IPRO Team 317

The VTOL Flying Car

Making it Work!

Team Objective

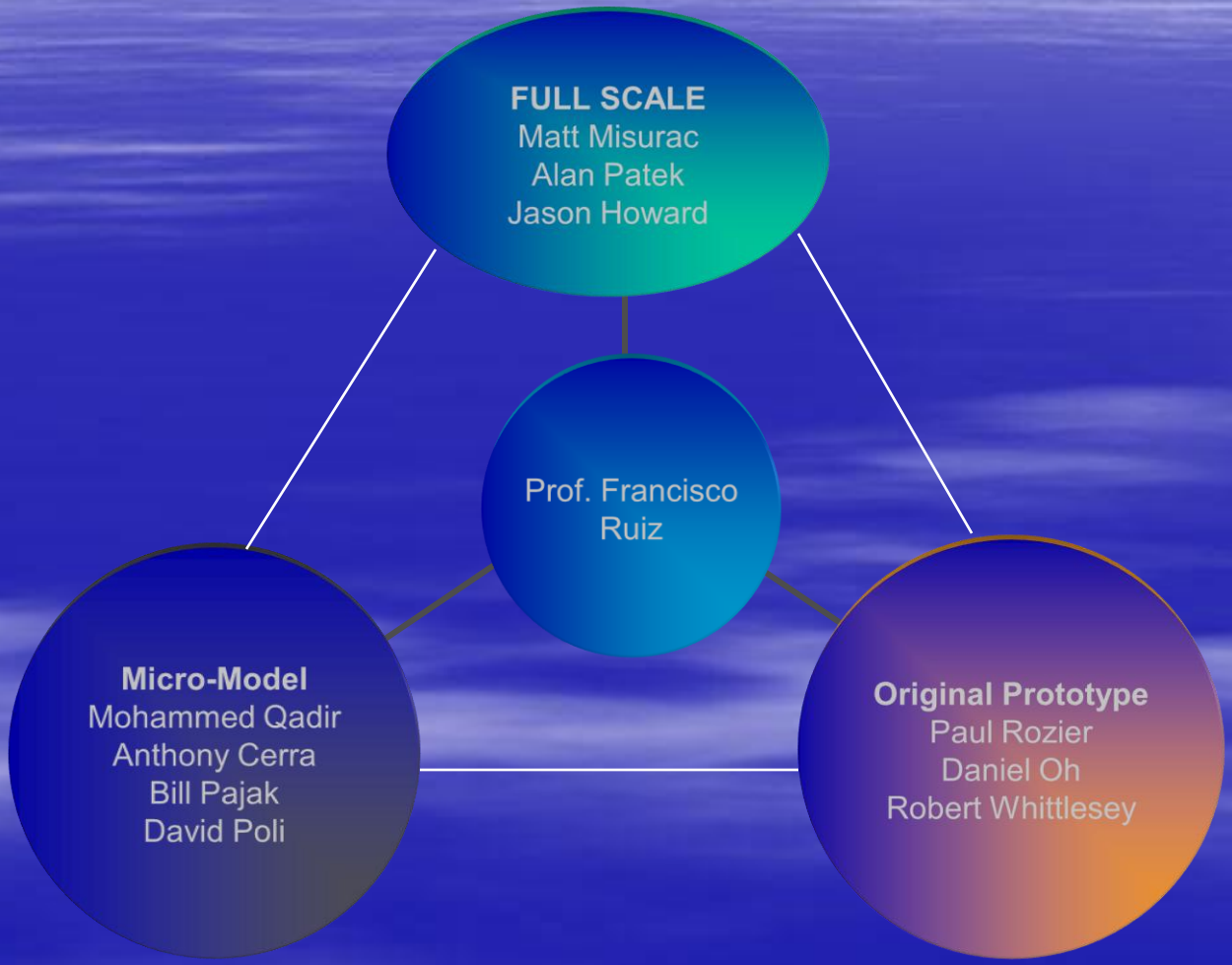
- Research, design, and build a marketable and affordable personal Vertical Take-Off and Landing (VTOL) vehicle for the masses
- Three Stages:

  - Small, electrical micro-model to demonstrate the feasibility of the design

  - Larger scale gas mini-model to give a better picture of operation

  - Full scale, market-ready model.

Team Rosters

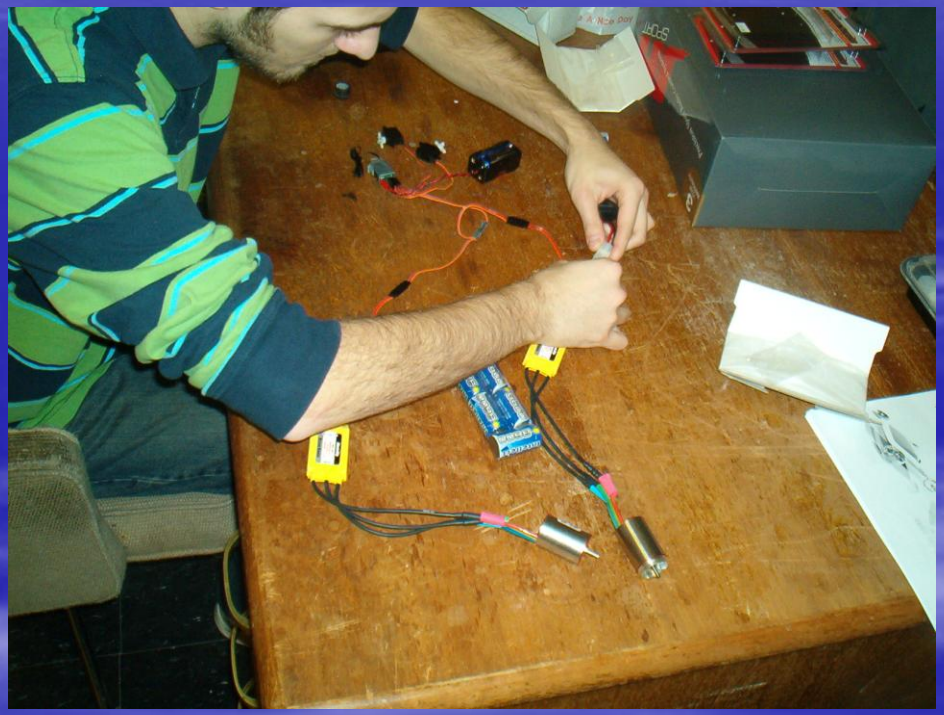


Team Experience

- Anthony Cerra – ECE
- Jason Howard – ECE
- Matt Misurac – ECE
- Daniel Oh – MMAE
- Bill Pajak - Aerospace
- Alan Patek – Aerospace, CS
- David Poli – ECE, Physics
- Mohammed Qadir – MMAE
- Paul Rozier - Aerospace
- Robert Whittlesey - MMAE

Micro-Model

- 3 subprojects: Design, Securing of Parts, and Assembly.
- Responsibility of every member
- Some members specialized in certain areas, such as electrical components.



Design Obstacles

- Basic design of the micro-model was laid out in the previous semester, but many specifics needed to be addressed
- two options for rotor angle:

  - beveled gears
    - rare
    - could not be manufactured on campus
  - jointed shafts
- Early designs incorporated two motors

  - A chance the motors would spin the rotors at slightly different rpms causing a conflict in the gears and jamming or destroying the machine.

More Obstacles

- Attaching the motors directly to the shaft
  - Would this create enough torque required for the machine to lift off?
- Parts:
  - where to obtain the parts on this scale
  - in what quantities
  - how to assemble them.

Possible solution: simply buy a model helicopter kit and modify it
  - deemed expensive and wasteful.

Solutions!

- Decision was made on jointed or flexible shaft rather than beveled gears

  - Based on input from Prof. Ruiz, and also from Original Prototype team, who had experience with beveled gears
- Rubber couplings from RoCom

  - Tried to obtain two, but unfortunately manufacturing time and shipping issues got in the way

  - decided to use simple u joints instead.
- Y-adapter and two speed controls allows for the use of 2 motors at once

  - This set up works perfectly at running two motors at the same time, in opposite directions as required

And More Solutions

- Very reluctant to assume that attaching the gears directly to the motors would allow for enough torque
- Team drew from their similar academic backgrounds and some clever physics to mathematically prove it would work
- Decided not to go with a complete model
- Team began picking through individual parts to discern what exactly was needed
- Assembled a parts list
- The whole team carefully picked over it to ensure everything was necessary
- Set about obtaining everything

  - Online (towerhobby.com, hobby-lobby.com)
  - Local Stores
  - Machine shop

The Future

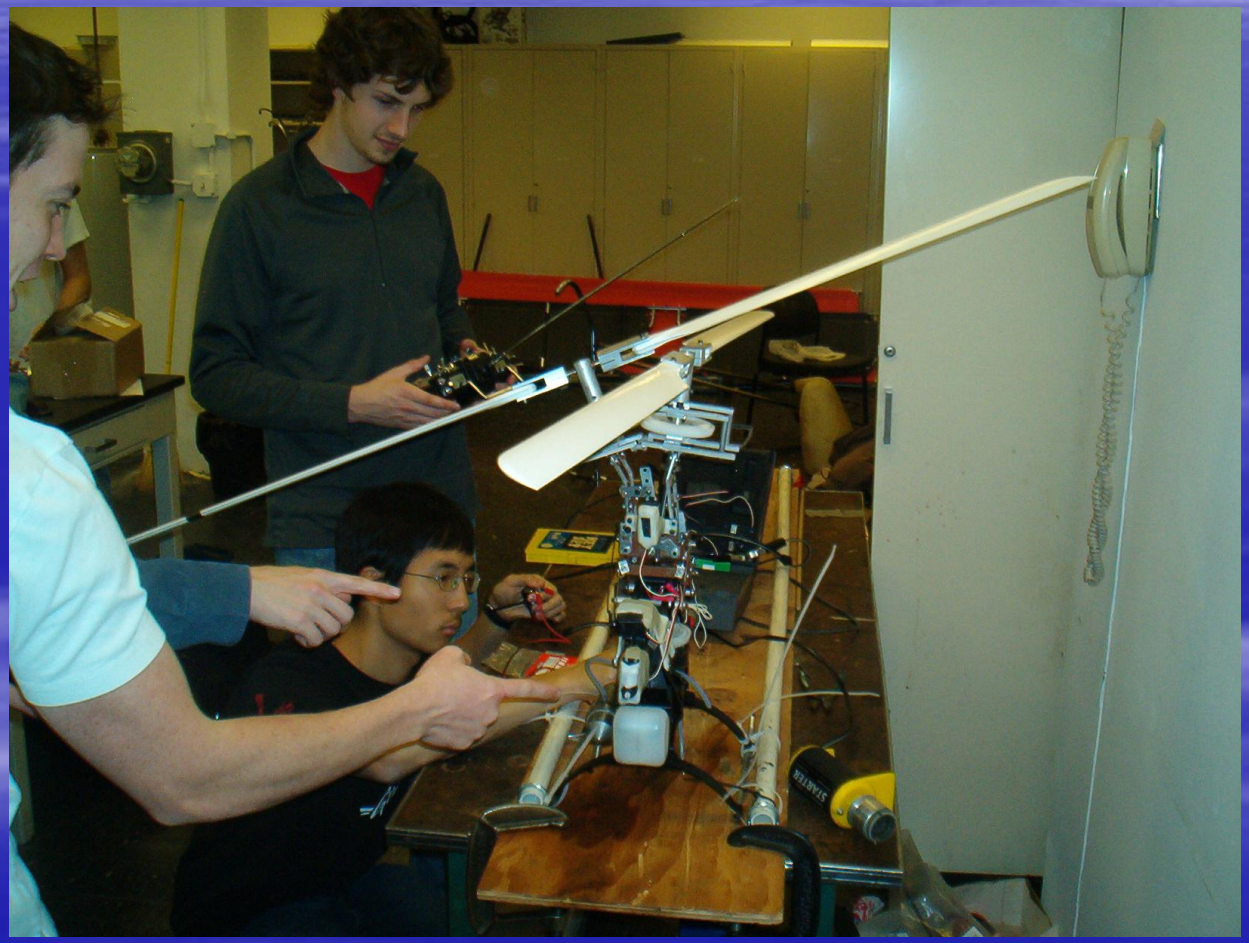
Model not completed

- Unexpected length of design phase
- Difficulty in obtaining necessary parts

Future IPRO teams:

- All necessary plans and parts ready
- Goals: complete assembly and flight

Original Prototype

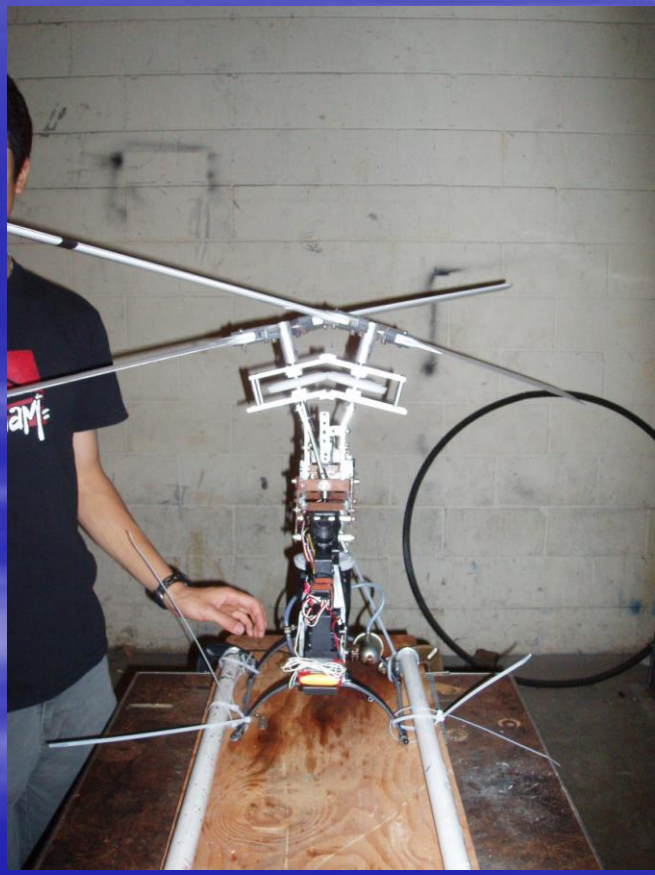


In the Beginning…

- Team Members' Experience
  - Team members lacked knowledge of RC Vehicles
- Engine Performance
  - Engine in very poor state
  - Would start but barely run
  - Gasket frequently blew out
- Overall Construction
  - Blades cause vibrations that loosen bolts
  - Beveled gears historically problematic

Solutions!

- Team Members' Experience
  - Brought in outside help
- Engine Performance
  - Researched new gasket material
  - Took apart engine
    - Cleaned and retuned everything
  - Weekly tethered flight tests
- Overall Construction
  - Thread lock proved temporary fix
  - Drafted beveled gear in cad
    - Machine shop couldn't manufacture



Flight Tests

- Original Goal: Un-tethered Flight
  - Delayed due to initial engine performance
- Tethered Flight Achieved
  - Engine perfectly tuned
  - Prototype lifted off
    - Last two gears destroyed due to off-design stress
- Aluminum Gear May Be Possible
  - Rapid prototyping machine soon operational

Conceptual Full-Scale

Prototype: Initial Research

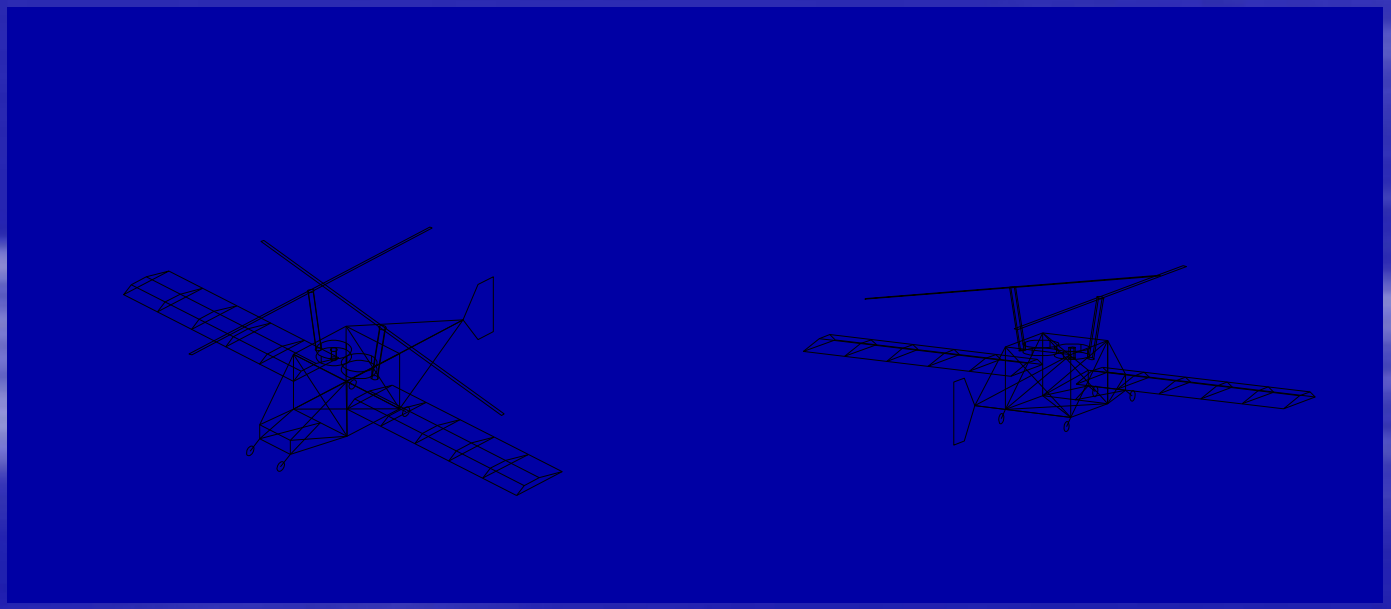
- X-Plane Models
  - Collaborated with continuing team members to learn software capabilities
  - Analyzed desired performance parameters
  - Worked in partnership with model design teams to incorporate developments

Prototype: Design Goals

- Aerodynamic Considerations
  - Utilized design resources left by previous teams
  - Researched existing “home-built” designs
- Legal Considerations
  - FAA requirements
    - Ultra-light vs. Experimental

Prototype: Preliminary Design

- Design models an Ultra-light
  - Simple construction
  - Incorporates working model designs



Prototype: Materials Selection

- Motor
  - Minimum 140hp : High RPM Low Torque
  - Primary Choice: Mazda RX-7
- Frame
  - Chromoly tubing
  - Light weight with sufficient strength
- Rotors
  - More research needed

Prototype: Conclusion

- Future Tasks
  - Perform detailed structural analysis
  - Incorporate design improvements made by model teams
  - Gather parts and begin construction

The Future of VTOL

- Achievements this semester:
- Micro-model brought to near-assembled stage
- Prototype made capable of tethered flight
- basic design of full-scale commercial completed.
- Future necessities:
- Micro-model assembly and flight
- Un-tethered flight of larger prototype
- Receive grants for full scale construction.