AVIONICS RESEARCH FOR LONG RANGE AND VERY HIGH ALTITUDE sUAS

PRESENTATION FOR SCCUR

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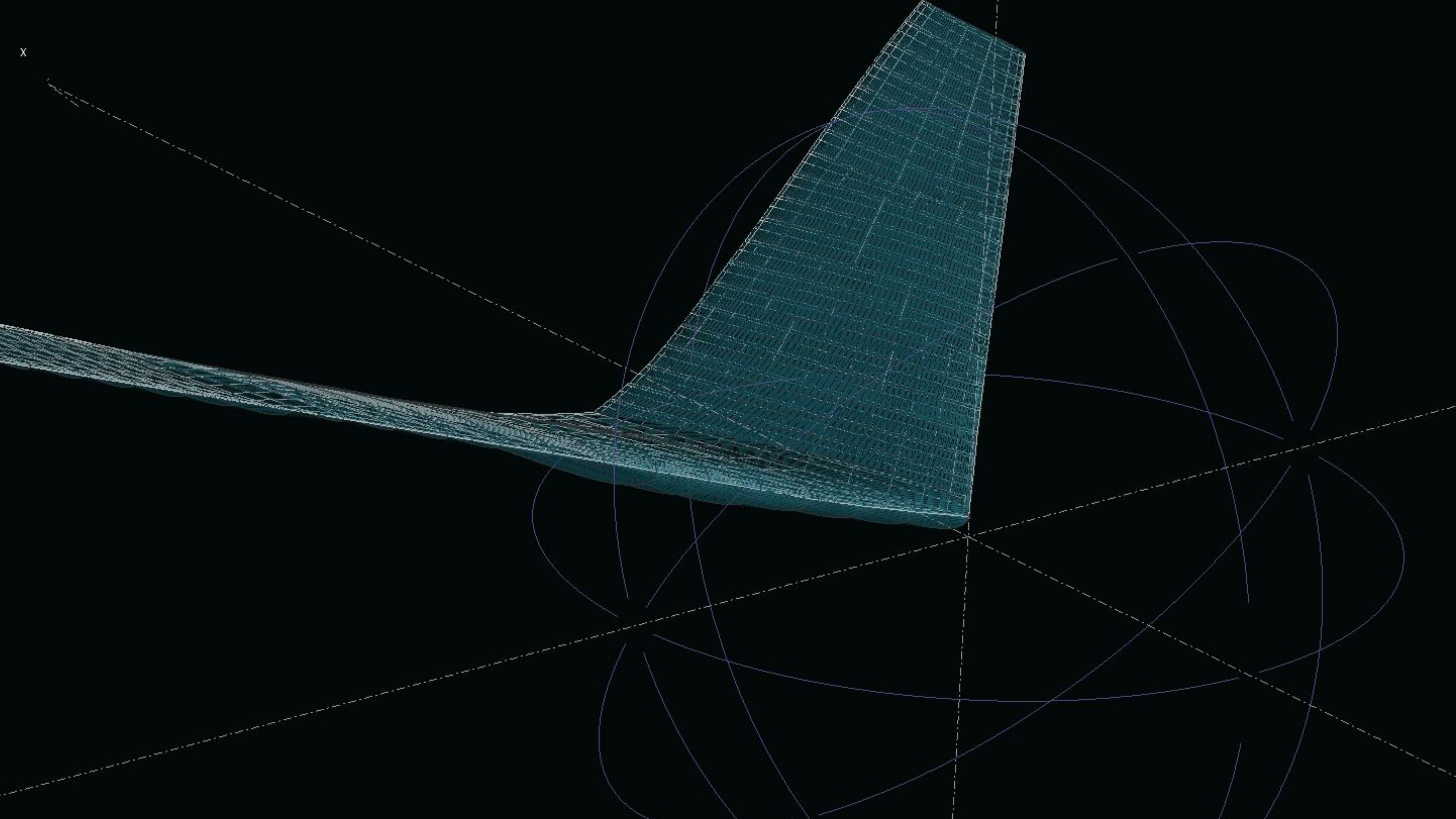
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John Bodylski:

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

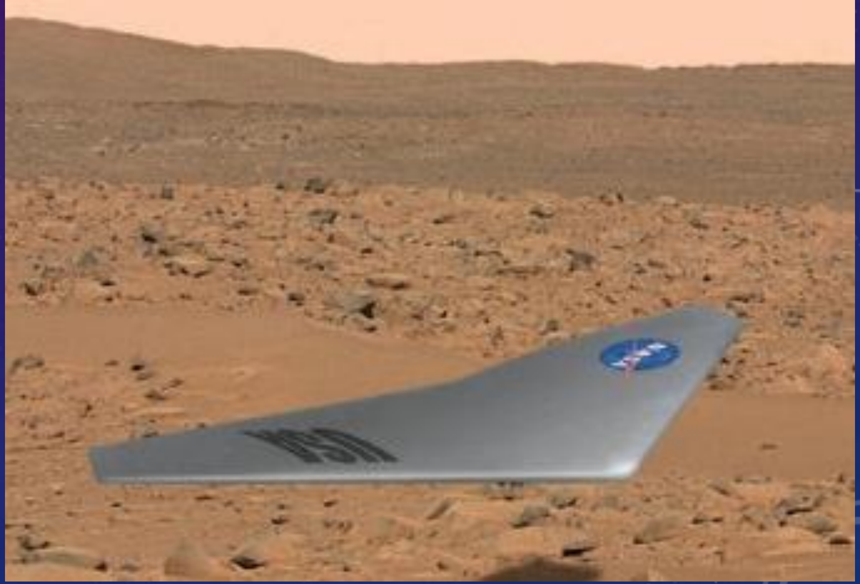
- What is PRANDTL-M
- What engineering problems we have to overcome
- How to communicate with small aircraft over long distances
- Designing the Electronics
- How we plan to test
- Spin off projects

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

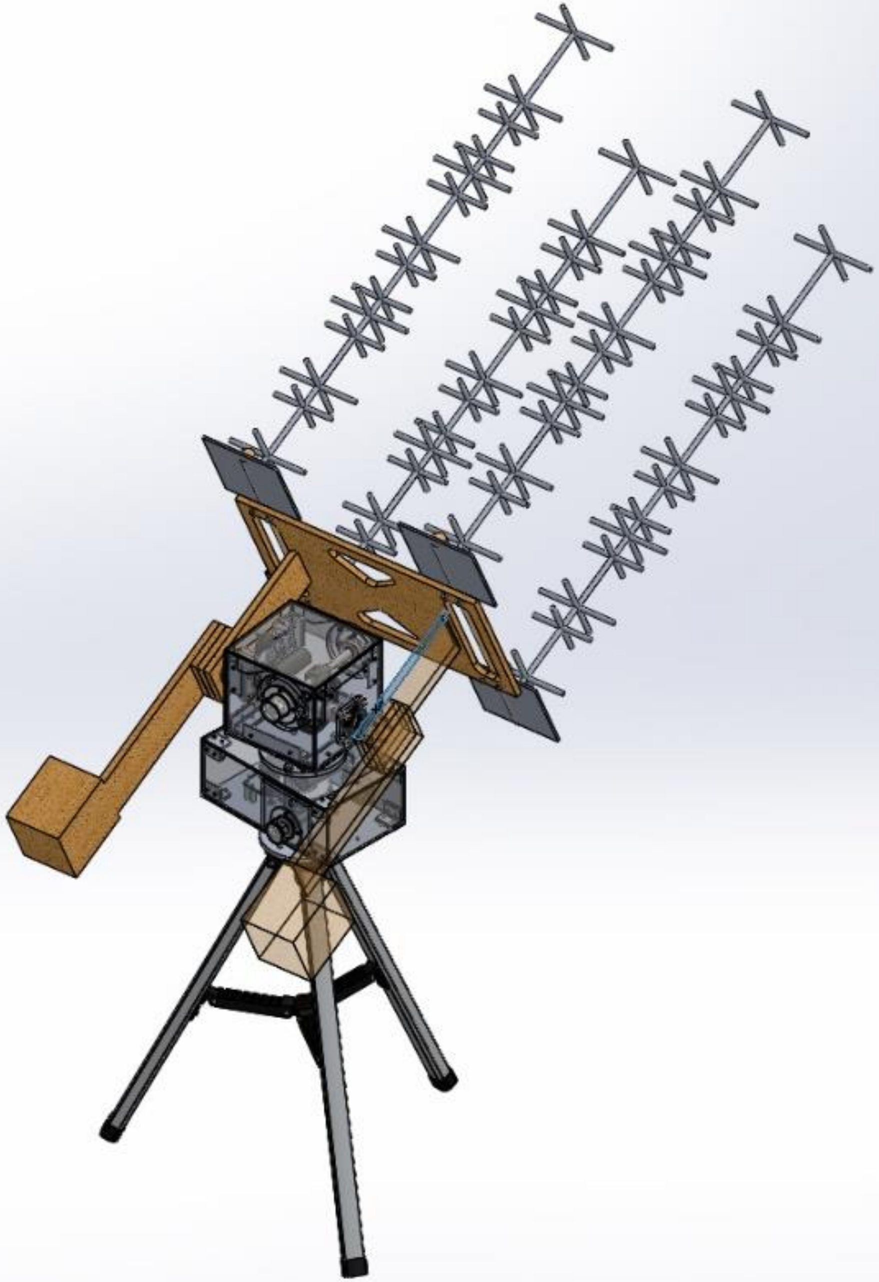


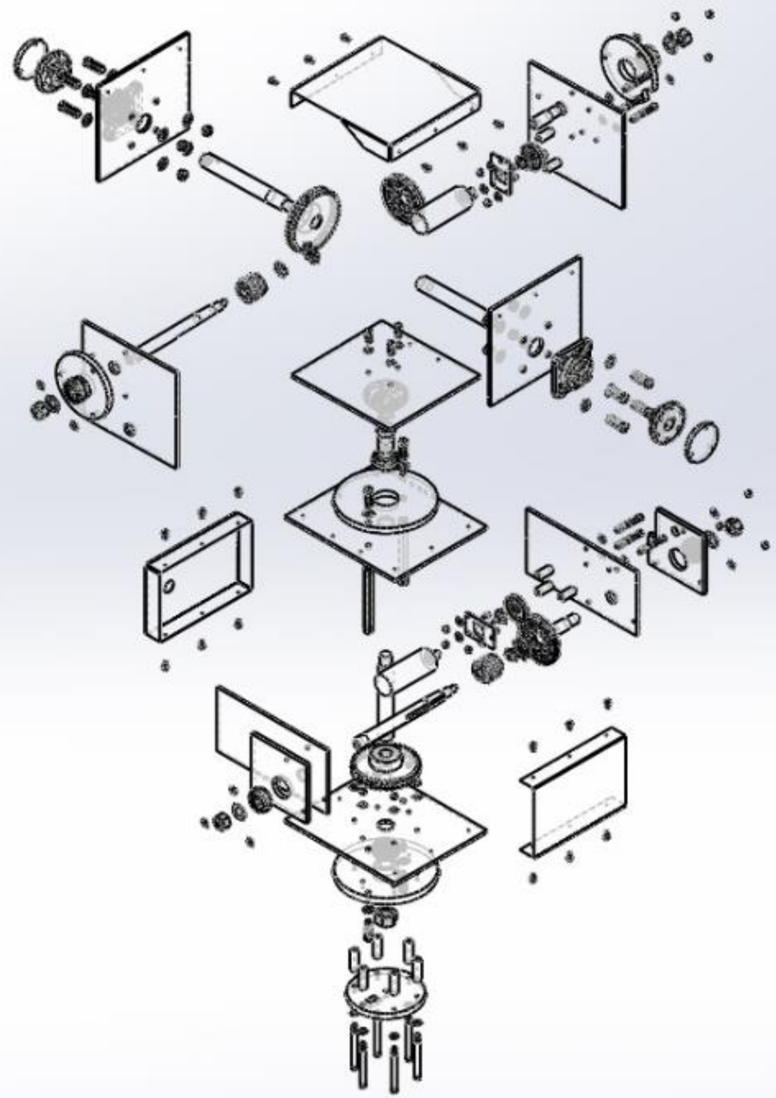
TESTING REGIME

- 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



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MOMENT OF INERTIA

- 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

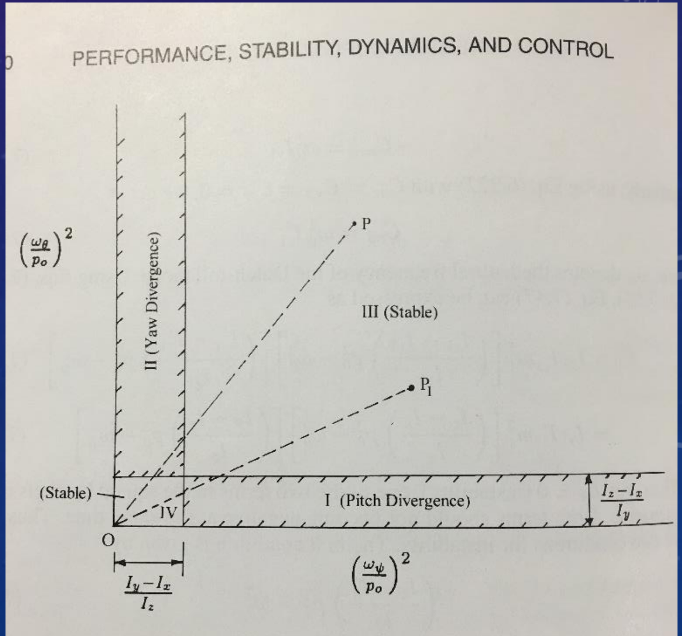
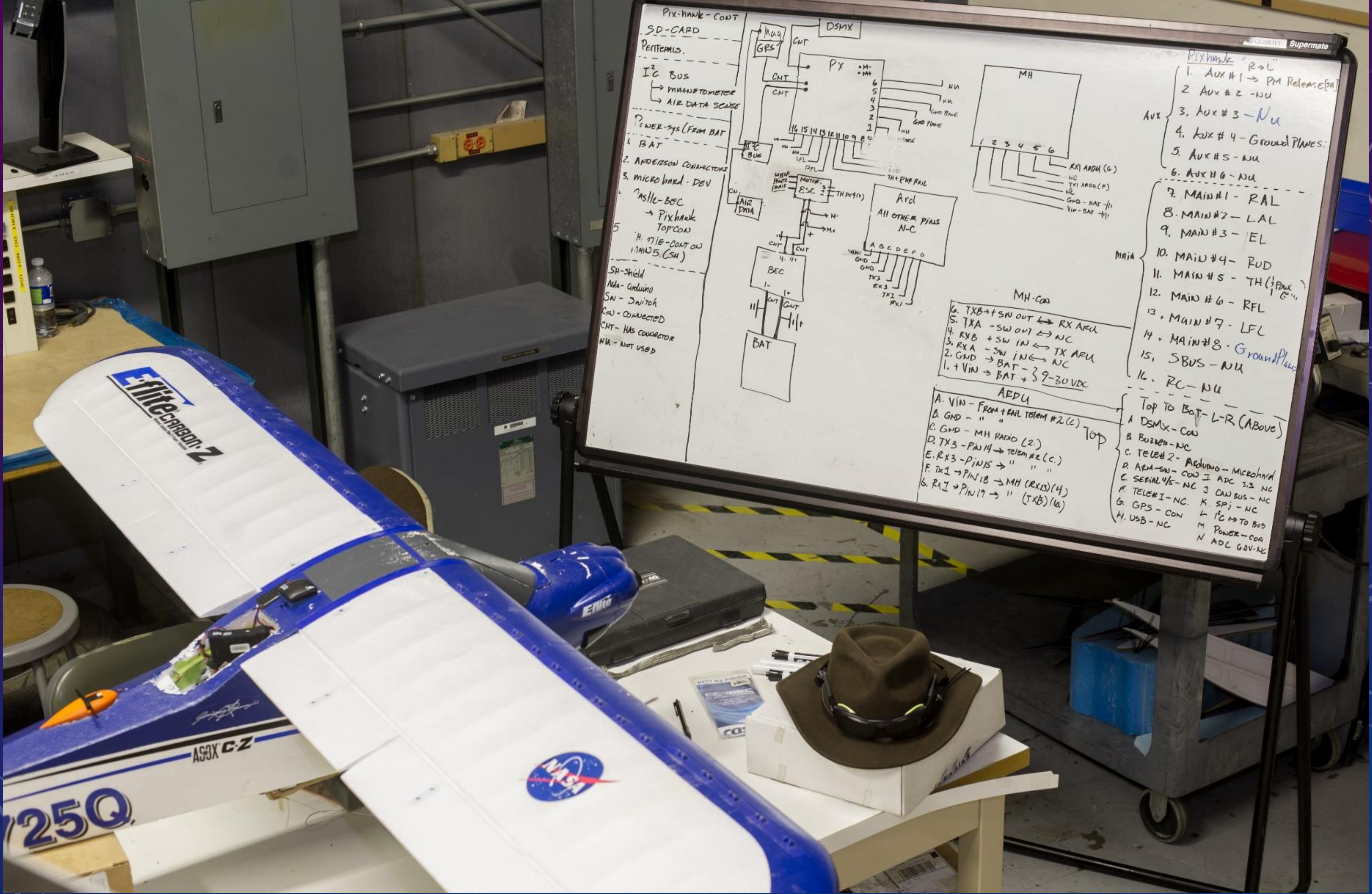


Fig. 7.2 Stability diagram.

GOALS/OBJECTIVES

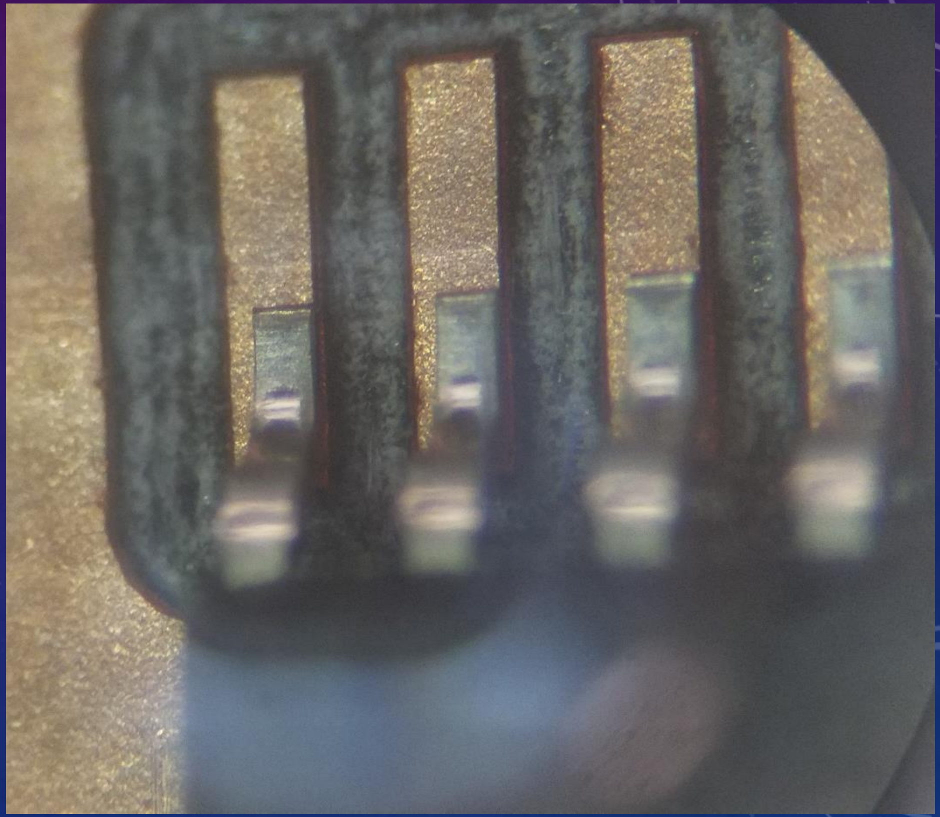
- Create and test an avionics package that can properly function for our flight testing regimes of altitudes up to 125k ft. and temperatures as low as -85° F
- Support new and innovate navigation techniques for use in gps and/or magnetometer denied environments
- Be able to support and test aircraft awareness technologies
  - ADS-B



Pix-hawk - CONT
SD-CARD
PERIFERALS
I2C Bus
MAGNETOMETER
AIR DATA SENSE
Power-sys (From BAT
1. BAT
2. ANDERSON CONNECTORS
3. micro board - DEV
Castle-BEC
→ Pixhawk Top-CON
SH-Shield
Adu - Arduino
SW - Switch
CON - CONNECTED
CNT - HAS CONNECTOR
NU - NOT USED
DSMX
MAG
GPS
PX
MH
Ard
All OTHER PINS N-C
ESC
AIR DATA
BEC
BAT
MH-CON
6. TXB → + SW OUT ↔ RX ARDU
5. TXA - SW OUT ↔ NC
4. RXB + SW IN ↔ NC
3. RXA - SW IN ↔ TX ARDU
2. GND → BAT -
1. + VIN → BAT + 9-30 VDC
ARDU
A. VIN - From + RAIL Telem #2 (C)
B. GND
C. GND - MH RADIO (2)
D. TX3 - PIN 14 → Telem #2 (C)
E. RX3 - PIN 15 →
F. TX1 → PIN 18 → MH (RXB) (4)
G. RX1 → PIN 19 → (TXB) (6)
Top
Pixhawk "R→L"
AUX
1. Aux #1 → PM Release
2. Aux #2 - NU
3. Aux #3 - NU
4. Aux #4 - Ground Planes
5. Aux #5 - NU
6. Aux #6 - NU
MAIN
7. MAIN #1 - RAL
8. MAIN #2 - LAL
9. MAIN #3 - EL
10. MAIN #4 - RUD
11. MAIN #5 - TH
12. MAIN #6 - RFL
13. MAIN #7 - LFL
14. MAIN #8 - Ground Planes
15. SBUS - NU
16. RC - NU
Top to Bot - L-R (Above)
A. DSMX - CON
B. Buzzer - NC
C. TELE#2 - Arduino - Microhard
D. ARM-SW - CON
E. SERIAL 4/5 - NC
F. TELE#1 - NC
G. GPS - CON
H. USB - NC
I. ADC 3.3 NC
J. CAN BUS - NC
K. SPI - NC
L. I2C ↔ TO BUS
M. POWER - CON
N. ADC 6.6V - NC
Supermate
E-flite CARBON-Z
NASA

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

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SPIN OFF PROJECTS

Weather Hazard Alert and Awareness Technology Radiation Radiosonde (WHAATRR) Glider

NKS NASA INNOVATION KICK START
We are all innovators

NASA

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 WHAATRR 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
Pixhawk auto pilots (2)	$ 400
900mHz uHard 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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- PRANDTL-M Team

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?