- Initial assumption same as jet: 'rate at which weight is reduced = rate at which fuel burnt

- However for propeller engine, f = mass of fuel burnt per unit of power per second
  (power ← rather than thrust for jet)

$$\frac{dW}{dt} = -fgP$$

(f for prop different to f for jet.)

Power delivered by propellor, $P = \frac{DV}{\eta}$ ← propeller efficiency

$$\frac{dW}{dt} = -fg\frac{DV}{\eta} \rightarrow \int dt = -\frac{\eta}{fg}\frac{C_L}{C_D}\int\frac{dW}{W}$$

$$E_{prop} = t_{12} = \frac{\eta}{fg}\frac{1}{V}\frac{C_L}{C_D}\ln\left(\frac{W_1}{W_2}\right)$$

For max endurance we require max $\frac{1}{V}\frac{C_L}{C_D}$ or minimise $\frac{VC_D}{C_L} = \frac{VD}{W}$

↳ maximise $\frac{C_L^{\frac{3}{2}}}{C_D}$

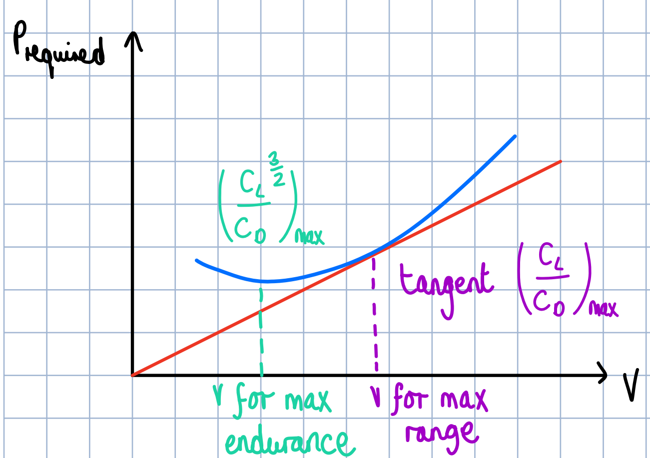
DV is power required to overcome drag

→ max endurance at min power speed

$$A_{prop} = S_{12} = \frac{\eta}{fg}\left(\frac{C_L}{C_D}\right)\ln\left(\frac{W_1}{W_2}\right)$$

$(E_{prop} \times V)$

max range at minimum drag speed



Drag Polar Relationships :

$\frac{C_L}{C_D}$ relation	Maximised When	C_L	C_D	Relates to
$\frac{C_L^{3/2}}{C_D}$	$C_{D_0} = \frac{1}{3}KC_L^2$	$\sqrt{\frac{3C_{D_0}}{K}}$	$4C_{D_0}$	Min power required Min sink rate Max prop endurance
$\frac{C_L}{C_D}$	$C_{D_0} = KC_L^2$	$\sqrt{\frac{C_{D_0}}{K}}$	$2C_{D_0}$	Min drag Max glide angle Max prop range Max jet endurance
$\frac{C_L^{\frac{1}{2}}}{C_D}$	$C_{D_0} = 3KC_L^2$	$\sqrt{\frac{C_{D_0}}{3K}}$	$\frac{4}{3}C_{D_0}$	Max jet range

Powers of C_L change according to velocity term in equation

→ V includes $\frac{1}{\sqrt{C_L}}$ term ∴ if multiplied by V → $C_L^{\frac{1}{2}}$

divided by V → $C_L^{\frac{3}{2}}$

V not included → C_L

Payload-Range Diagrams :

- Represents trade off between aircraft payload and range
  ↳ provides understanding of utility of airplane

Aircraft Weight :

Max. take-off weight (MTOW) - max authorized weight for takeoff due to strength & airworthiness requirements

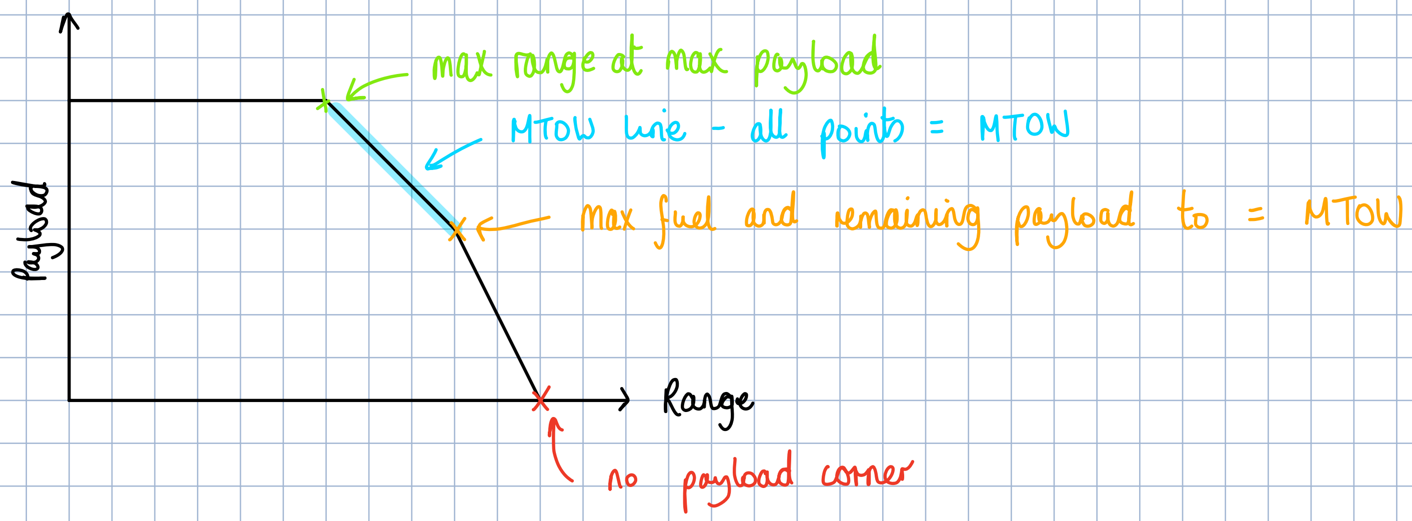
Operational empty weight (OEW) - basic weight of aircraft including all equipment and supplies needed for standard operation (does not include fuel & payload)

Max zero-fuel weight (MZFW) - max weight allowed before fuel is loaded

W_{final} = OEW + payload + reserve fuel weight

$W_{initial} = W_{final}$ + trip fuel weight

Example Diagram:



Aircraft families (e.g A350-900 vs 1000) made to have different payload-range lines.