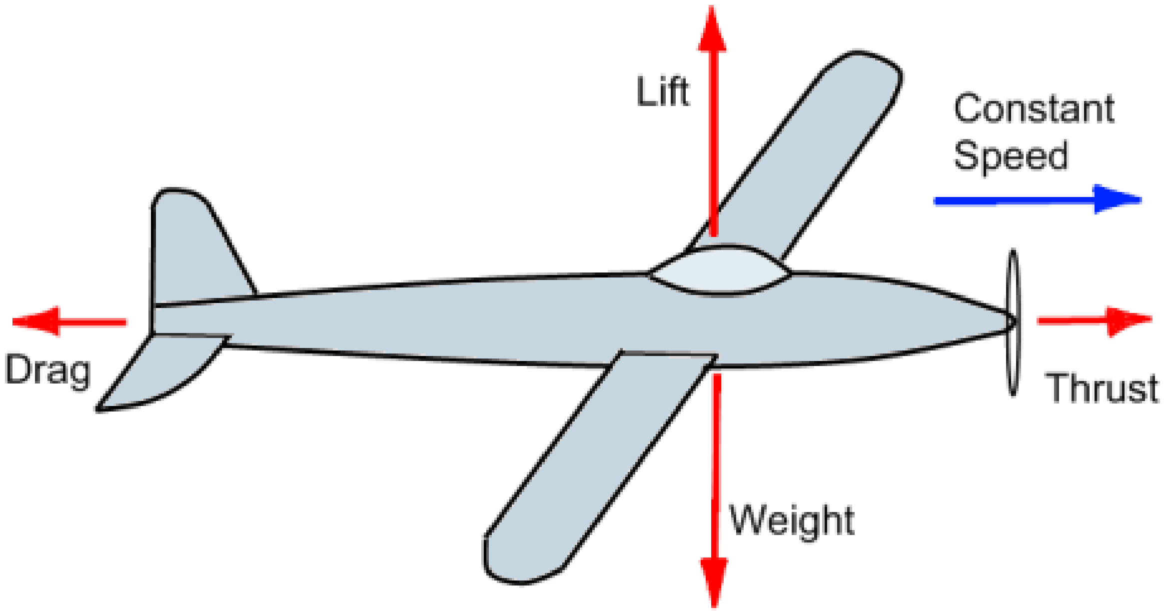
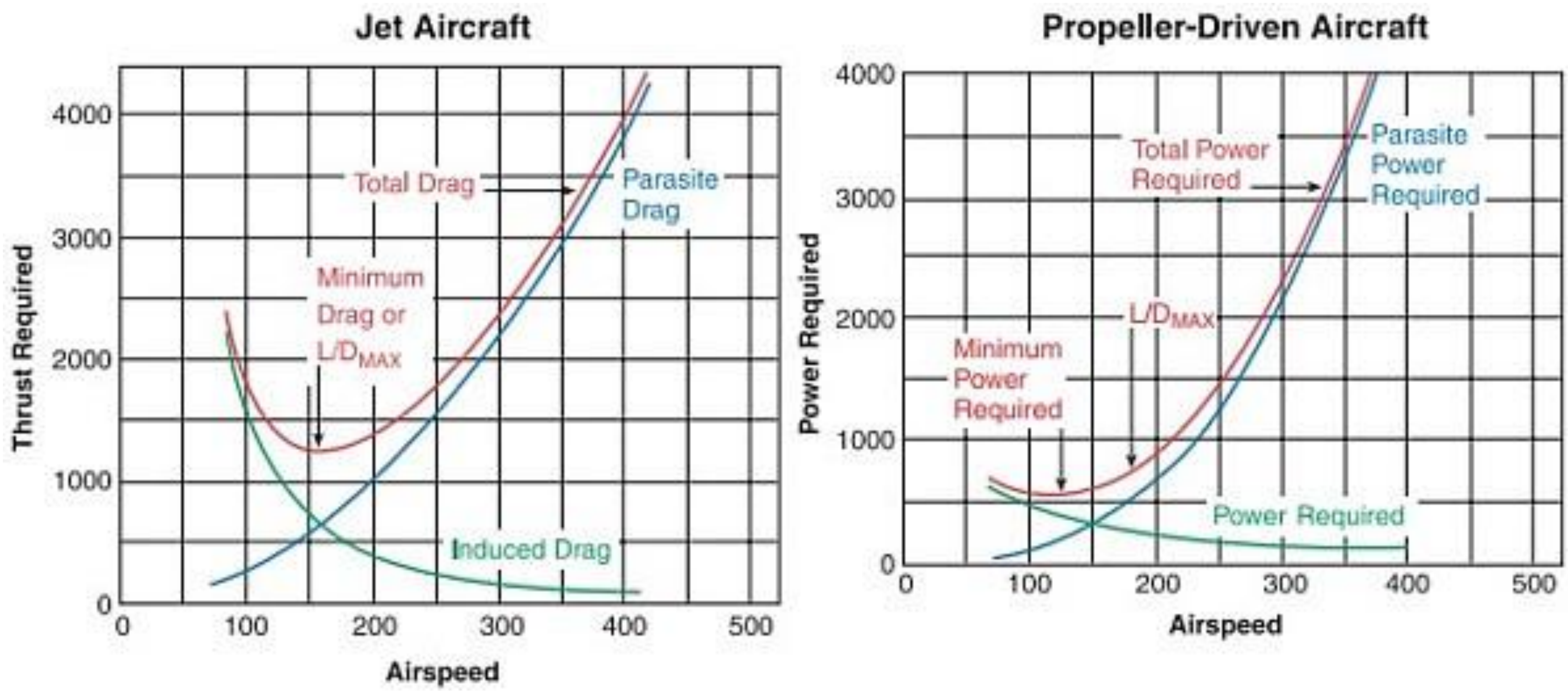
Level Flight



In level flight the upward lift applied to the wings is equal to the downward weight of the plane, while the forward thrust of the propeller is equal to the air frictional drag on the plane.

http://www.dinosaurtheory.com/flight.html

Required Thrust



https://www.theairlinepilots.com/forum/viewtopic.php?t=622

Power Required

13.2 Power Required

Now we can look at the propulsion system requirements to maintain steady level flight since

$$T_{\mathrm{req}} = D$$

and

$$P_{\mathrm{req}} = T_{\mathrm{req}} V = DV.$$

$$P_{\mathrm{req}} = \frac{1}{2}\rho V^3 S C_{D_0} + \frac{W^2}{\frac{1}{2}\rho V S}\left(\frac{1}{\pi e AR}\right).$$

http://web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node97.html

Excess Thrust

(Thrust – Drag)

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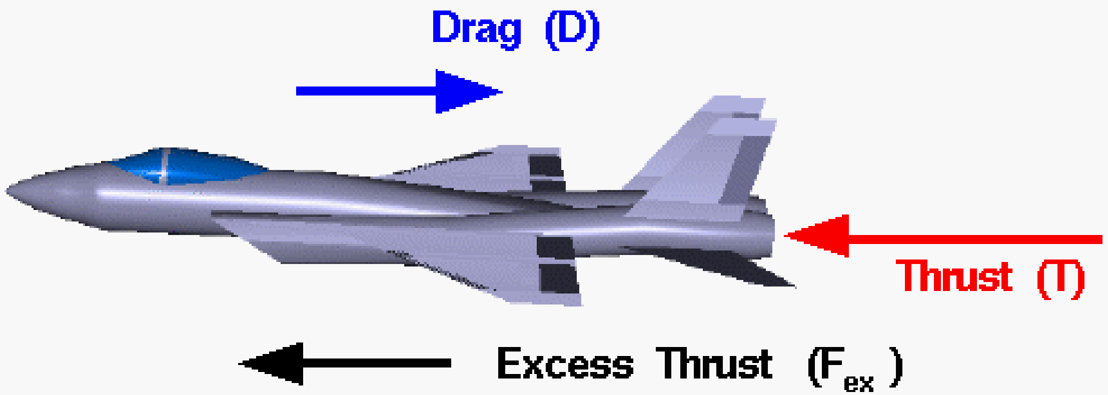


Excess Thrust = Thrust – Drag

$$F_{ex} = T - D$$

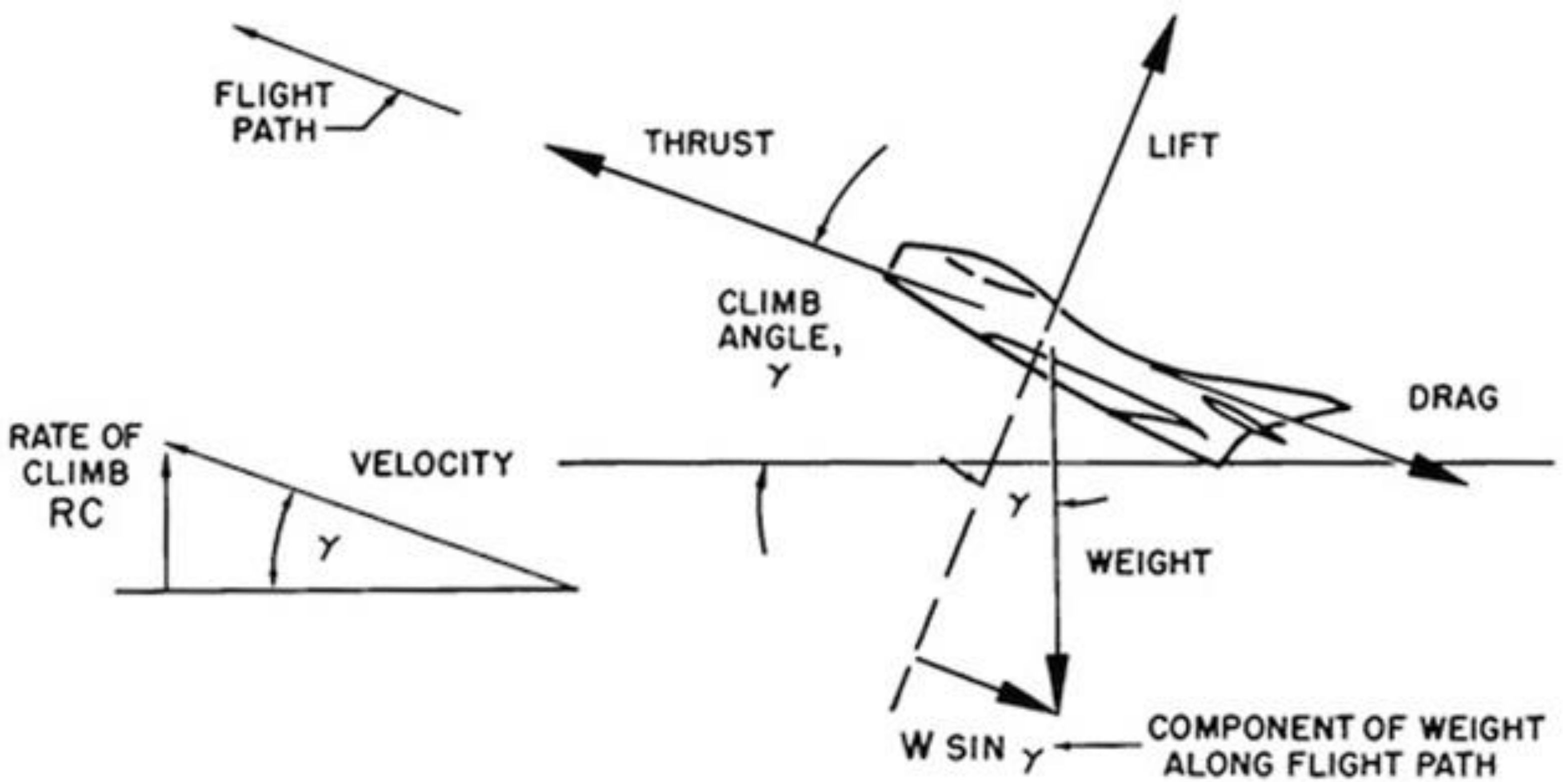
Newton's Second Law: $F_{ex} = m\ a$

$$a = F_{ex} / m$$

a = acceleration of aircraft

m = mass of aircraft

Rate of Climb



http://code7700.com/v-y.htm

Forces in a Climb

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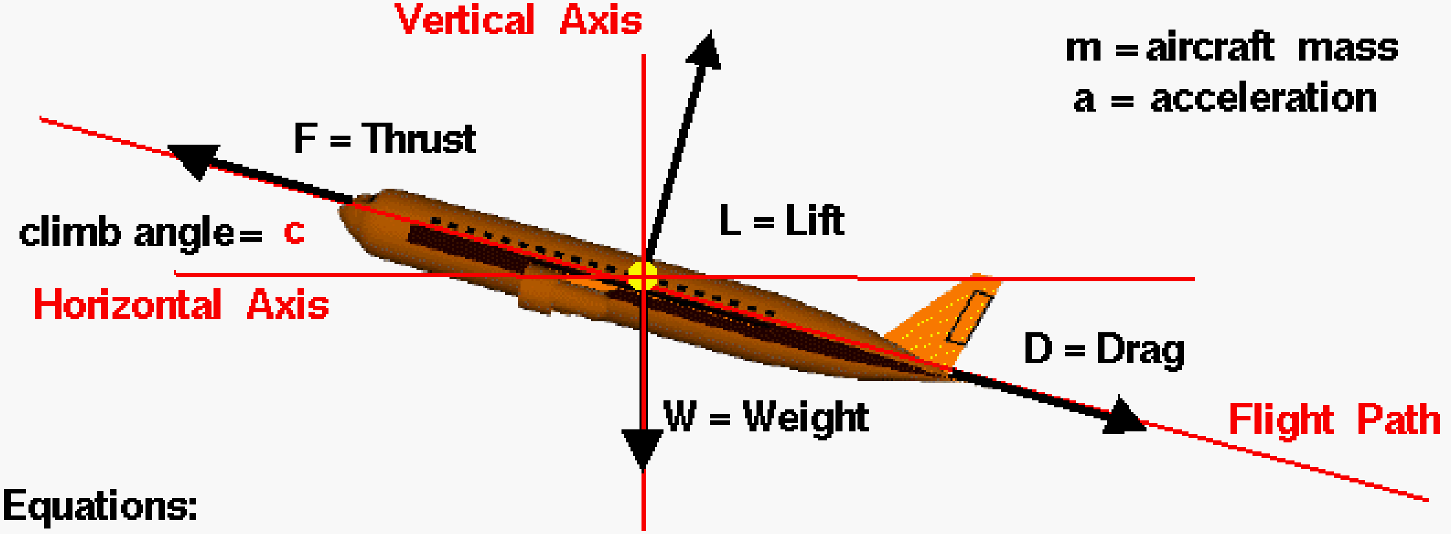


m = aircraft mass
a = acceleration

Equations:

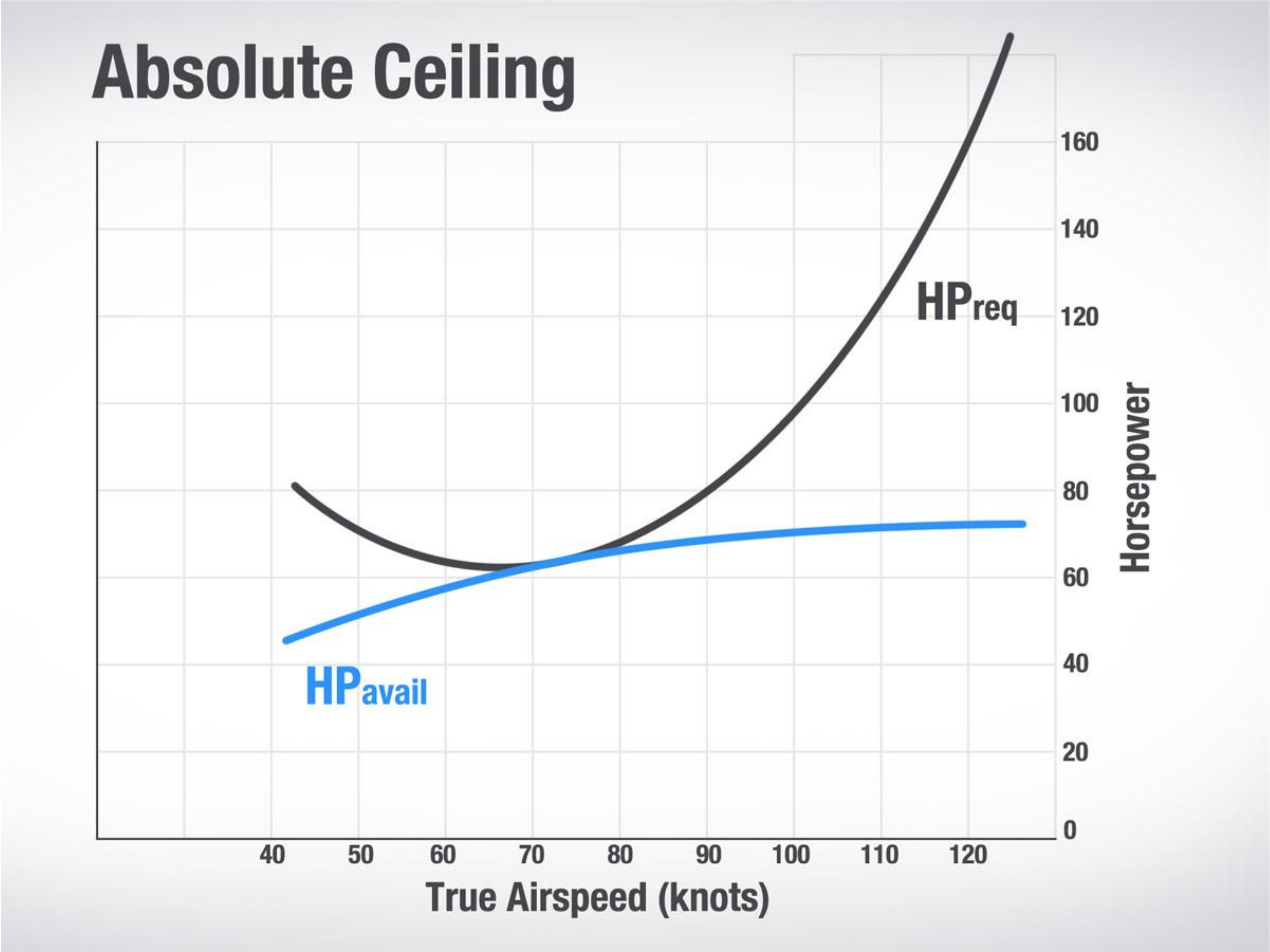
Vertical $F \sin(c) - D \sin(c) + L \cos(c) - W = m\, a_v$

Horizontal $F \cos(c) - D \cos(c) - L \sin(c) = m\, a_h$

Definition of Excess Thrust: $F - D = F_{ex}$

Vertical $F_{ex} \sin(c) + L \cos(c) - W = m\, a_v$

Horizontal $F_{ex} \cos(c) - L \sin(c) = m\, a_h$



http://www.boldmethod.com/learn-to-fly/performance/vx-vy-altitude-and-where-they-meet/

OPERATIVE CEILINGS

Adventia

SERVICE CEILING

Since reaching the absolute ceiling is impossible in practice, the service ceiling is considered. At this altitude the aircraft has a maximum **rate of climb of 100 fpm**.

DESIGN CEILING

It is the maximum altitude that the aircraft can reach taking into account the structural limits (maximum differential pressure, etc).

https://www.slideshare.net/chococrispis37/5-climb

Ceilings

Based on maximum climb rates

- Absolute Ceiling = 0 ft/min ROC
- Service Ceiling = 100 ft/min ROC
- Cruise Ceiling = 300 ft/min ROC
- Combat Ceiling = 500 ft/min ROC

http://slideplayer.com/slide/4908075/

Range – Constant Velocity

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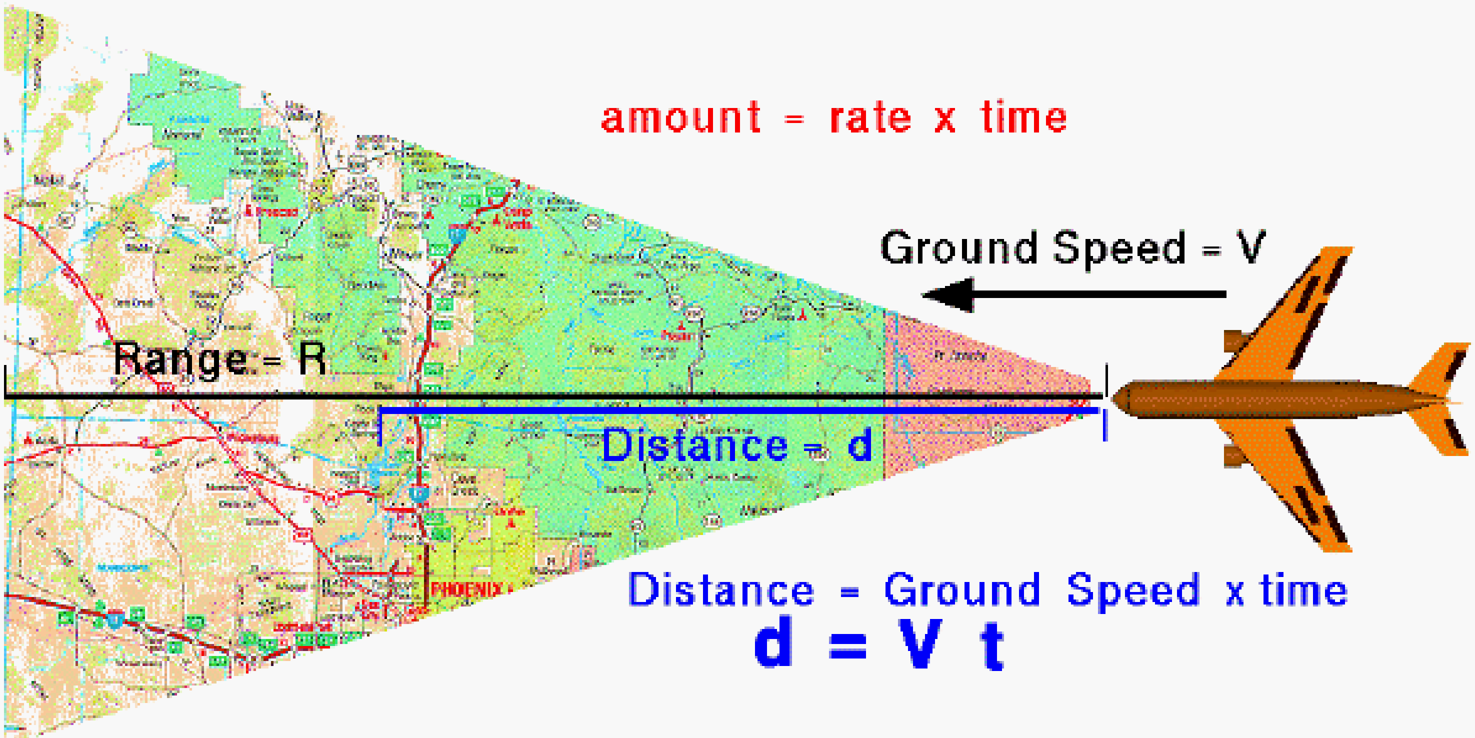


Distance = Ground Speed x time

$$d = V\ t$$

Range = Ground Speed x max flight time

$$R = V\ t_{max}$$

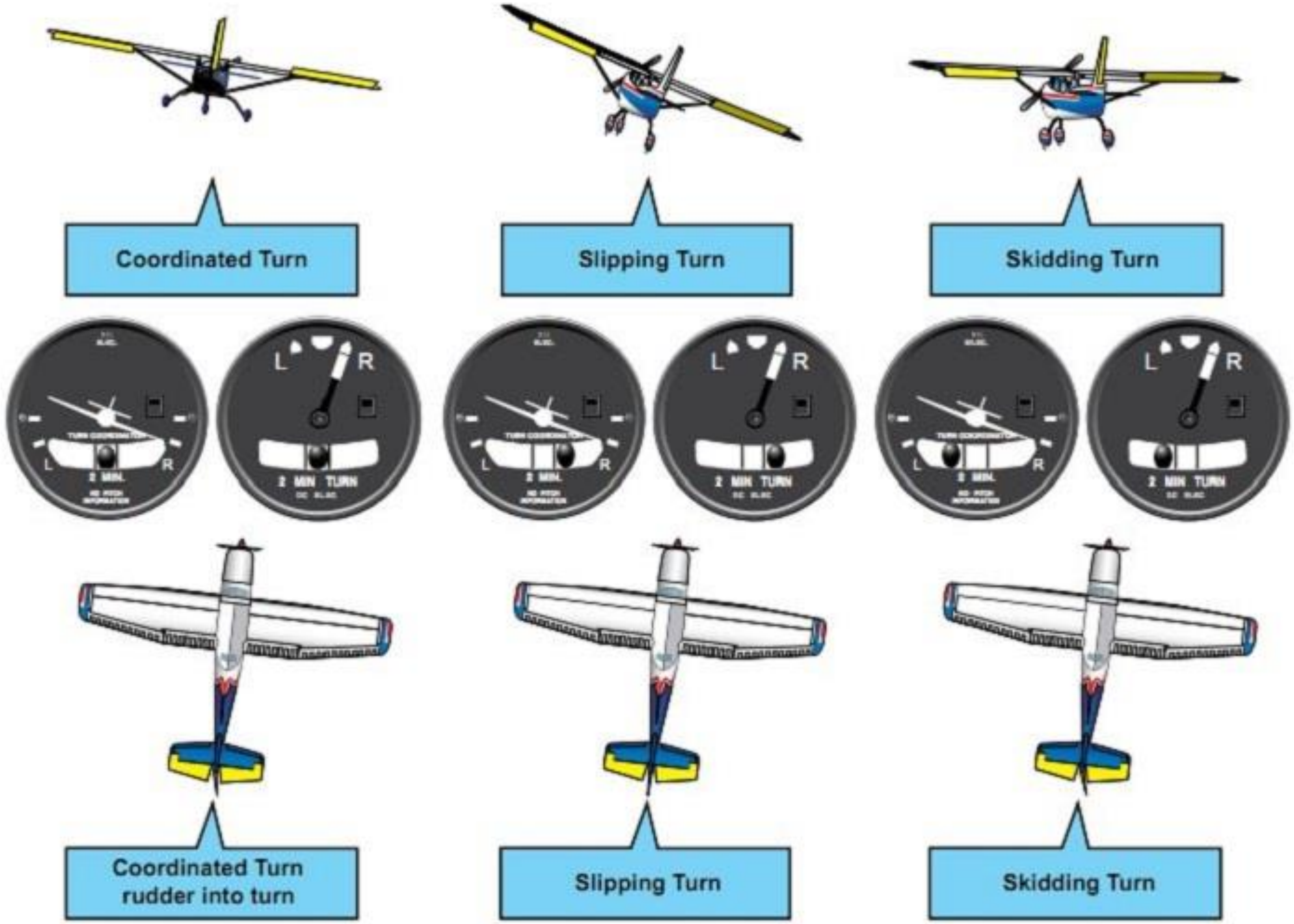
RANGE AND ENDURANCE

- **Range:** Total distance (measured with respect to the ground) traversed by airplane on a single tank of fuel
- **Endurance:** Total time that airplane stays in air on a single tank of fuel

- Parameters that maximize range are different from those that maximize endurance
- Parameters are different for propeller-powered and jet-powered aircraft

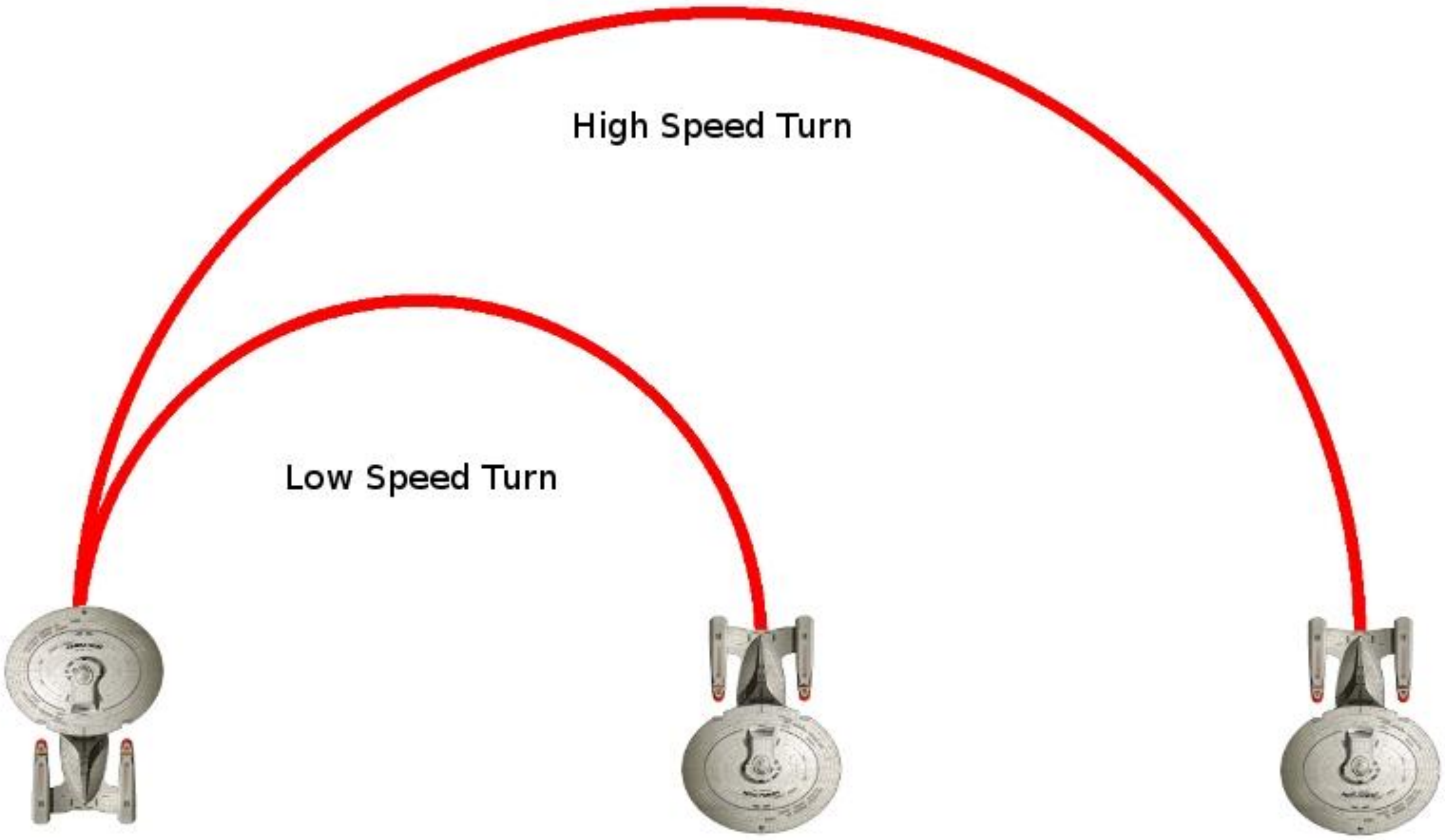
- Fuel Consumption Definitions
  - Propeller-Powered:
    - Specific Fuel Consumption (SFC)
    - Definition: Weight of fuel consumed per unit power per unit time
  - Jet-Powered:
    - Thrust Specific Fuel Consumption (TSFC)
    - Definition: Weight of fuel consumed per unit thrust per unit time

http://slideplayer.com/slide/5750482/

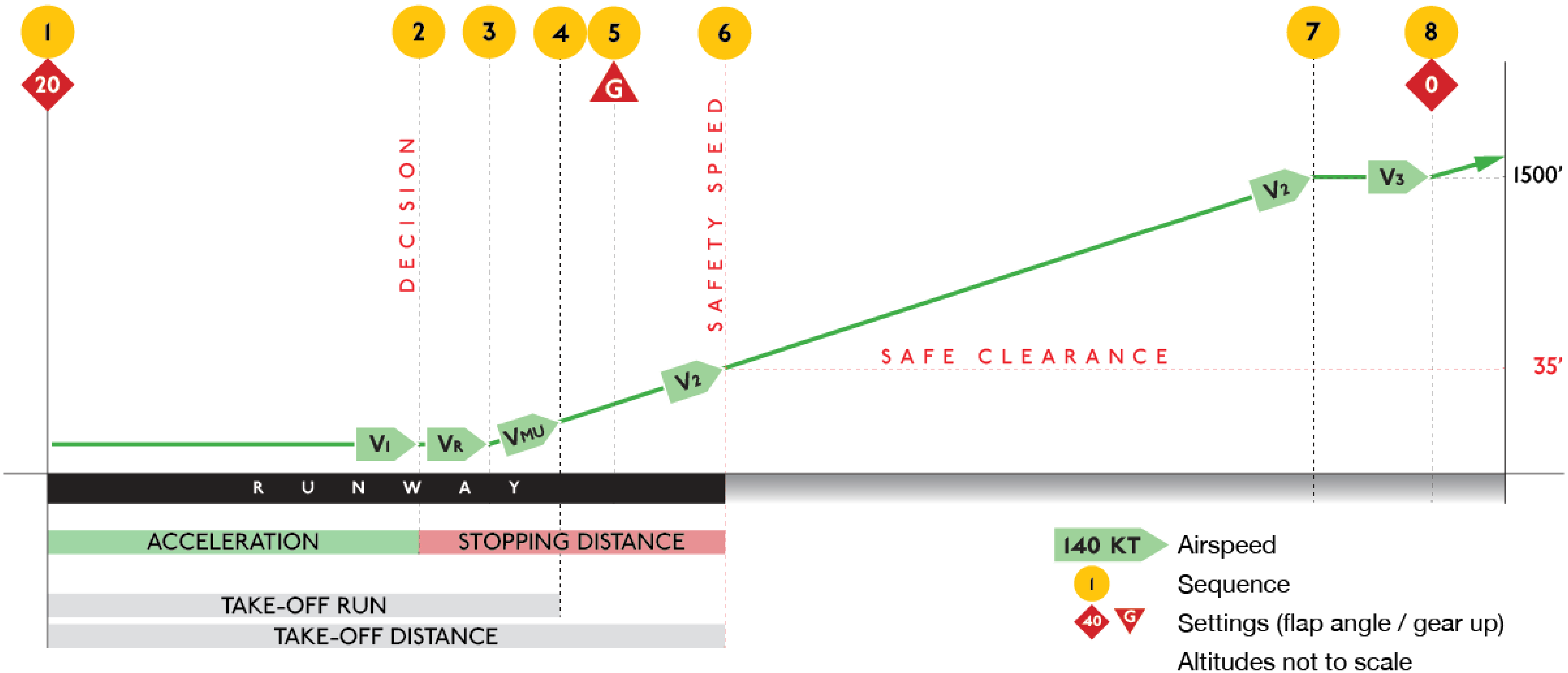


Note the slight differences in rudder placement.

https://aviation.stackexchange.com/questions/24101/are-the-functions-of-ailerons-and-rudder-similar



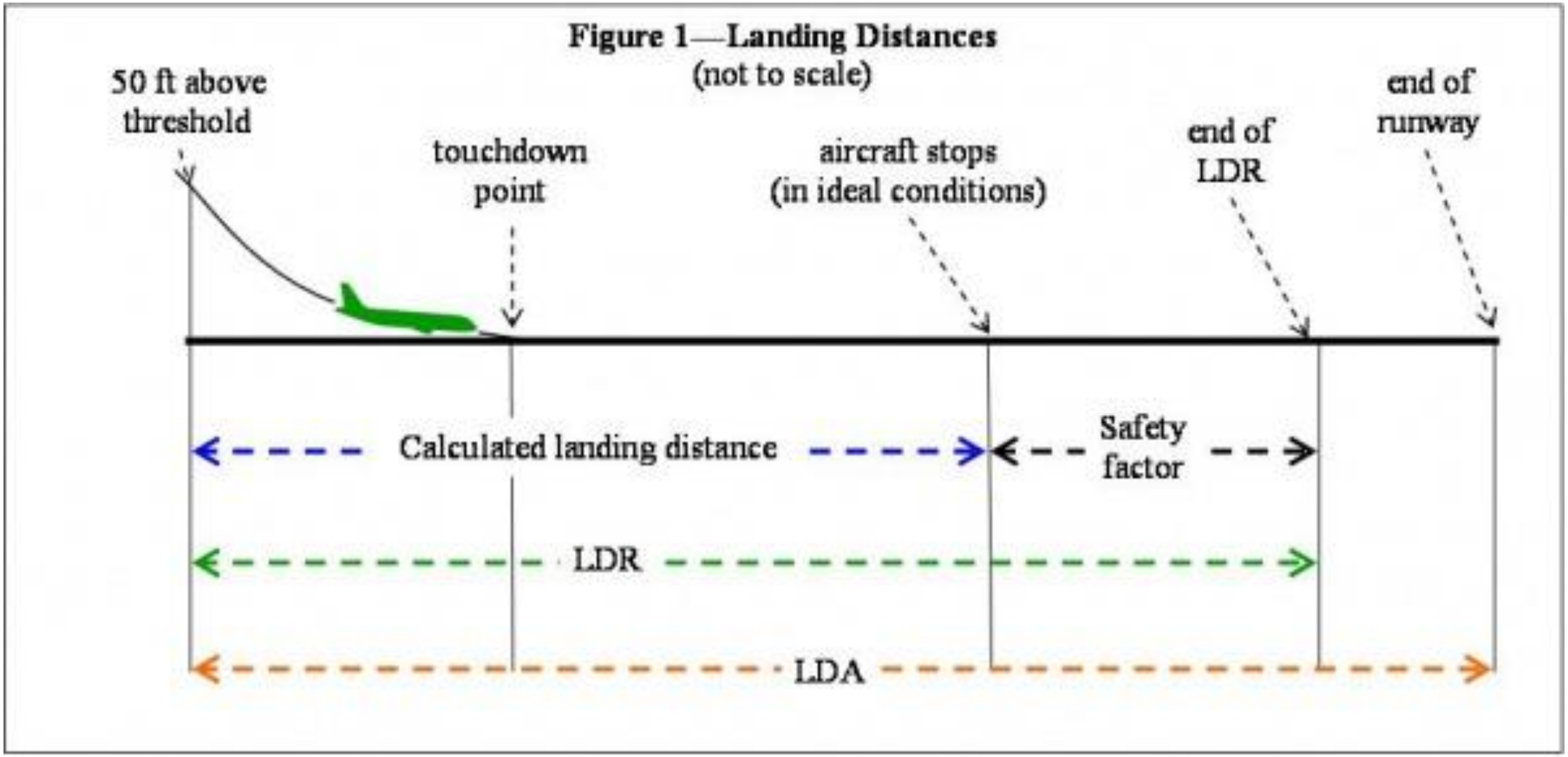
https://theenginescannaetakeit.wordpress.com/articles-3/starship-mechanics/



http://www.dh-aircraft.co.uk/news/files/961130b11c2bc7b6a35a6b91e79ce63c-119.html

JATO

https://commons.wikimedia.org/wiki/File:KC-130F_Blue_Angels_JATO_1984.JPEG



http://www.skybrary.aero/index.php/Landing_Distances

Reverse Thrust

http://siamagazin.com/incredible-boeing-747-400-mega-splash-during-thrust-reverse/