Introduction to Aerospace Engineering
A Freshman-level Course in Aircraft Performance and Design

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

AE 100: Introduction to Aerospace Engineering

- Objective: Introduce incoming freshman students to aspects of aerospace engineering giving them hands-on problem solving design and data collection experience
- Currently: two sections
  - Spacecraft and rocket design
  - Aircraft design

AE 100: Intro to Aerospace Engineering

- History of Aircraft Design
- Case Study of Vehicle Development
- Aircraft/Flight Theory and Design
- Engineering Ethics
- Hands-on Experiences (2 of 3)
  - Discovery Flights
    - Students fly in an aircraft
  - Radio Control Flying and Aircraft Performance
    - Students learn to fly R/C planes and take data from instrumented aircraft
  - R/C Aircraft Design Project
    - Students design a R/C hand launched glider or flying wing

R/C Flying and Aircraft Performance

- Student R/C Flying Experience (CCRCC-AMA)

  Description: Students have the opportunity to pilot a 4-channel R/C trainer with hobbyists from the local R/C flying club. Students learn about basic flight maneuvers and aircraft control.

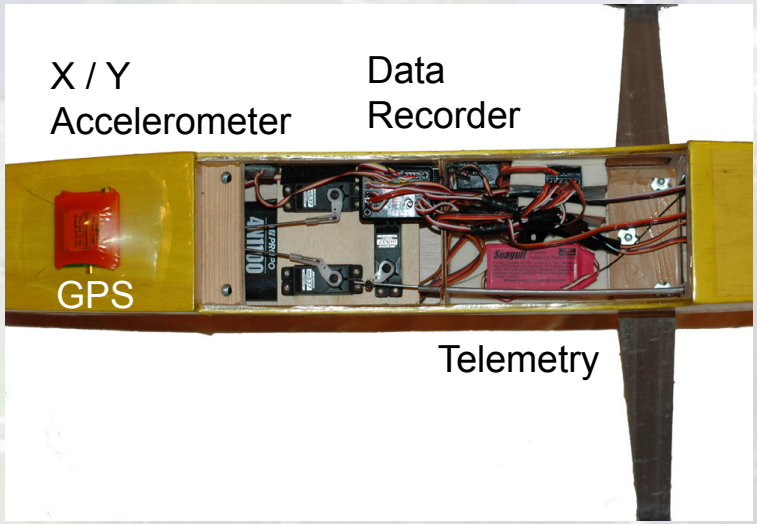
- Instrumented R/C Aircraft Performance

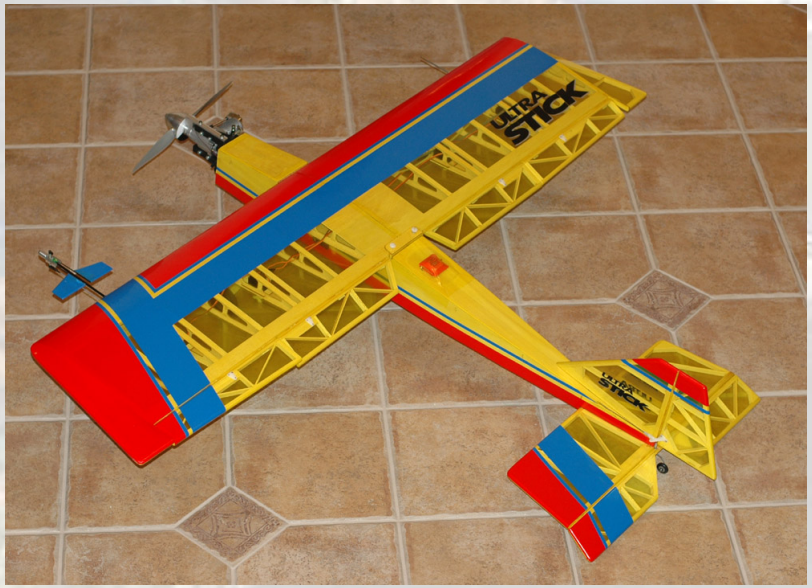
  Description: Students collected data from instrumented R/C aircraft with on-board imaging data recording and telemetry for class examples and home-work problems.

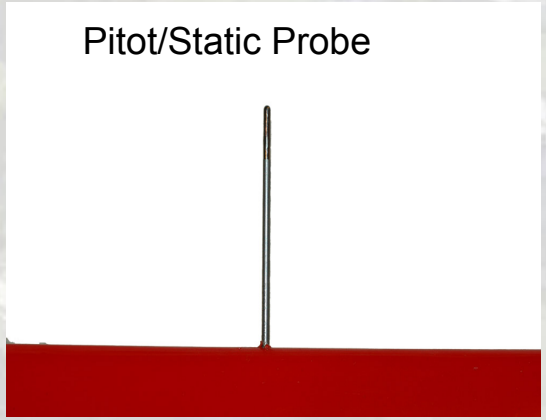
Instrumented R/C Aircraft Flight Testing

Eagle Tree Systems

- GPS
- Altimeter
- Pitot/Static Pressure
- x / y Accelerometer
- Optical RPM
- Engine Temperature
- Current / Voltage
- Telemetry
- Servo Positions
- Angle of Attack

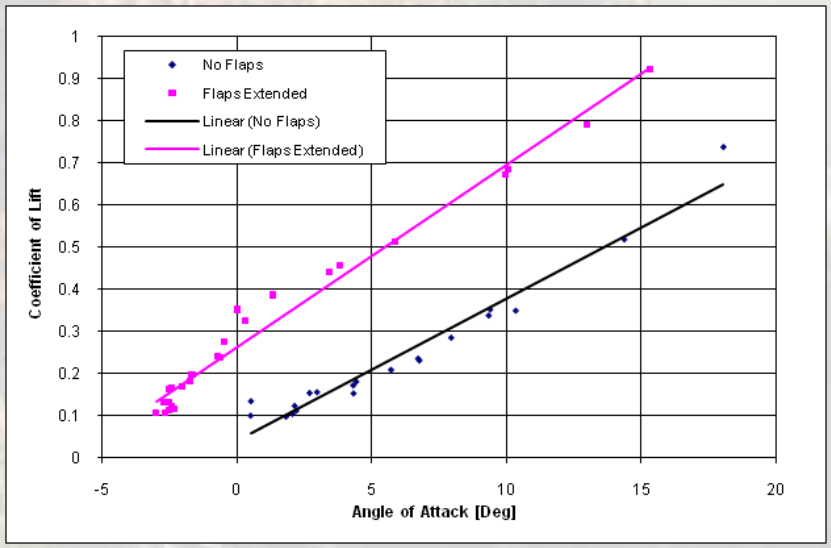




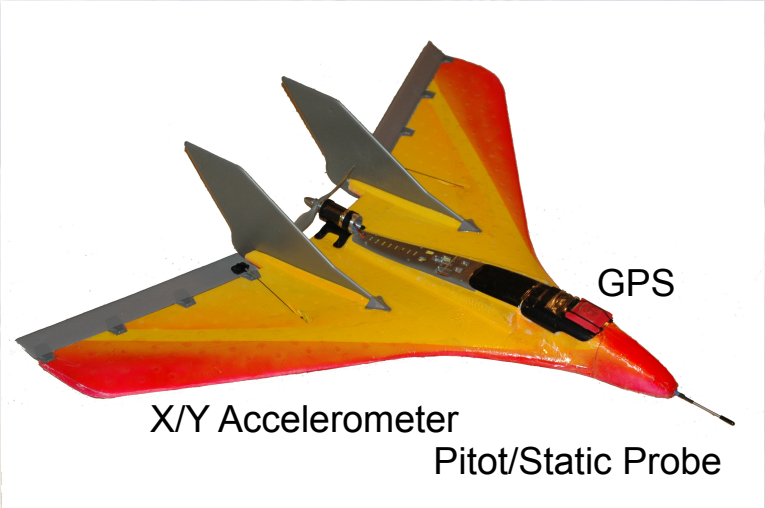


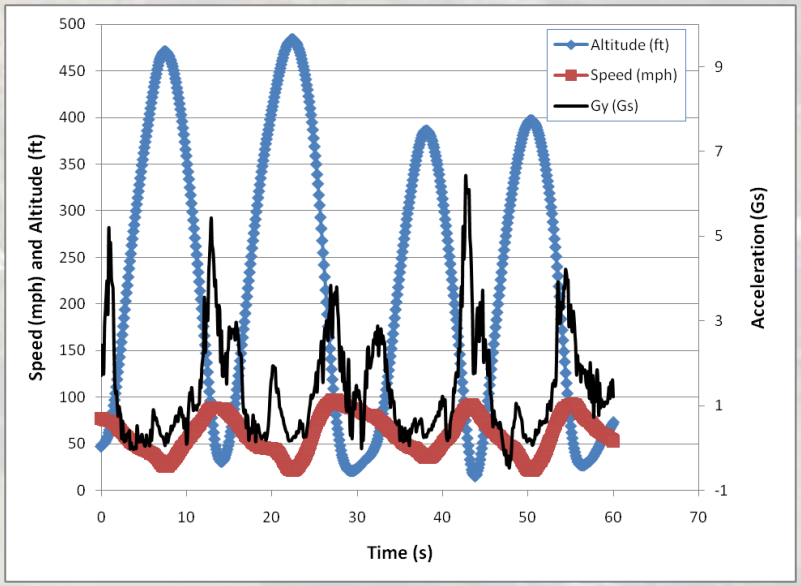
Instrumented R/C Aircraft Flight Testing

Flaps and lift



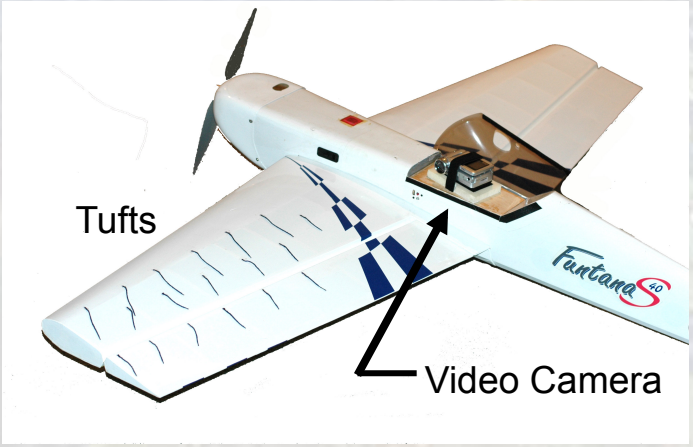
Airspeed, altitude, and acceleration

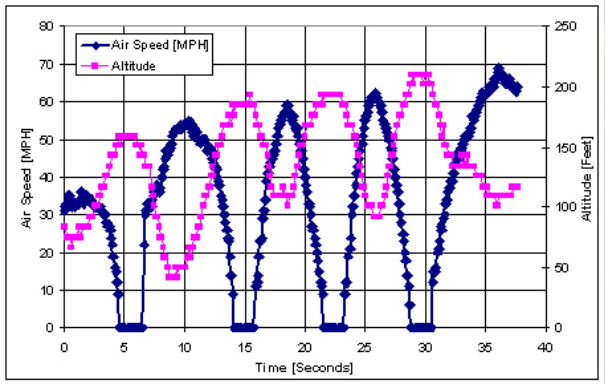


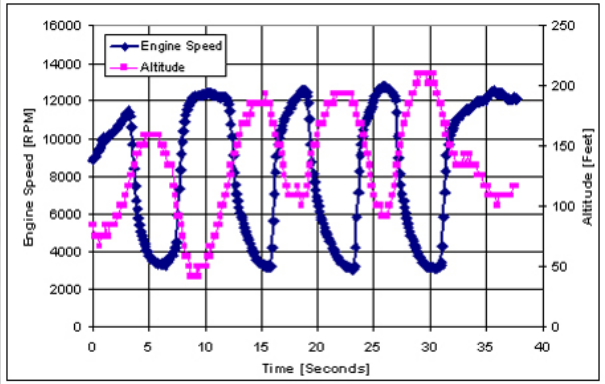


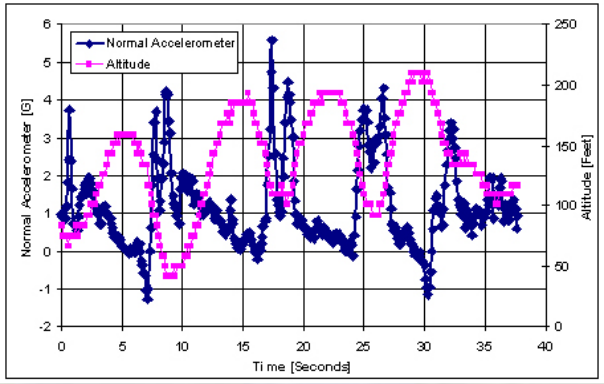
Instrumented R/C Aircraft Flight Testing

Stall and Flow Separation



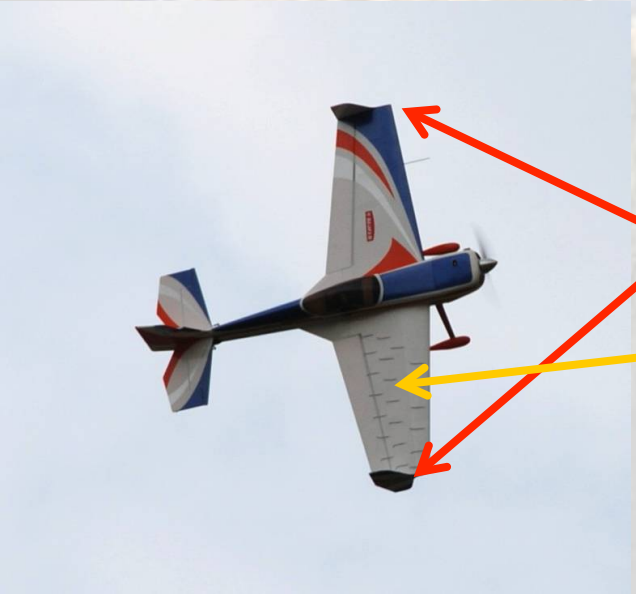






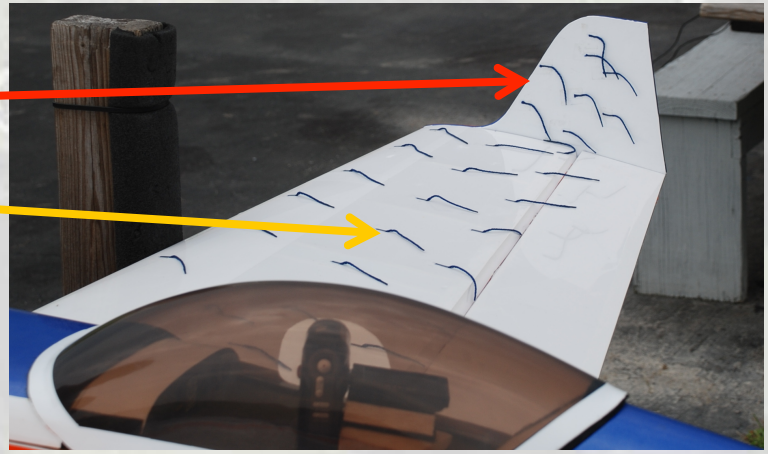
Instrumented R/C Aircraft Flight Testing

Flow Separation and Effectiveness of Wingtip Side-Force Generators (SFGs) During Knife-Edge Maneuvers



SFGs

Tufts



Instrumented R/C Aircraft Flight Testing

Flow Separation and Effectiveness of Wingtip Side-Force Generators (SFGs) During Knife-Edge Maneuvers

Ground and in-flight video of R/C aircraft with SFG
First with tufts on low-pressure side and then with tufts on high-pressure side of SFGs

Instrumented R/C Aircraft Flight Testing

Flow Separation and Effectiveness of Wingtip Side-Force Generators (SFGs) During Knife-Edge Maneuvers

Viewing low pressure side of SFG
- Tufts on wing indicate no separation
- Tufts indicate flow separation on SFG

Viewing high pressure side of SFG
- Tufts on wing indicate no separation
- Tufts indicate no separation on SFG

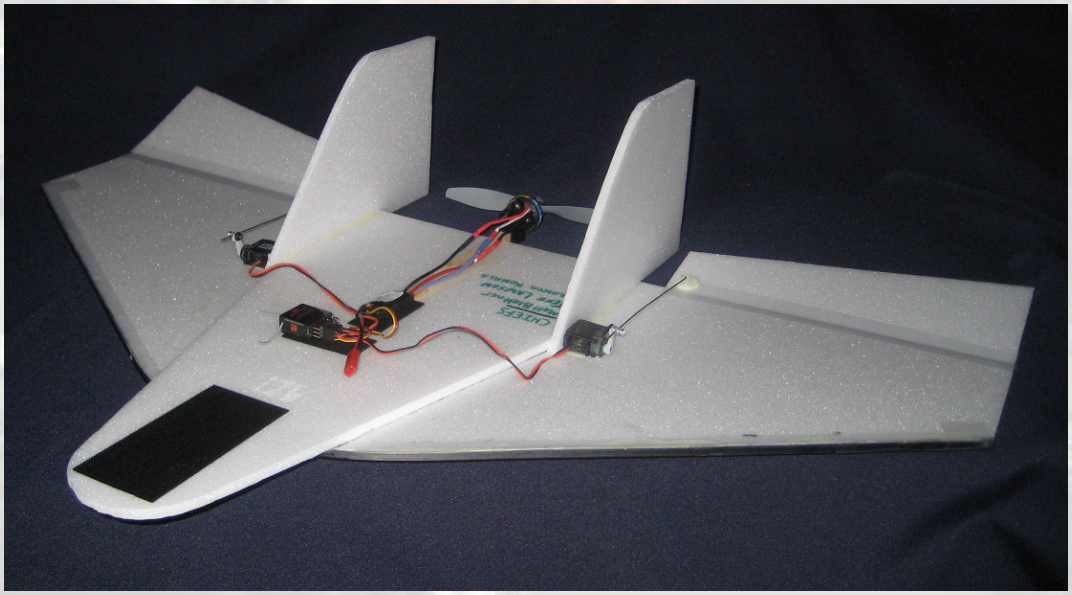
Flight Data of Aircraft in Knife-Edge with and without SFGs

	Airspeed [mph]	Rudder Deflection [Degrees]	Motor Speed [RPM]
No SFGs	59.8	25.7	8841
With SFGs	59.6	12.6	8789

* For approximately the same aircraft speed the rudder deflection angle (indicating to a first order the yaw angle) is less when using SFGs

R/C Design Project

Description: Students are given a foam wing, battery pack, and flexible servo package which they utilize to design and evaluate the performance of a hand-launched glider or powered flying wing.



Initial Measurements and Calculations (weight)

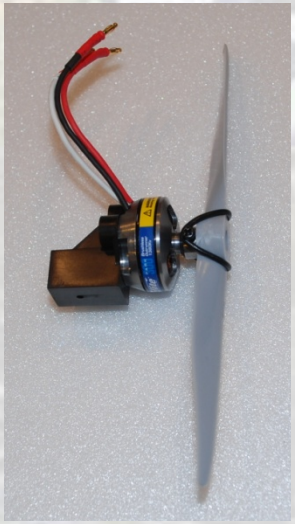
– Wing, Battery, and Servo Package

Flat swept wing

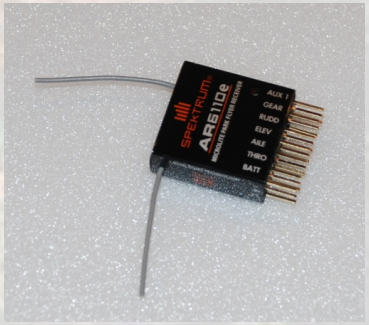
Relatively Low AR

Carbon fiber leading edge

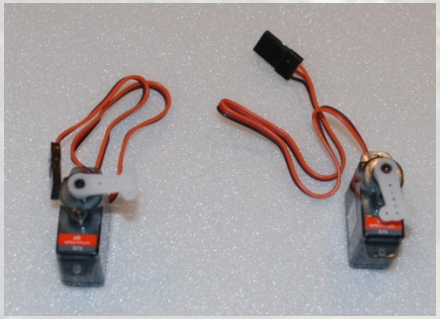
E-flite 300 motor, Propeller, and mount:



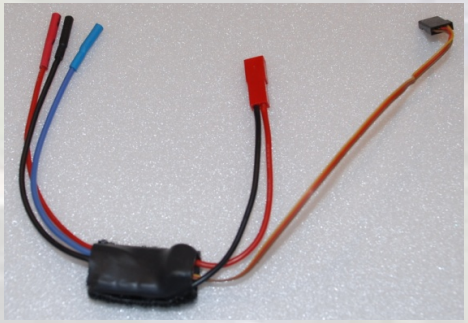
Spectrum AR6110e Receiver (Rx)



Servos Spectrum S75 (2)



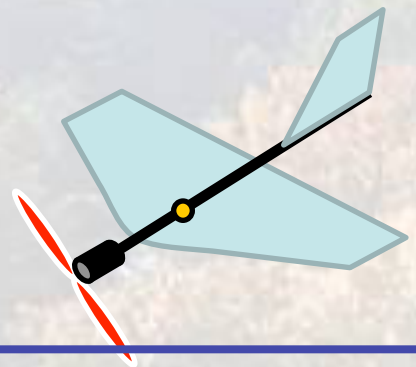
E-flite 10amp Electronic Speed Controller



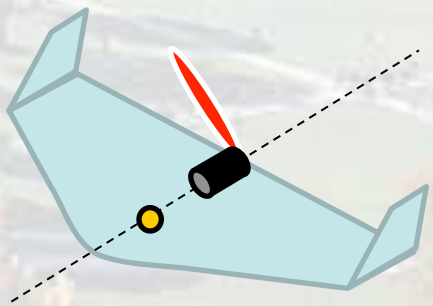
Conceptual Designs and Evaluation

Motor/Propeller Configuration

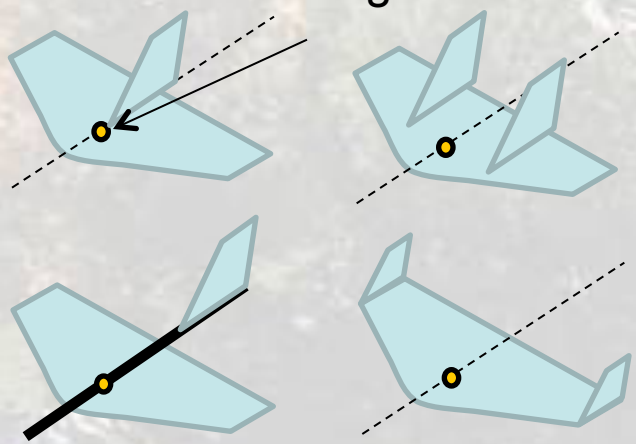
Front Prop



Pusher Prop



Vertical Stabilizer Configuration and Location



Elevon Shape

Rectangle

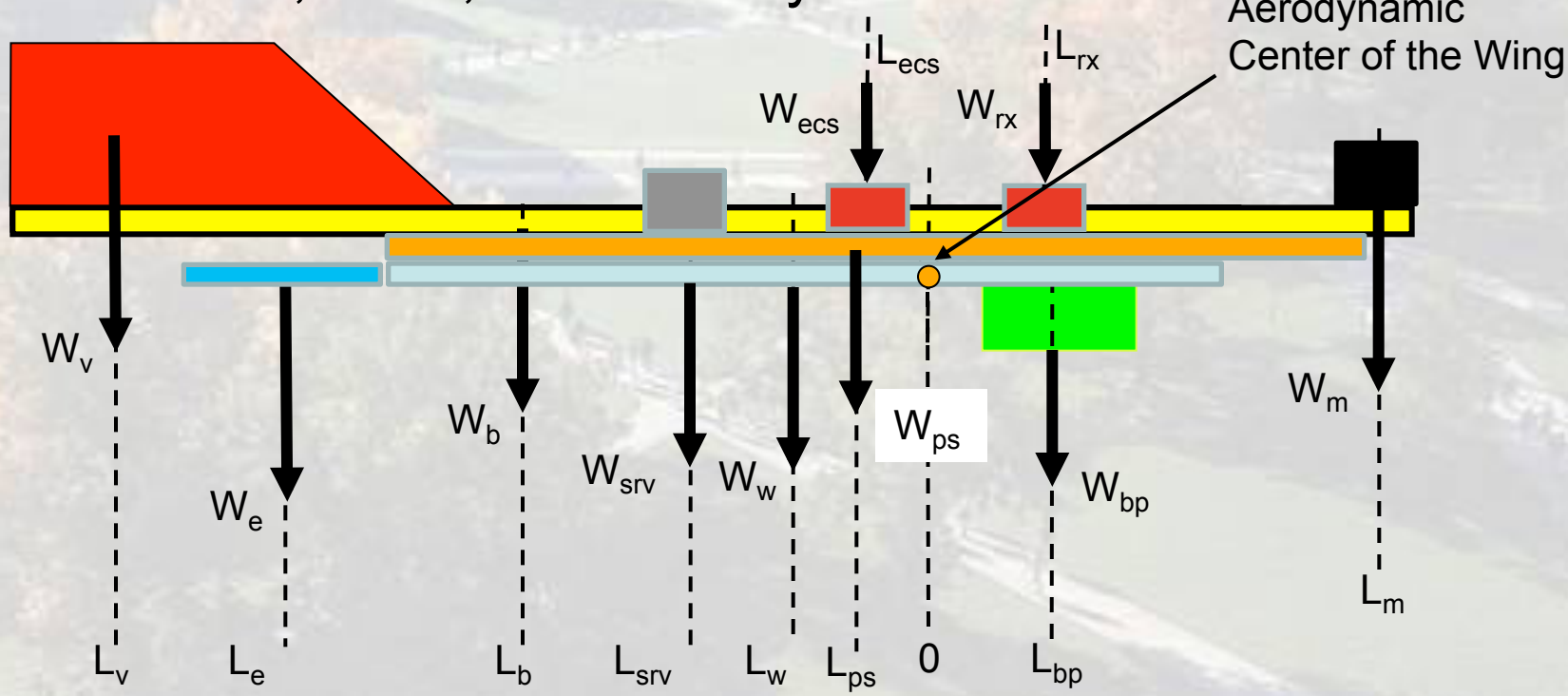
Arc /ellipse

Trapezoid

Other

Design Calculations

- Tail length
- Tail and control surface sizing (TVR)
- Moment, force, and stability calculations



- Component dimensions and lay-out

R/C Flying Wing Design Project

Thank you