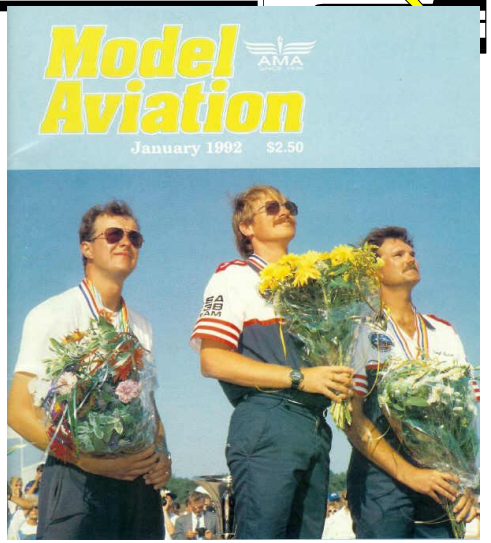
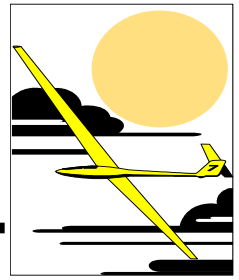
My Background

- Flying RC sailplanes since 1976
- First competition 1977 US Nationals, placed 2nd
- Only pilot to win world champion for both FAI recognized soaring disciplines
- FAI world record holder for declared distance to a goal (141 miles, set in 1988)
- A “lifer” in the sport

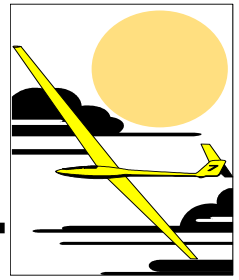




Finding and Recognizing Thermals

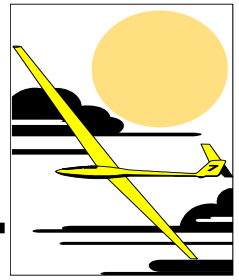
Joe Wurts

Topics of Discussion



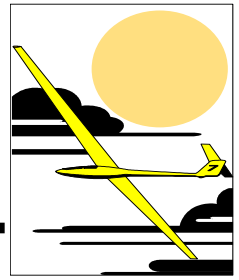
- Thermal Theory
- Application
- Thermal Sources
- Non-Thermal Lift

Thermal Theory - Basics



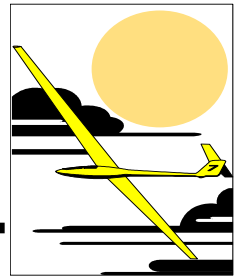
- Basic definition: lighter than the surrounding air
- Thermal shapes
  - Column
  - Bubble
  - Disorganized blob
  - Streets

Thermal Theory - Climate Influences

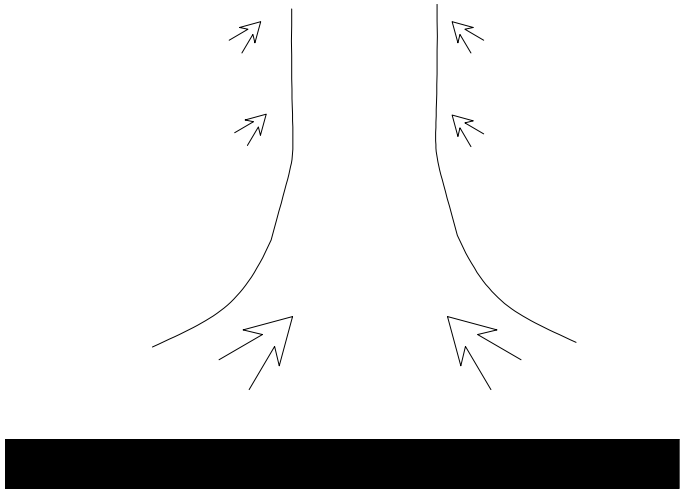


- Humidity
- Ground moisture
- Lapse rate
- Inversion height
- Cloudiness

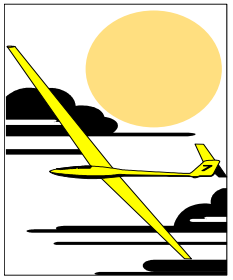
Thermal Theory - Characteristics



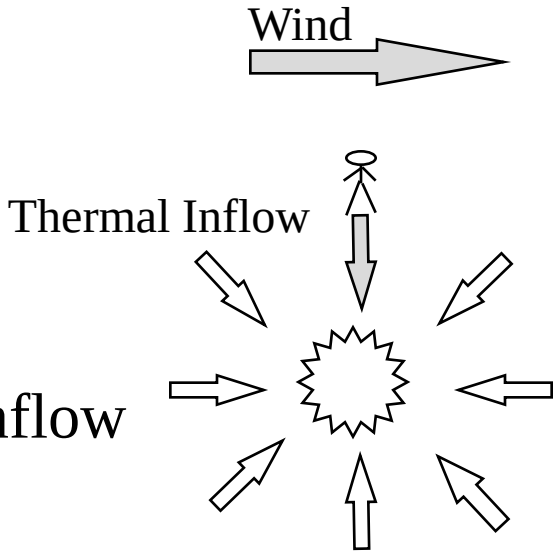
- Feeds from warm air near the ground
- Drifts with the wind
- Attraction to other thermals
- Thermal aspect ratio

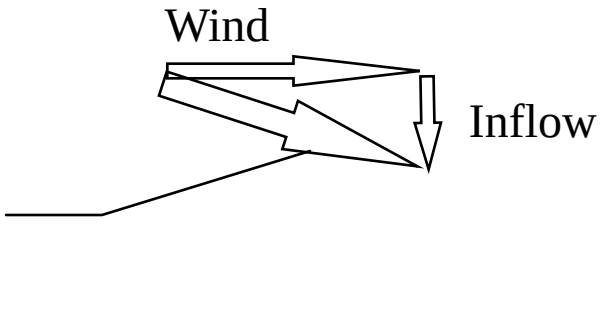


Application - Clues to Finding Thermals

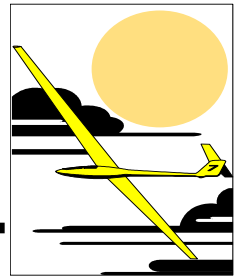


- Detecting thermal inflow
  - Inflow signs
  - Wind lulls, changes
  - Wind shifts
    - » Do not confuse with thermal inflow
- Ground signs
  - Look for the “third vector”

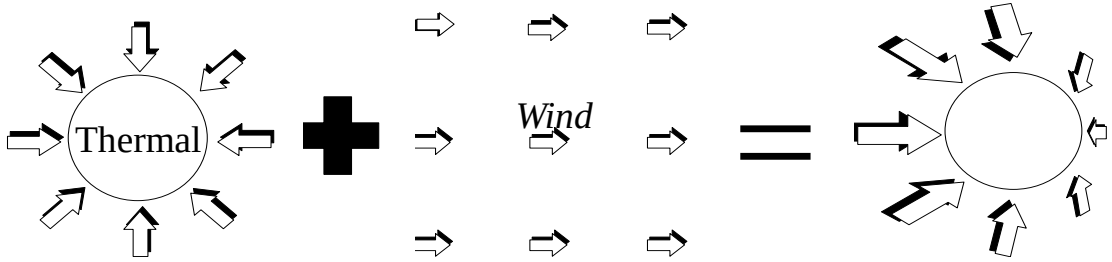




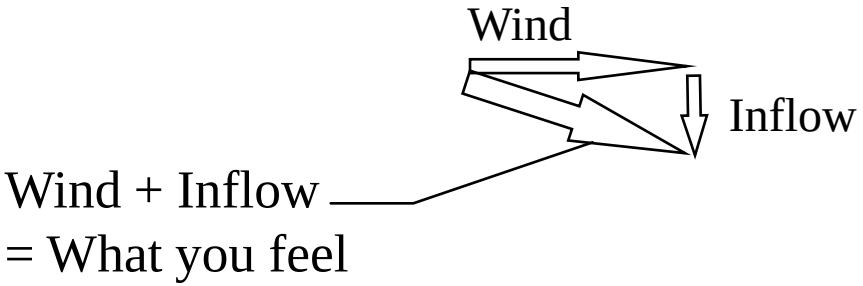
Application - The Third Vector



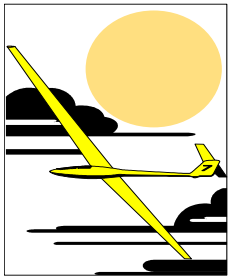
- Mental vector math = Direction to thermal



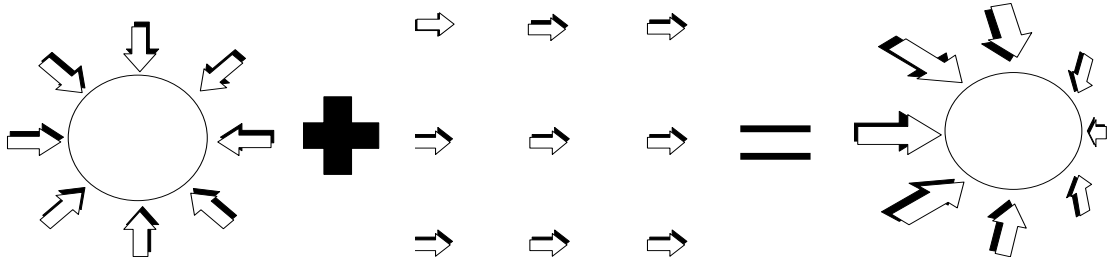
- What to look for
  - Temporary changes in the wind
    - » Direction
    - » Speed



Application - The Third Vector

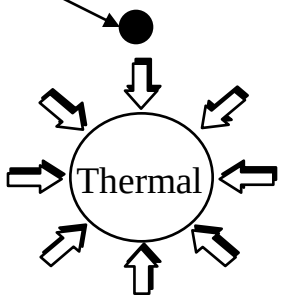


- Mental vector math = Direction to thermal

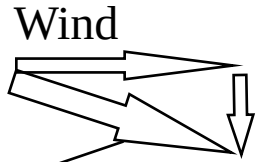


If you are standing here...

Thermal Inflow



The wind if there was no thermal



Wind

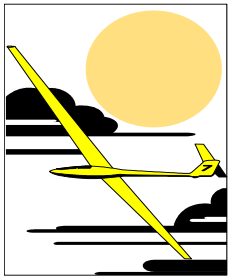
Inflow

(The third vector)

What you feel

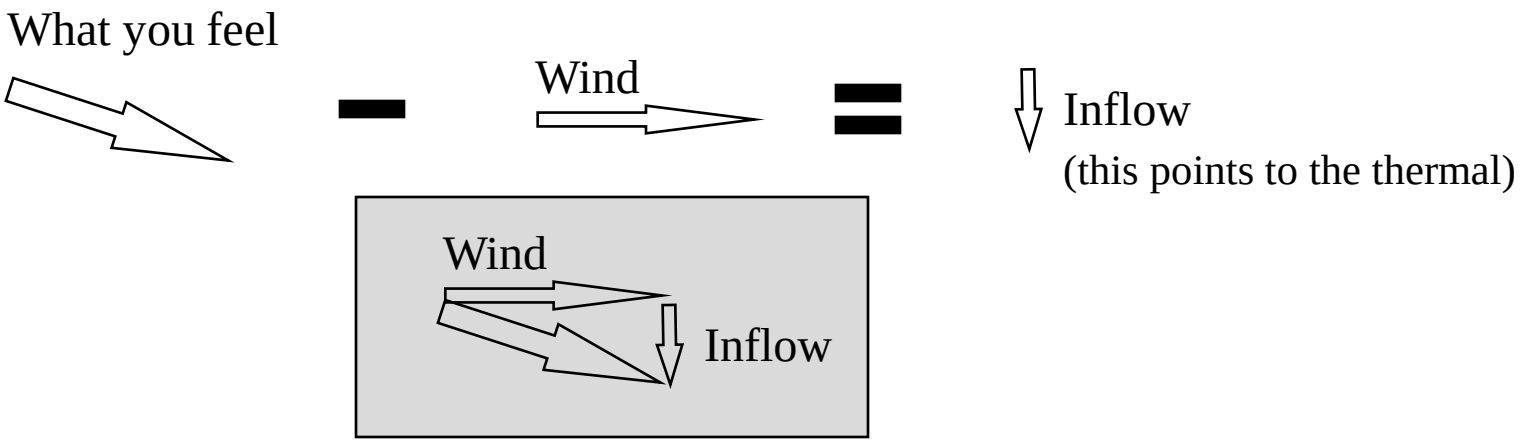
The wind + thermal inflow = the wind that you feel

Application - The Third Vector



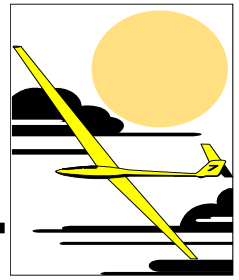
- Mental vector math = Direction to thermal

Do the math to derive the direction to the thermal

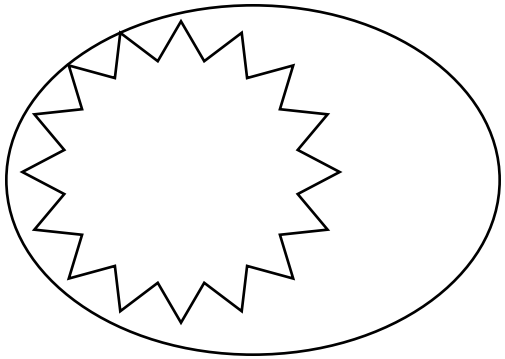


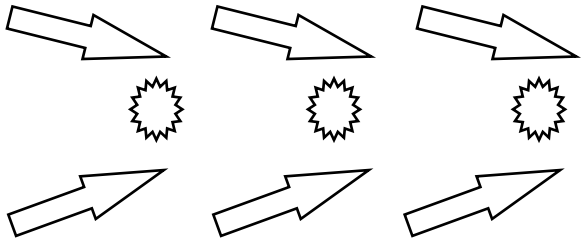
Note the wind speed and direction that you feel
Subtract the basic wind
The result is the change caused by the thermal

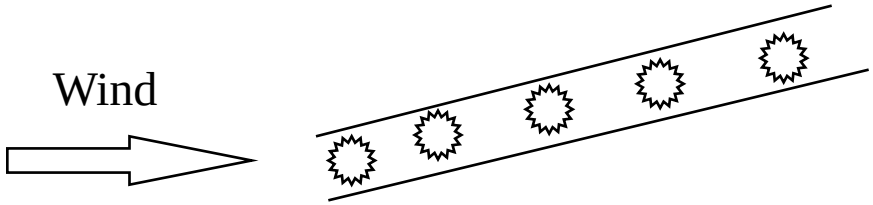
Application - Practical Guidelines



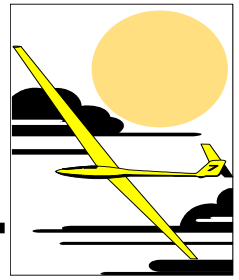
- Sharply defined upwind edge
- Diffuse downwind edge
- Convergence zones
- Angled streets



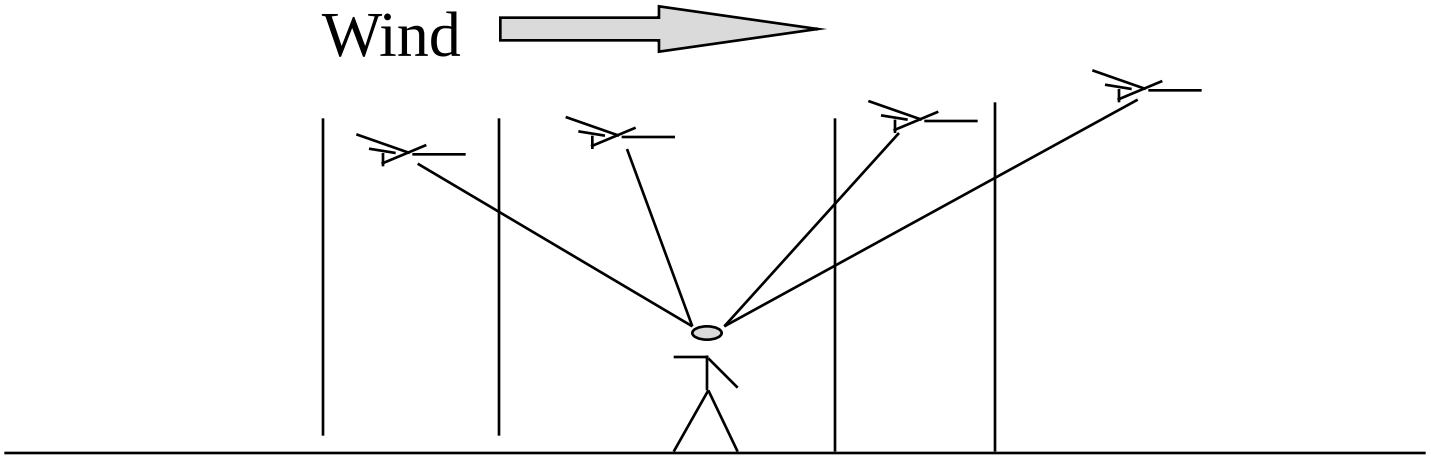




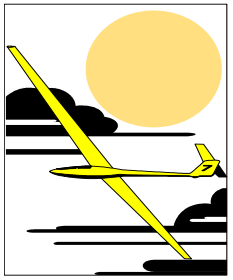
Application - Perspective Challenges



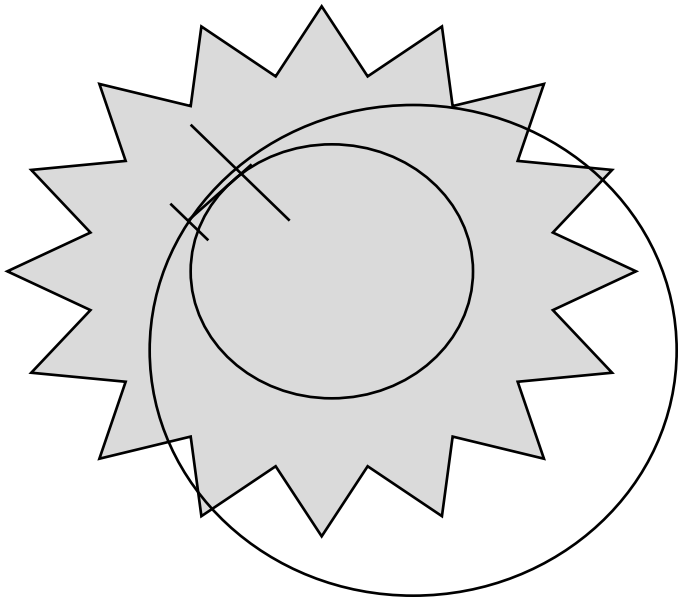
- Confusion between range and altitude
- Elevation angle confusion

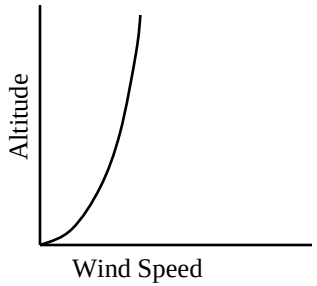


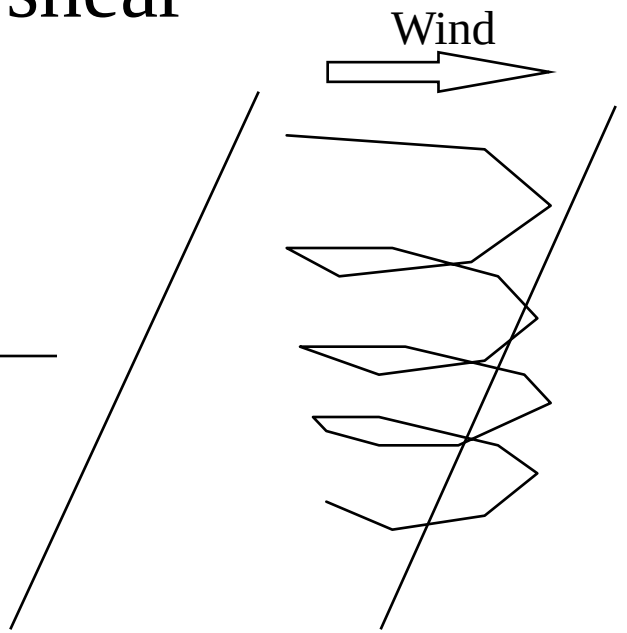
Application - Hints on Recentering



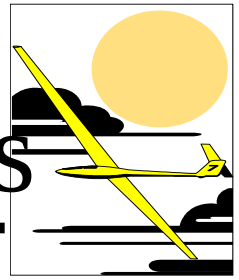
- Turn tighter in the stronger lift
- Constantly reevaluate on each circle
- Be wary of subconscious upwind drift
- Effects of horizontal wind shear



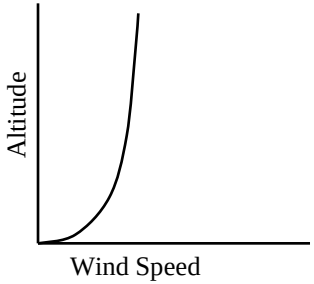




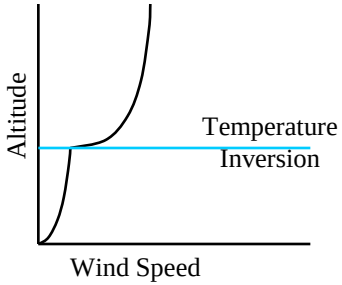
Morning Conditions - Inversions



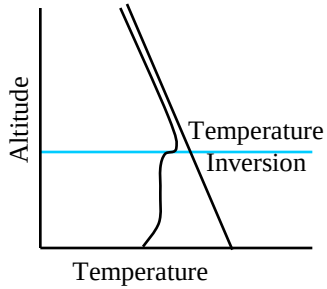
Typical wind profile with altitude



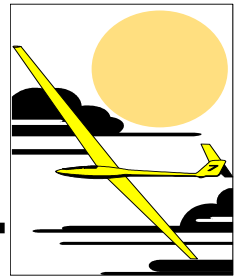
Wind profile low level inversion



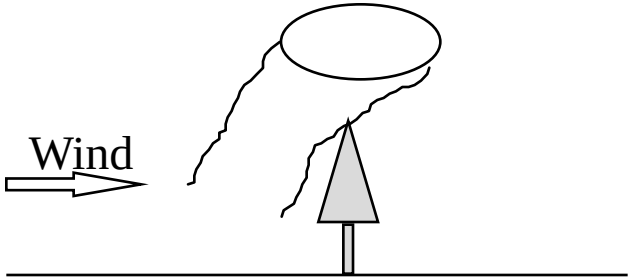
Temperature profile low level inversion



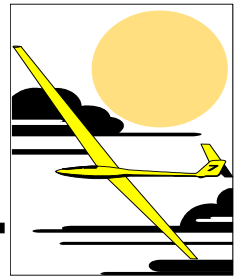
Thermal Sources



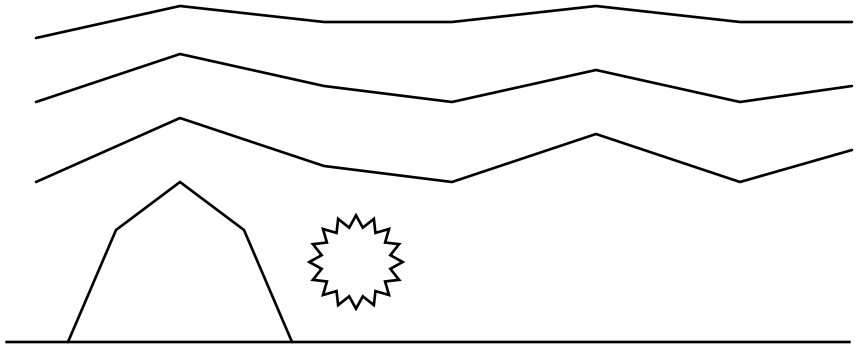
- Heating sources
  - Drier ground
  - Radiation sources
- Terrain influences
  - Tree lines
  - Hills



Non-Thermal Lift



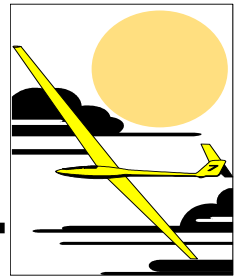
- Wave
  - Conditions necessary
  - When likely
- Shear line
- Hydraulic wave
- Dynamic soaring



Optimizing Your Aircraft Set-up

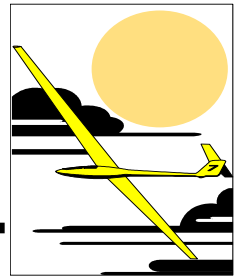
Joe Wurts

Topics of Discussion



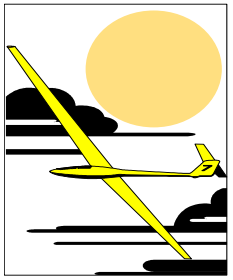
- Philosophy
- The Mechanical Aspects
- Mixing
- Flight Modes

Philosophy

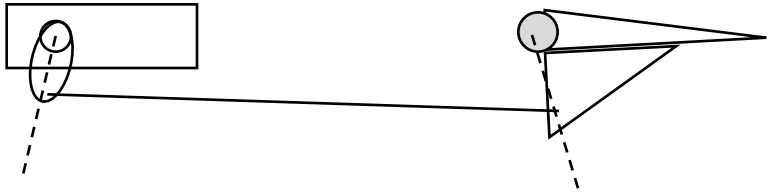


- Optimizing the aircraft efficiency and performance
  - Minimizing drag
  - Getting the most capability
- Eliminating the “cross-talk” in inputs
  - Goal is coordinated flight without difficulty
- Ease of Control
  - Ease of flying = more performance realized

The Mechanical Aspects

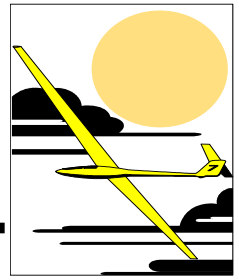


- Servo installation
  - Install servos to get straight pushrods
- Servo linkage and throws
  - Stiff and tight linkage without drag
- Wiring suggestions



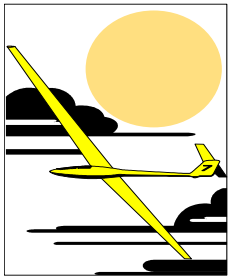
Note servo arm angle forward and control arm angle aft, produces progressive mechanical differential - good for ailerons

Mixing - Roll Axis



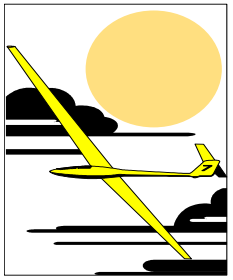
- Goal - Coordinated roll w/o separate rudder
- Aileron to Flap mixing
  - Increases roll efficiency (I use Flap = 40% Ail)
- Differential vs Rudder coupling
  - Best help in setup - slope on a light day
  - Slow speed vs high speed
  - Dependence on aircraft configuration
  - Typical 1.5:1 to 2.5:1 differential

Mixing - Pitch Axis

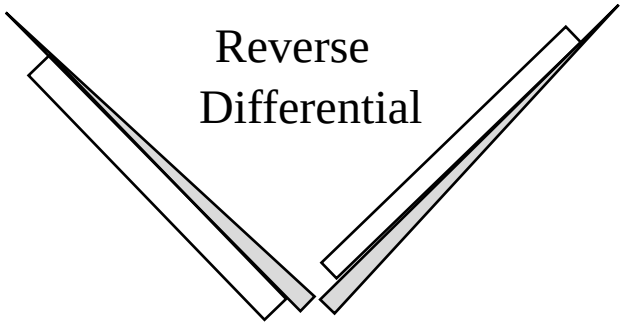


- Primary mix is Elevator to Camber
  - Camber should be even across the wing
  - If possible, use an inverse exponential mix
    - » More camber mix initially
  - A good start is full up mixes to 10° camber
    - » Highly dependent on airfoil usage
- Vee Tails
  - More down throw than up for a symmetric pitch response

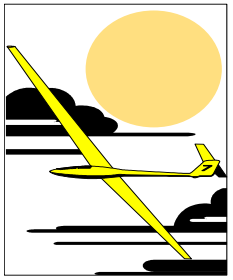
Mixing - Yaw Axis



- Vee Tails
  - Rudder mix typically needs “reverse differential”
    - » The more “vertical”, the more “reverse differential”
  - Less efficient than a cross-tail
- Mostly covered in “roll axis”

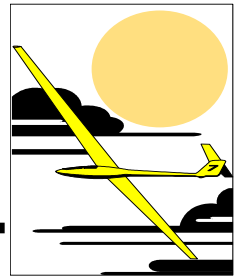


Flight Modes



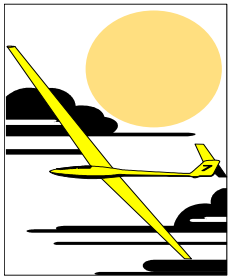
- I use four flight modes
  - Launch
  - Speed
  - Cruise
  - Thermal
- Each mode has a different, ail>rud mix, differential, camber and elevator preset, as well as control throw setting

Flight Modes - Launch



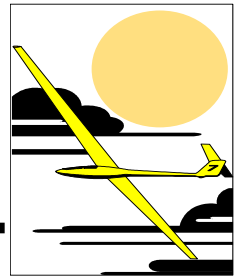
- Camber preset
  - 15° to 30° camber preset (full span)
  - Dependent on airfoil usage
- Elevator preset
  - Highly dependent on towhook position
  - Neutral to slight amount of up is best
- Aileron to Rudder mixing
  - More is better
- Up to 100% aileron differential

Flight Modes - Thermal



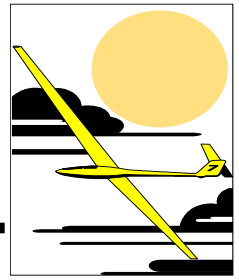
- Camber presets or adjustments
  - I use flight mode presets, with adjustable slide for fine tuning
- Camber to (Ail to Rud) gain adjustments
  - More camber should give more Ail to Rud gain
- Elevator to Camber mix
  - Keep this mix (many people do not)
- Aileron to Rudder mix
  - Go to a higher rate for slow speeds
- Reduced Aileron and Elevator throws

Flight Modes - Speed



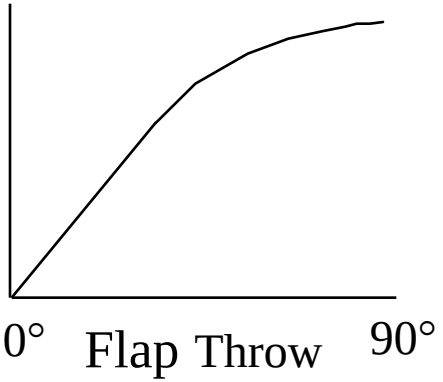
- Reflex Camber settings (fallacies)
- Elevator to Camber mix
  - Use a bit more (higher loads cause “blow-back”)
  - More if using reflex camber preset
- Aileron to Rudder mix
  - Minimize this
- Differential changes
  - Possibly a reduction is warranted

Flight Modes - Landing

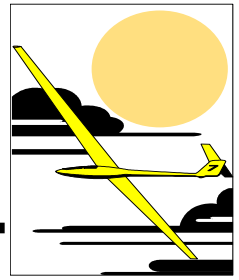


- Flap to Elevator mix
  - Highly non-linear after 45° flap
- Flap to Aileron (crow)
  - I use about 10° up aileron
- Aileron to Rudder mix
  - Add some to suit
- Differential adjustments
  - Typically a bit more is needed

Pitch up is caused by downwash on the elevator



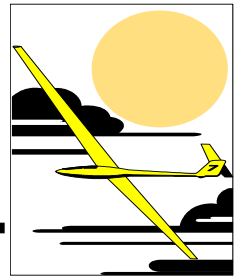
Goal of crow/ail>rud/diff is slightly proverse yaw response with a roll input



Launch Optimization

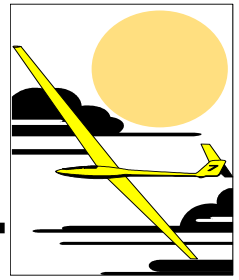
Joe Wurts

Topics of Discussion

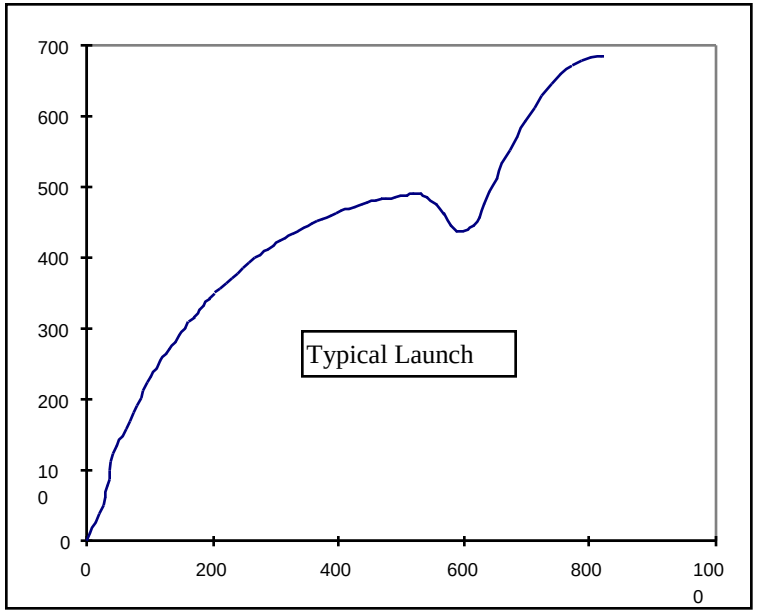


- Launch Modelling Program
- Aircraft Set-Up for Launch
- The Throw
- The Zoom
- Winch/Line Optimization
- System Losses
- Steering on Tow
- Crosswind Launching
- Circle (Weave) Towing

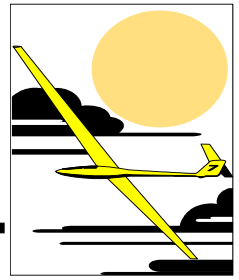
Launch Modelling Program



- Baseline Assumptions
  - Straight tows only (no weaving)
  - Power on 100%
  - Default data:
    - Weight 96 oz
    - Aspect Ratio 12.5
    - Wing Area 7.0 ft^2
    - Throwing Line Ten 50 lb.
    - Launch C_l 0.80
    - Wind Velocity 10 ft/sec
    - Zoom Point 75 deg up from turnaround
    - Winch Drum Dia 3.5 inches

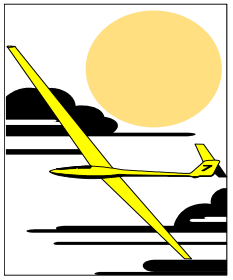


Aircraft Set-Up for Launch

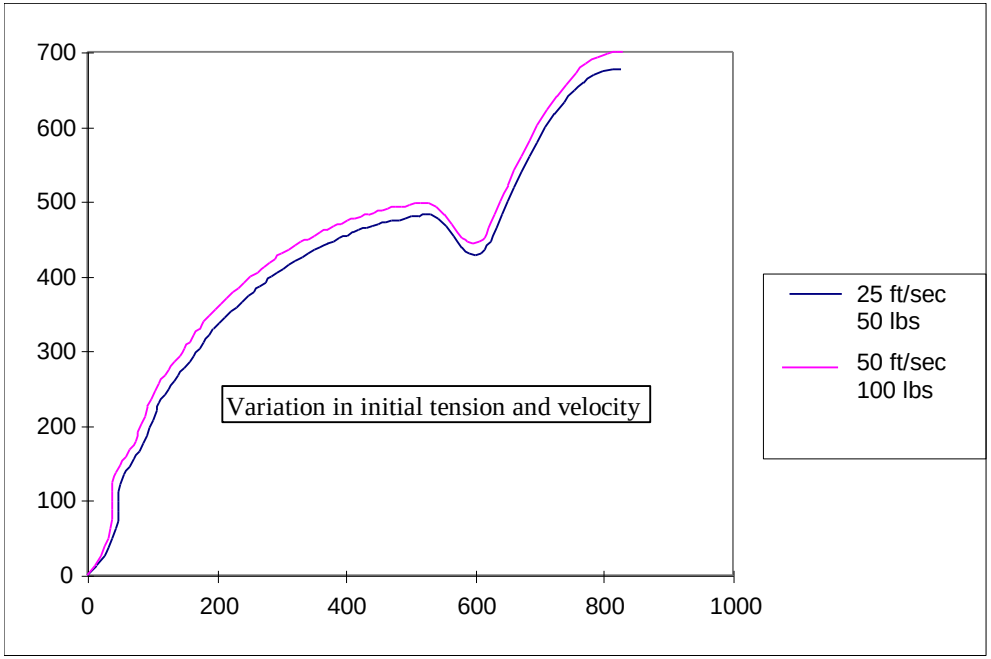


- Full-span launch camber typically 20 to 25°
- Elevator pre-set
  - Most fliers have too little up pre-set and/or towhook too far forward
- More Aileron to Rudder mix
- Tow hook position (very important)
  - Optimum needs just a little up pre-set

The Throw

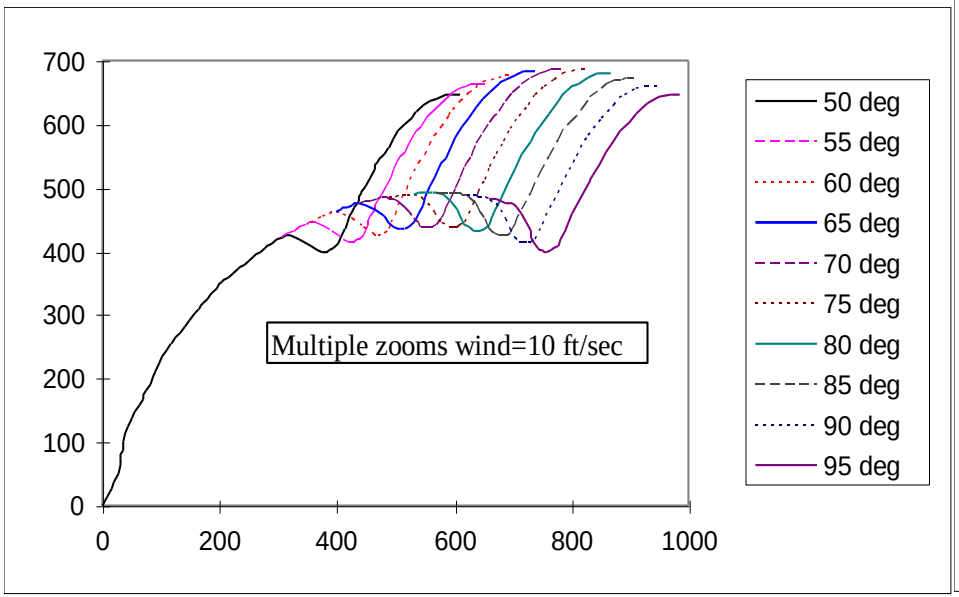


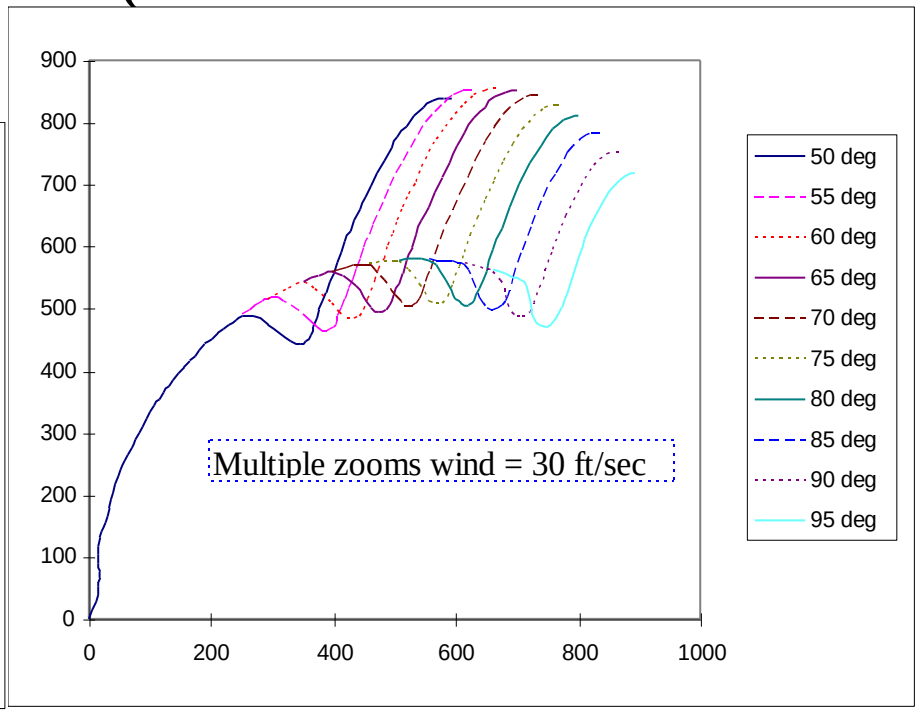
- In general, as hard as possible with as much tension as possible
  - Exception - circle towing
- Should be more vertical



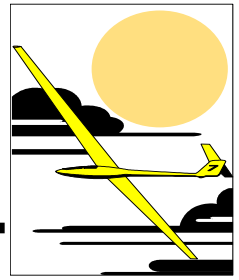
Effect of Zoom Position

- Zoom start point from 50° to 95°, measured from the turnaround
  - Zoom early in the wind (30 ft/sec wind optimum is 60°)



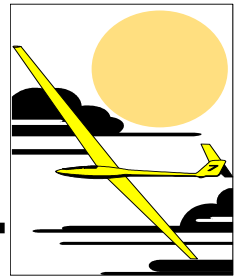


How Deep to Zoom

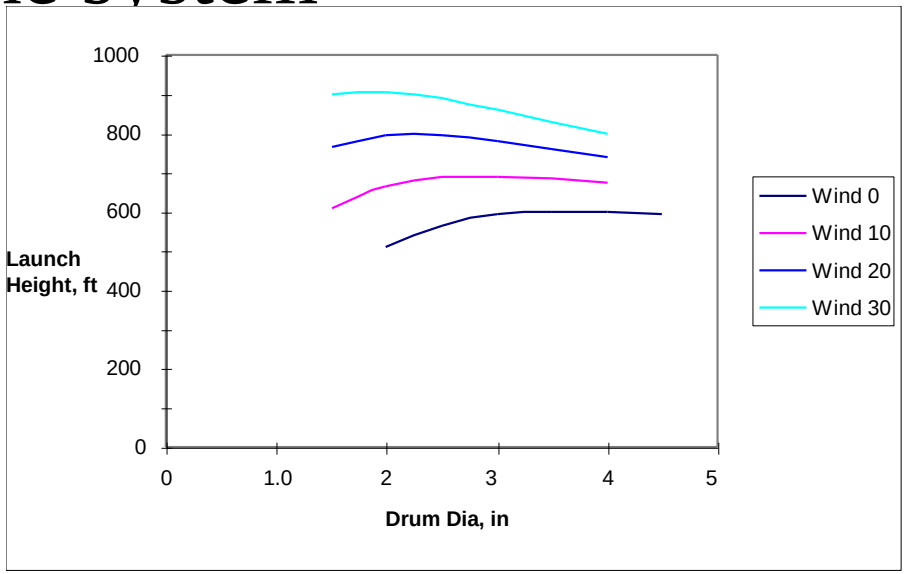


- It is better to be too shallow than too deep
  - The pullout is very expensive in energy
  - Deeper = faster (and draggier)
- Start your pullout with 10 to 20 lbs tension
  - Best with a slight “pop” of the chute
- Go to nearly vertical quickly (hard pull-out)
  - Fast transition from high drag to low drag

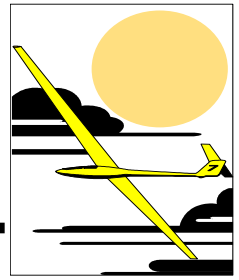
Winch Optimization



- Use the correct drum size for the conditions
- Use the "right" resistive material
  - Try Constantin
- Minimize losses in the system
  - Heavy duty selenoid
  - Large, short cabling

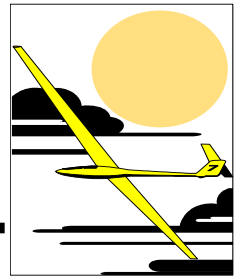


Line Optimization



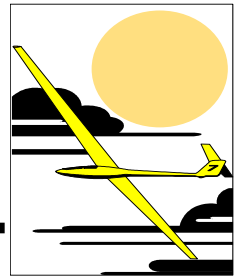
- Line size
  - Use the minimum size that wil not break
- Stretch characteristics
  - Optimum line for wind is different than no wind
  - Line that has some plasticity is good for "weaving" in the wind
- Rebound characteristics
  - Some lines do not spring back quickly

System Losses

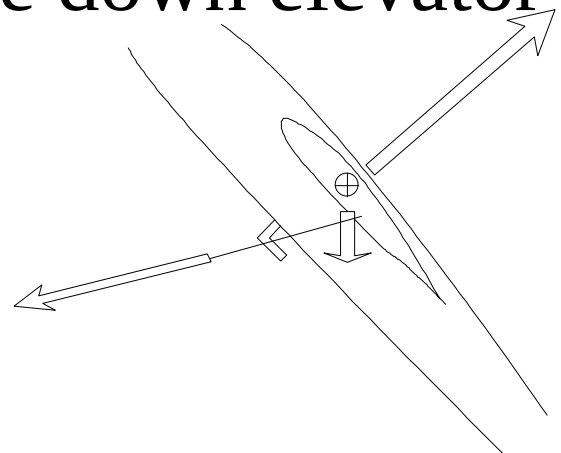


- The biggest is line drag in the air
  - Minimum line size for the conditions
  - Maximize C_l capability on tow
- Parachute drag is important
  - Minimize parachute and shroud size
  - Try “double-hooking”
- Aircraft set-up can have a factor (Trim C_l)

Steering on Tow

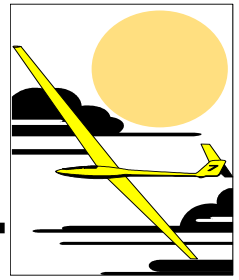


- Being on tow is similar to flying very slowly (high C_l)
- You should use a lot of rudder along with a little aileron
- When there is little tension, the plane might need some down elevator



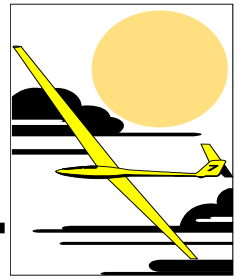
Note line tension is behind the CG

Crosswind Launching



- The optimum launch is from straight downwind of the turnaround
  - As soon as is practical after the throw, turn the aircraft to get downwind of the turnaround
  - Then turn back up the tow to finish the launch
- A side benefit is that you can better gauge your zoom dive/pullout

Circle (Weave) Towing



- The basic idea is to use the energy of the wind instead of the winch motor
  - Line that stays off of the drum helps your launch height
  - Tension is everything
- Use weaving to build tension and gain altitude