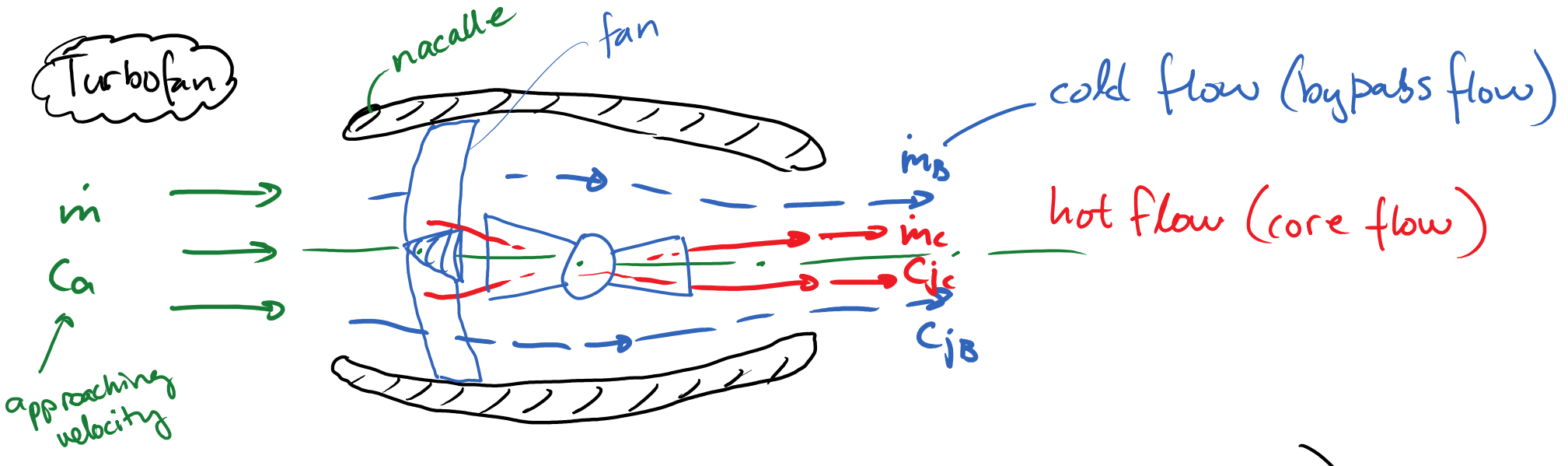
Current development in airbreathing propulsion



$\dot{m} \approx \dot{m}_B + \dot{m}_c$ (neglect $\dot{m}_f$, fuel massflow)

$\frac{\dot{m}_B}{\dot{m}_c}$: Bypass ratio (BPR)

Thrust force: $F = \dot{m}_B \cdot c_{j_B} + \dot{m}_c \cdot c_{j_c} - \dot{m} \cdot c_a$

when BPR=0 $\rightarrow$ $\dot{m}_B = 0$ $\therefore$ turbojet

$\dot{m}_c = \dot{m}$

Propulsive efficiency

$$\eta_{prop} = \frac{P_a}{P_j} = \frac{\dot{m} c_a (c_j - c_a)}{\frac{1}{2}\dot{m} c_j^2 - \frac{1}{2}\dot{m} c_a^2} = \dots\dots = \frac{2}{1 + \frac{c_j}{c_a}}$$

P_a – available power

P_j – jet power

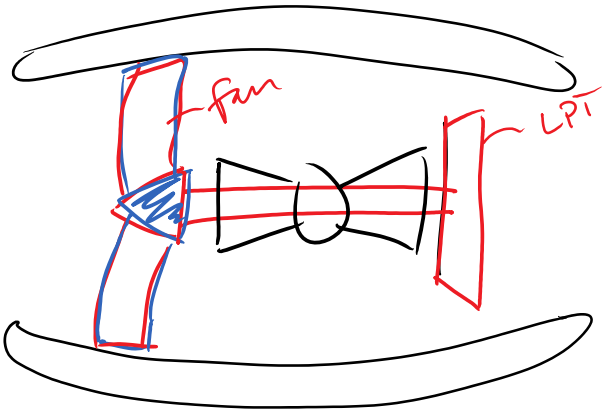
if $c_j \uparrow \rightarrow F \uparrow$; $\eta_{prop} \downarrow$

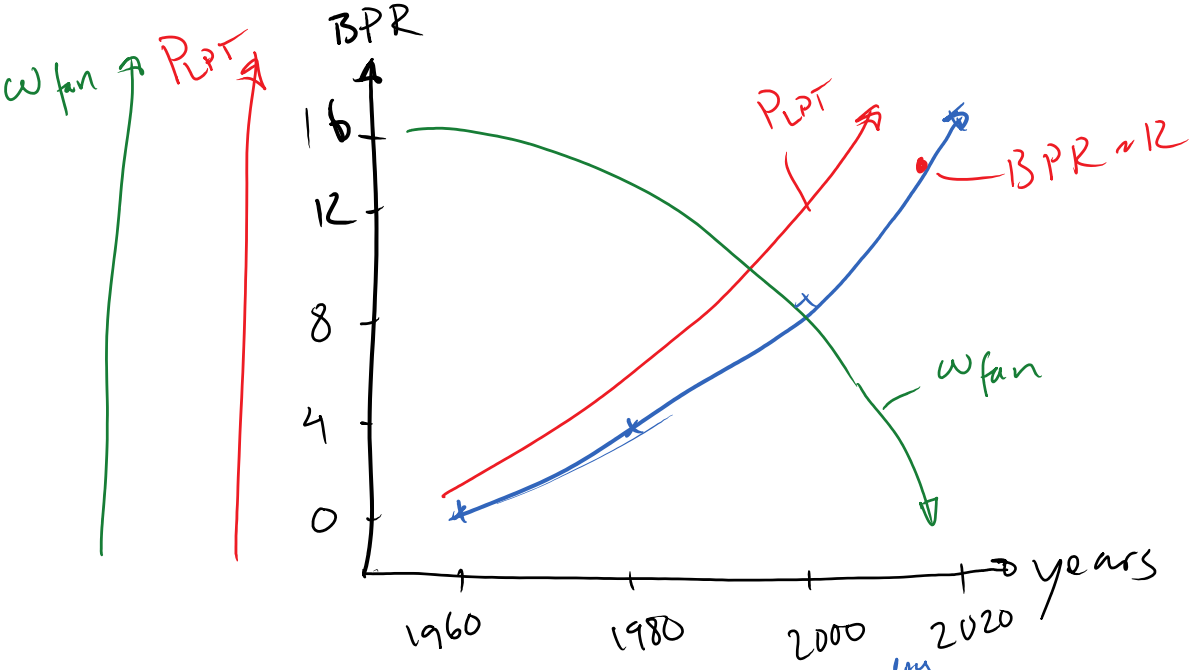
$c_j = c_a \rightarrow F = 0$; $\eta_{prop} = 1$ (theoretical)

optimum $c_j \gtrsim c_a \rightarrow F > 0$; η_{prop} maximised

thrust $F = \dot{m}(\overbrace{c_j - c_a}^{\text{small}})$

this is the reason for the steady increase in BPR over the last decades (~85% in bypass)





LPT: $P = \dot{m} \Delta h_0$; $\Delta h_0 = \psi \cdot u^2 \cdot N$

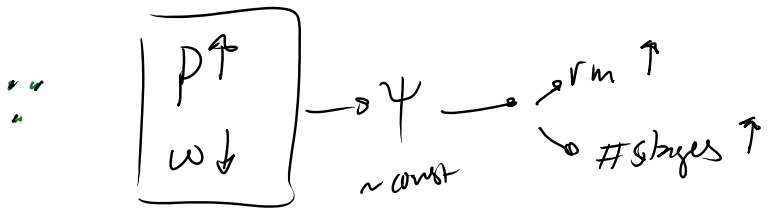
actual enthalpy drop

repeating stage design LPT

number of stages

tang. speed ($u = r_m \cdot \omega$)

loading coefficient



GTF : geared turbofan