Moments of Inertia

Uninhabited Aerial Vehicle (UAV)
Dryden Remotely Operated Integrated Drone (DROID)

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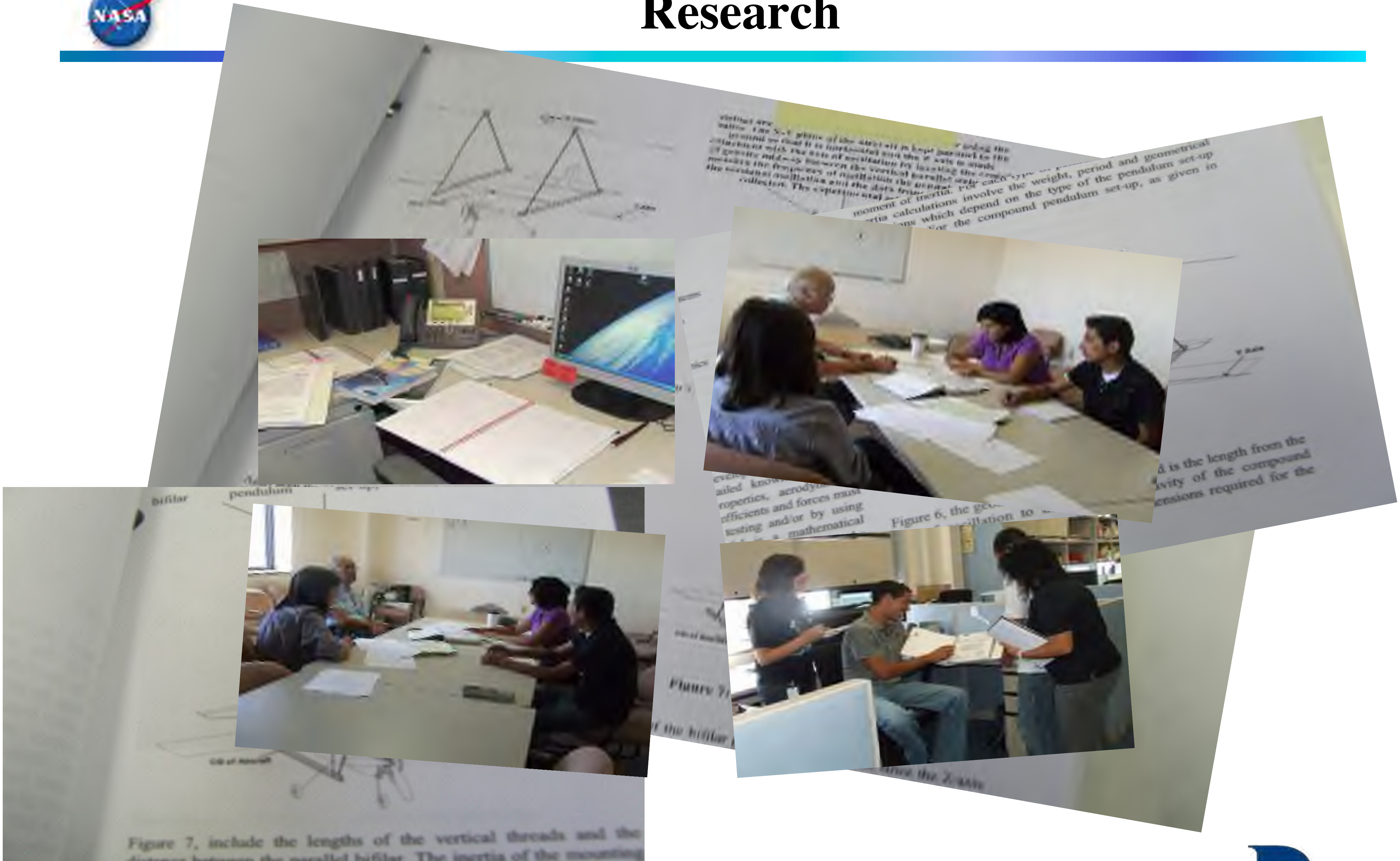
Agenda

- Personal Background
- Research
  - Importance
  - Measure, Weight, CG
  - Design Hardware and Test
  - Machining
  - Hangar
  - Safety Mitigations
  - Critical Design Review (CDR)
  - Tech Brief
  - Test
  - Analyze Data
- Lessons Learned
- Future Plans
- Questions

Research


calculations involve the weight, period and geometrical
which depend on the type of the pendulum set-up
for the compound pendulum set-up, as given in
d is the length from the
avity of the compound
ensions required for the
Figure 7, include the lengths of the vertical threads and the
distance between the parallel bifilar. The inertia of the mounting

Mass Properties

The mass properties of an object are simply the proportionality constants between applied force and the resulting acceleration:

$$f = m\ddot{x}$$

$$T = j\alpha$$

This is Newton's 2nd law for 1 Degree of Freedom (DOF) translation and rotation, respectively

When expanded to 6 DOF:

Mass

6 DOF force

CG information

Inertia Tensor

6 DOF acceleration

$$\begin{Bmatrix} F_x \\ F_y \\ F_z \\ M_x \\ M_y \\ M_z \end{Bmatrix}_P = \begin{bmatrix} m & 0 & 0 & 0 & mZ_{CG} & -mY_{CG} \\ 0 & m & 0 & -mZ_{CG} & 0 & mX_{CG} \\ 0 & 0 & m & mY_{CG} & -mX_{CG} & 0 \\ 0 & -mZ_{CG} & mY_{CG} & I_{xx} & -I_{xy} & -I_{xz} \\ mZ_{CG} & 0 & -mX_{CG} & -I_{yx} & I_{yy} & -I_{yz} \\ -mY_{CG} & mX_{CG} & 0 & -I_{zx} & -I_{zy} & I_{zz} \end{bmatrix} \begin{Bmatrix} \ddot{x} \\ \ddot{y} \\ \ddot{z} \\ \ddot{\theta}_x \\ \ddot{\theta}_y \\ \ddot{\theta}_z \end{Bmatrix}_P$$

Importance

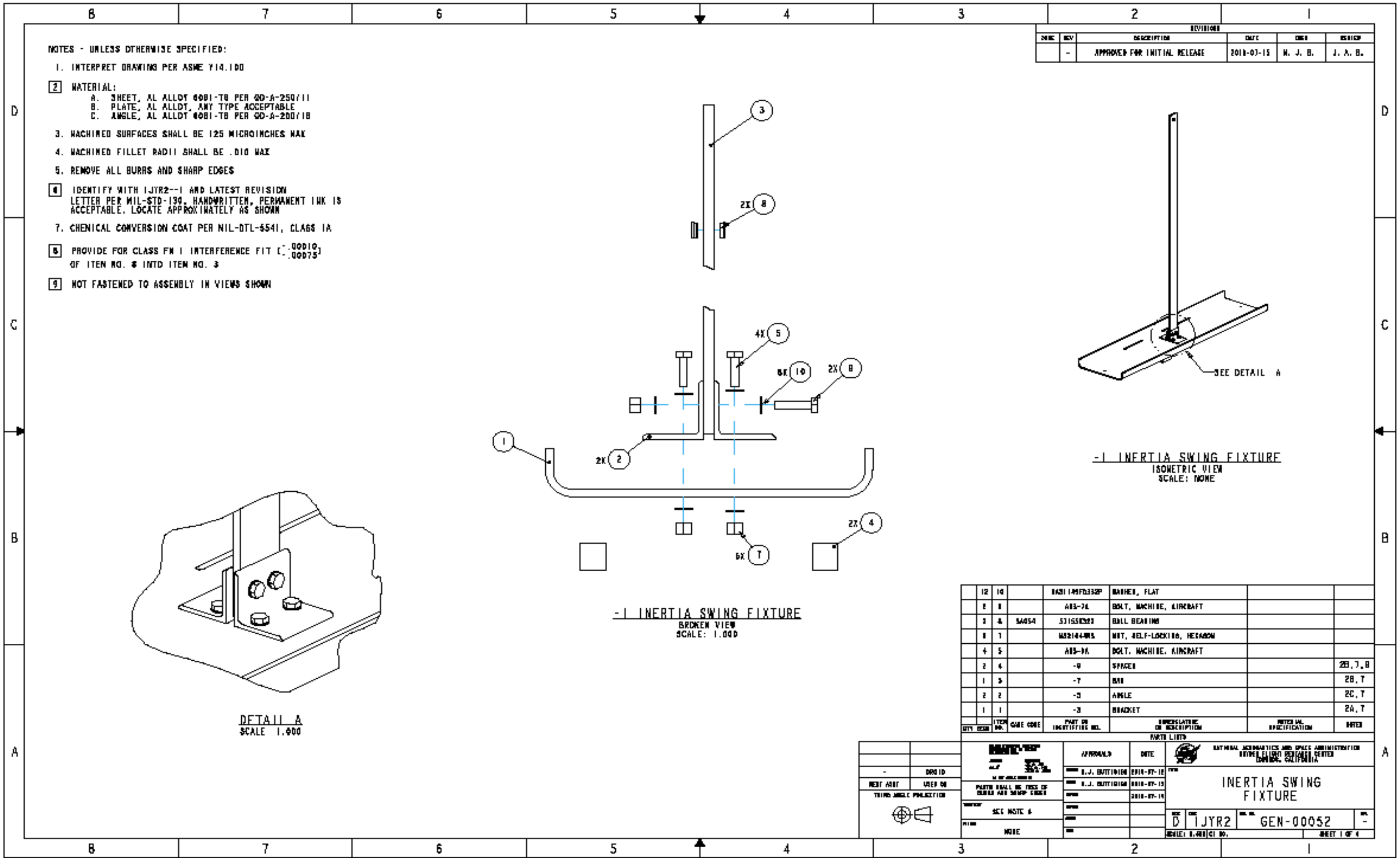
The inertial characteristics have direct !
consequences on:!

Aerodynamics !
! ! ! Propulsion!
! ! ! Structures!
! ! ! Control!

Measure and Weight

Design

Manufacturing



Shuttle Hangar

Safety

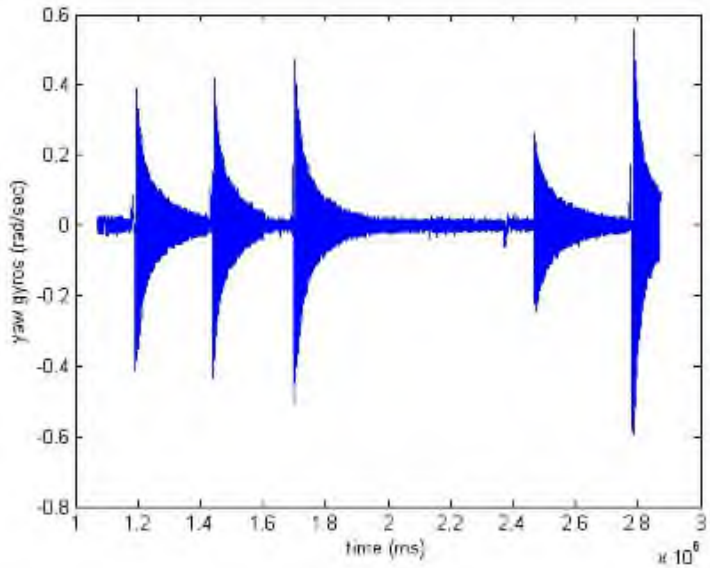
- Human Hazard Analysis
- Loss of Asset/Mission Hazard Analysis

Approvals

- Critical Design Review (CDR)
- Tech Brief


DROID 3

Data Analysis



- Time Constraints
- Basic Geometric Shapes
- MATLAB
- Error

Lessons Learned

- Dryden vs. Disneyland
- Learning
- Team Effort
- Double check all work
- Stress Testing
- Use steel instead of aluminum

Future Plans

- GSRP at NASA Headquarters
- Graduate
- Work for NASA

Questions?

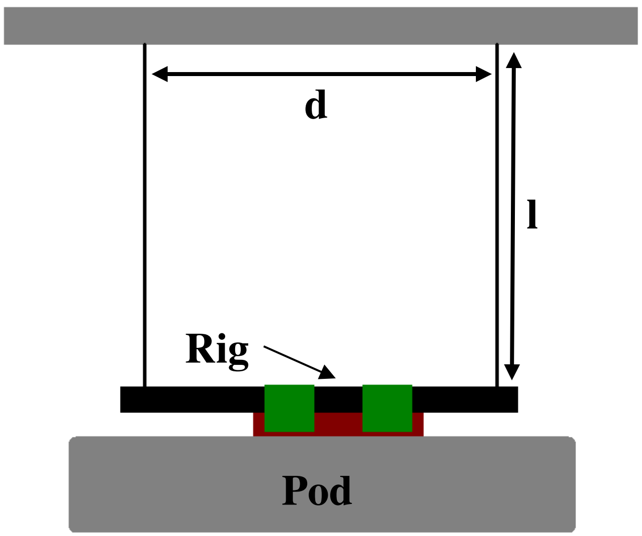
All photos provided by: NASA photographer, Thomas P. Tschida and INSPIRE Team!

BACK-UP: Inertia Calculations

$$I_{Pod} = \left(\frac{g}{16\pi^2}\right)\left(\frac{d^2}{l}\right)T^2\left(W_{Pod} + W_{Rig}\right) - I_{Rig}$$

Where,

- I = Yaw Mass Moment of Inertia, [lb-in^2]
- g = gravity, [in/sec^2]
- d = Distance Between Cables, [in]
- l = Cable Length, [in]
- T = Period of Oscillation, [sec]
- W = Weight, [lb]



Reference:
NACA TN No.351