AVIONICS RESEARCH FOR LONG RANGE AND VERY HIGH ALTITUDE sUAS

PRESENTATION FOR SCCUR

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John Bodylski:
From Santa Ana, CA
30 years old

Attended UC Santa Cruz
• BA in US History

Attending Irvine Valley College
Planning to apply to a 4 year University
• Mechanical Engineering Degree
  • Focus on mechatronics

Private Pilot
• Instrument Flight Rules Rating
• High Performance Endorsement
• Complex Endorsement

• Amateur radio operator since 2000
• Eagle Scout
• Have worked on PRANDTL-M since summer 2015
WHAT WE WILL DISCUSS

• What is PRANDTL-M
• What engineering problems we have to overcome
• How to communicate with small aircraft over long distances
• Designing the Electronics
• How we plan to test
• Spin off projects
FLIGHT IN THE MARTIAN ATMOSPHERE

• Atmosphere is very thin
• Aircraft missions unattractive due to high cost and short duration of science
• Aircraft complexity decreases chances of successful mission
PRANDTL-M

• Preliminary Research Aerodynamic Design to Land on Mars (PRANDTL-M or PM)
• The first application of the PRANDTL-D technology using a flying wing design in which the spanloading of the wing is altered to reduce drag and aircraft complexity
• Glide through the Mars atmosphere to collect scientific data and high resolution images of the landscape
• Expected flight time of ~4 minutes
• Covering a range of dozens of miles
• Very compact (24” wide)
• Ejected with ballast of larger mission entering atmosphere
TESTING REGIME

• Atmospheric Density on Earth at 100,000 feet MSL is comparable to surface atmosphere of Mars
• Atmospheric Pressure at 125,000 feet MSL is comparable to surface of Mars
• Use of large weather balloons to ferry aircraft to altitude for testing aerodynamics
• Use of Sounding Rockets for testing of aircraft entry
COMMUNICATIONS GOALS

• Support aircraft telemetry
  • Enough data to determine aerodynamic problems is aircraft is unrecoverable

• Slant Distance >55 miles

• Small enough to fit battery, radio, and antenna onboard aircraft

• Ground Station needs to be portable for practical testing operations
After initial testing of the aircraft, we suspected that we may have inertial coupling of PM aircraft.

Heavier configurations of PM were found to have large ranges of yaw instabilities due to MOI.
GOALS/OBJECTIVES

• Create and test an avionics package that can properly function for our flight testing regimes of altitudes up to 125k ft. and temperatures as low as -85° F

• Support new and innovate navigation techniques for use in gps and/or magnetometer denied environments

• Be able to support and test aircraft awareness technologies
  • ADS-B
**LPKF PROTOMAT S103**

- Precise circuit board plotter designed for rapid production of prototypes.
- Alternative to Acid Etching by Hand or sending design of board to a manufacturer.
Weather Hazard Alert and Awareness Technology Radiosonde (WHAAATRR) Glider

**GOAL:** Reduce weather/space weather impacts to space flights and aviation

**MOTIVATION:**
- We must learn more about radiation to achieve safe Mars & deep space missions
  - Earth’s atmosphere & magnetic field reduce radiation impacts to terrestrial life
  - Astronauts and flight crews are exposed to harmful solar and cosmic radiation
- In the US alone each year weather costs...
  - $Billions in economic losses due to delays
  - $Millions in aircraft losses
  - Hundreds of lives lost

**APPROACH:**
- CIF funds used to piggyback WHAAATRR on existing Prandtl Glider. NIKS funds allow custom built Prandtl optimized for our span and payload requirements

**INNOVATION:**
- Detection of radiation/weather hazards using in situ airborne observations
- Targeting radiosondes to hazardous weather and radiation hot spots
- Capability to RTB and are reusable
- Improvements to weather/space weather forecast models

**MATERIALS:**
- PRANDTL-M glider mold/materials $5225
- Pihawk auto pilots (2) $ 400
- 900mHz ultrard transmitters (2) $1400
- Mks servos (4) $ 400
- Powerboard (2) $ 600
- Airspeed (2) $ 75
- GPS (2) $ 180
- ADS-B (2) $ 260
- Sentera video $1250
- Batteries (3) $ 210

**APPLICATIONS:**
- Preliminary work for Mars glider in both terrestrial and Martian atmospheres
- Savings of 15 million replacing throw away radiosondes at NASA, DOD, NOAA/NWS
- Airborne Sciences research platform

**AFRC:** Luke Bard, Scott Wiley, Albion Bowers, Dave Berger, Robert Jensen
**WFF:** Geoff Bland, GSFC: Antti Pulkkinen

Requesting: $10,000
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IMAGE SOURCES

- Kevin Lin
- NASA Langley Research Center
- NASA Armstrong Flight Research Center
  - Lauren Hughes
  - Miranda Pickett
- Perkins, “Airplane Performance, Stability and Control” 1949, Wiley
QUESTIONS?