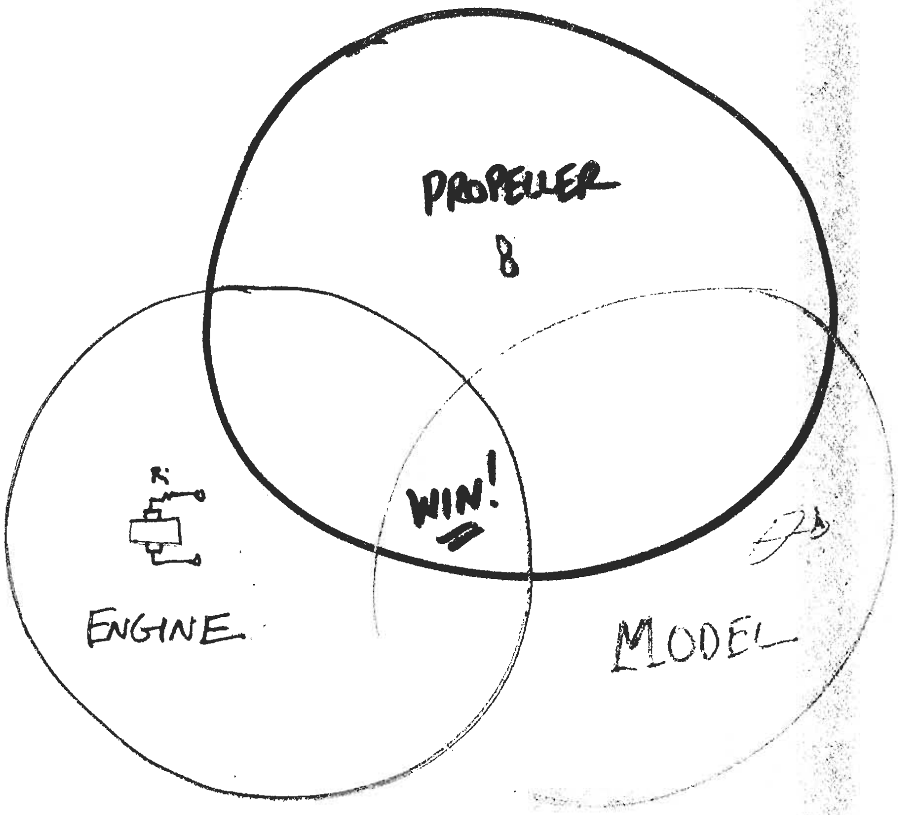
Objective

Give you methodology and tools to begin optimization & trade studies



HERR PROF DR R. EPPLER

Where to begin....

Dragonfly

Wingspan	b	48in
Wing Area	S	450 sq in
Weight	W	15 oz
Wing Loading		5 oz/sq foot
Chord	c	10in
Length		35in
Motor		Graupner Speed 400 7.2V
Battery		7 cells (1.2V each cell) 600 mAh

Velocity anyone . . .

$$V = 20 \text{ ft/sec}$$
$$= 20 \cdot 0.681\,818\,182 \,[\text{ft/sec}] \left[\frac{\text{mph}}{\text{ft/sec}}\right]$$
$$\approx 13.64 \text{ mph}$$

Reynold's Number

$$Re = \frac{\rho V c}{\mu}$$

$V = 16.64 \text{ mph}$

$c = 10 \text{in}$

$$\boxed{Re = V\,[\text{mph}] \cdot \text{chord}\,[\text{in}] \cdot 780}$$

$$Re = 13.64\,[\text{mph}] \cdot 10\,[\text{in}] \cdot 780\,[\quad]$$
$$= 106{,}392$$
$$\boxed{Re \approx 100K}$$

- Most powered model A/c operate in Re 200,000 to well over Re 1,000,000

Aspect Ratio

$$AR = \frac{b^2}{S}$$

$$AR = \frac{\text{Span}^2\,[in^2]}{\text{Wing Area}\,[in^2]}$$

$$AR = \frac{48^2\,[in^2]}{450\,[in^2]}$$

$$AR = 5.12$$

	Wing Loading	AR
High speed, Highly maneverable	22 - 26 [oz/sqft]	4 - 6
Moderate speed sport	16 - 22	6 - 8
Low speed trainer	12 - 16	8 - 10
Slope gliders	12 - 14	8 - 10
Soaring gliders	8 - 12	10 - 15

Wing Loading

$$S = 450 \text{ sqin}$$
$$= 450 \cdot \frac{1}{144} \text{ [sqin]} \left[\frac{\text{sqft}}{\text{sqin}}\right]$$
$$S = 3.125 \text{ sqft}$$
$$W = 15 \text{ oz}$$

$$\text{Wing Loading} \quad \frac{15 \text{ oz}}{3.125 \text{ sqft}} = 4.8 \text{ [oz/sqft]}$$

C_L

$$L = \frac{1}{2} \rho V^2 C_L S$$

$$L = W$$

$$L = \frac{C_L \cdot \sigma \cdot V^2 \cdot S}{3519} \; [oz]$$

$W = 15 oz$

$V = 13.64 mph$

$S = 450 sq in$

$\sigma = 1$ @ sea level

$$C_L = \frac{3519 \cdot 15 [oz]}{1 \cdot (13.64)^2 (mph)^2 \cdot 450 sq in}$$

$$C_L = .63$$

C_D

$$C_D = C_{DO} + \frac{C_L^2}{\pi AR}$$

$$\boxed{C_D = C_{DO} + \frac{(0.318 \times C_L^2) \cdot (1+\delta)}{AR}}$$

SAY $C_{DO} \approx .015$ (I looked at a lot of graphs...)

GIVEN $\delta \approx .04$

$AR = 5.12$

$$C_D = .015 + \frac{(.318)(.63)^2(1.04)}{5.12}$$

$$\boxed{C_D = .0406}$$

Drag

$$D = \frac{1}{2} \rho V^2 C_D S'$$

$$\boxed{D = \frac{C_D \cdot \sigma \cdot V^2 \cdot S'}{3519} \text{ [oz]}}$$

$\sigma = 1$ [*]
V [mph]
S' [sq in]

$$= \frac{(.0406)(1)(13.64)^2(450)}{3519}$$

$$\boxed{D = .97 \text{ [oz]}}$$

Is there anything else we can do?

Power

$$T = D$$

$$\boxed{P = T \cdot v}$$

$$P = D \cdot V$$

$$P = P_m \cdot \eta$$

$$[W] \quad P_m \cdot \eta = D \cdot V \quad [oz][mph] \ldots\ldots$$

$$1\,mph = .447\,040\ [m/s]$$

$$1\,oz = \frac{4.448\,221\,654}{16}\ [N]$$

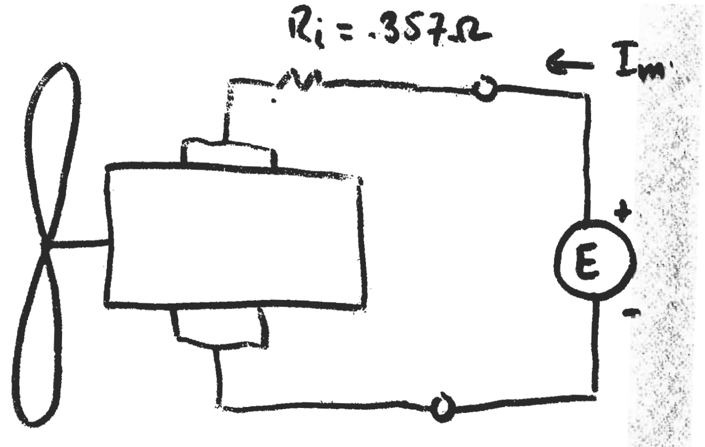
$$\eta = .8$$

$$[w] \quad P_m = \frac{D \cdot V}{\eta}(.12428331) \quad [w]$$

$$= \frac{.97[oz] \cdot 13.64\,(mph) \cdot .12428331}{.8} \quad [w/oz \cdot mph]$$

$$\boxed{P_m = 2.06\ W}$$

Power



$E = 8.4\ [W/A]$

$R_i = .357\ \Omega$

$I_o = .72\ A$

$P_m = 2.06\ W$

$$P_m = (E - R_i I_m)(I_m - I_o)\ [W]$$

$$I_m \approx 1.02\ A$$

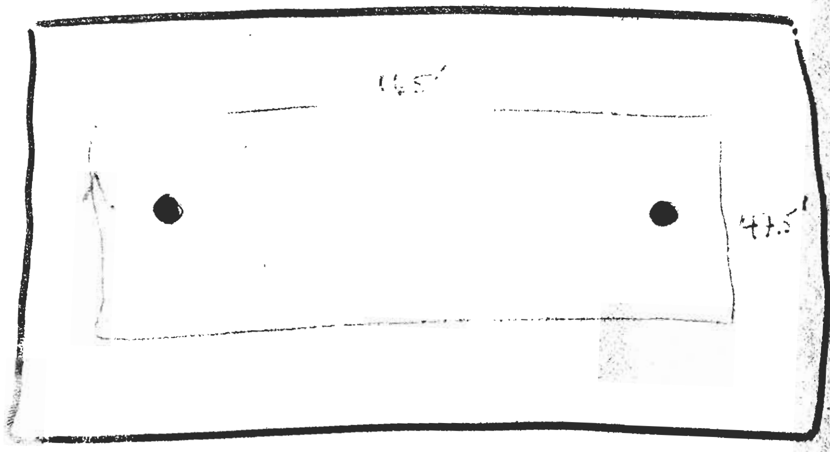
FLIGHT TIME ?

$$t = \frac{600 mA \cdot hr}{1.02 A}$$

$$= .59\ hr$$

$$t \approx 35\ min$$

Can I complete the course?



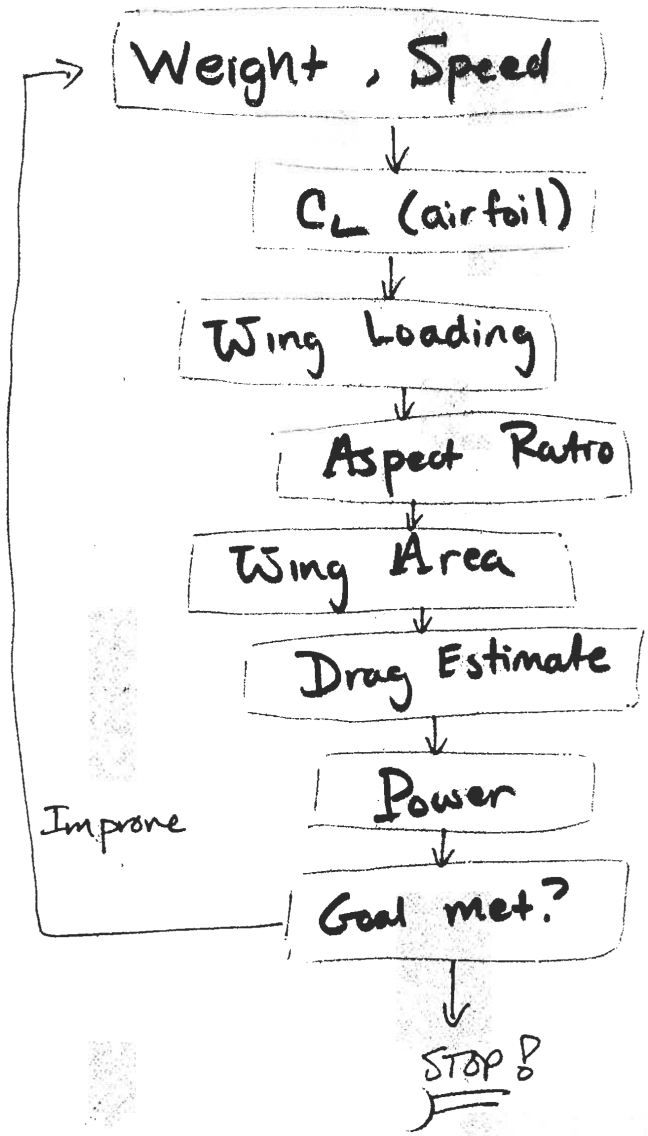
COURSE LENGTH = 425'

NO OF LAPS = 4

TOTAL COURSE LENGTH = 1700' (.32 mi)

$$t_{TOTAL} = \frac{.32\,mi}{13.64\,mph} = 1.42\ min$$
(NON-STOP)

?


Weight, Speed
C_L (airfoil)
Wing Loading
Aspect Ratio
Wing Area
Drag Estimate
Power
Goal met?
Improve
STOP!