PSU Zephyrus

HPA Sport

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Zephyrus (Greek Ζεφύρος) is the Classical Greek god of the west wind, a wind that originates in the west and blows east.

The most favorable of the four winds, Zephyrus is associated with the coming of spring.
Wing

- Dimensions
  - Span = 17.5m
  - Root chord = .73m
  - Tip chord = .52m
  - Thickness = 16% - 14%
  - Airfoil = FX 76 MP (modified)
- Span broken into 3 sections
  - 6m center section
  - 5.5m outboard sections
  - .25m winglets
Wing
Construction

- Carbon fiber tube spar
  - Woven ± 45°
  - Spar caps woven at 0°, 90°
- Foam ribs
  - Minimal use of carbon fiber rovings for support
- Very thin foam-fiberglass sandwich panel covering entire wing
- Wing covered in Mylar film
Empennage

- First iteration sizes based on scaling from parent aircraft (Musculair 2)
- Dimensions
  - Horizontal
    - Span = 2.89m
    - Chord = .71m - .42m (linear taper)
  - Vertical
    - Height = 1.7m
    - Width = 1m
Fuselage

- Fairing
  - Lightweight
  - Does not bear structural loads
  - To reduce drag
- Structure
  - Hold pilot
  - Load bearing
Dimensions

ALL DIMENSIONS IN METERS
DIMENSIONS BASED FROM 0.778 m PILOT (5’10’’)
Structure
Materials

- Fuselage cage from wired
  - Easily molded
  - Light
- Bottom of fuselage from fiberglass
- Remainder: Mylar and Lexan
Primary Hardpoint

- Minimal breaking of skin
- Aerodynamic and structural concerns
- Needs to be strong in tension
- Lift
- Torsional strength still a concern
Propeller

- Target RPM - 200-300
- Pedal RPM (fixed) - 90-120 (max)
- Gear Ratio (fixed) 1:2.5

- Propeller diameter:
  - Musculair 1 2.72m
  - Musculair 2 2.68m
- Determined largely by design of aircraft
Propeller

- What has been done:
  - Contacted Dr. Mark Drela of MIT for XRotor program
  - Research

- What will be done:
  - Numbers! —— XRotor
  - Scale model of propeller (Water tunnel?)
Propeller Construction

- Can certainly be done on-site
- Foam core
- Durable covering
  - Kevlar (Daedalus) or carbon fiber
Drive Train

- Elliptical gear at the feet
- Constant power output through stroke
- Unconventional chain to reduce weight
  - Reinforced perforated belt
- Carbon fiber drive-shaft to propeller
HPA Flight Simulator

Goals:

- Use as a training aid
- Understand aircraft performance based on necessary conditions
- Utilize and modify current set up

Current work:

- Choosing software
- Meeting with Dr. Horn and grad students
Flight Gear

Pros

› Easy to program (Fortran)
› Students with experience available for help (Dr. Horn)
› Open source, source code available

Cons

› No wind or ground on Dr. Horn’s simulator
Microsoft Flight Simulator

- **Pros**
  - Already contains wind parameters
  - Inputs (throttle) can be modified

- **Cons**
  - Modeling software difficult to use
Pros

- Easy to use modeling software
- Very accurate flight characteristics

Cons

- Not open source
- Different approach to modeling

X-Plane
Future Work

- Continue with X-Plane and Flight Simulator
- Working model by start of spring semester
- Start work on hardware (bicycle throttle)
Challenges:

- Pilot Power Output
  - Needs to power aircraft
- Pilot Core Stability
  - Needs to control aircraft
- Aerobic vs. Anaerobic Training
  - Sprint and Endurance
Pilot Training

- Three main aspects:
  - Power Training
  - Stability Training
  - Strength Training
Interval Training

- One set on, One set off:
  - Trainee does a set at peak power, then does an equal length set at low power. Repeat.

- Rotate fixed and non-fixed cycling work.
  - Inside work on stationary bike, outside work with modified recumbent bike.
Improves sprinting and endurance performance

Work way up and down the pyramid
Stability Training

- Improve the pilot’s core strength.
- Important to be able to remain fairly still in flight to be able to effectively control the aircraft.
Strength Training

- Promotes all around fitness and health
- Makes it easier to increase strength and power output in specific areas
Trailer

- U.S. and U.K. roadworthy
- Needs to be easily accessible
What We Are going to Do

- Open vs. Box Trailer
- Buy vs. Build
- Dimensions: 8m x 2.35m x 2.8m (internal)
Future Considerations / Work

- Resize as the aircraft dimensions change
- Unloading optimization
  - Time, accessibility, part safety, etc.
- Shipping logistics
- Manufacturing of final design
- Storage
Future

- Finalize design
- Website
- Cost build-up
  - Materials
- Construction location
  - Will it work?
- Sponsorship
  - Rules?
Far Future

- Scoping out flight site (UK)
- Test site
- Pilot(s)