

# VU NGUYEN

*AN ENGINEER'S EDUCATION AND ITS USE IN AEROSPACE*



# Education

- Absegami High School – Galloway, NJ
  - Honors Algebra 2, Honors Geometry, Honors College Math (Pre-Calc), AP Calculus I, AP Calculus II
  - Honors Chemistry I & II, AP Physics
  - Honors/AP English
  - AP US History 1 & 2, AP European History
- Rutgers University, College of Engineering – Piscataway, NJ
  - Electrical Engineering Major, 2004
    - Multivariable Calculus, Differential Equations, Linear Algebra
    - Chemistry, Physics (Newtonian, Electricity & Magnetism, Quantum/Relativistic), Statics, Assorted EE Courses
    - English

# Work Experience

- **Robert Wood Johnson Medical School/University Hospital, New Brunswick, NJ**
  - Electron Microscopist (2003-2006)
- **Gulfstream Aerospace Corporation – Savannah, GA**
  - Mass Properties Engineer (2006 – 2014)
  - Flight Test Engineer (2014 – Present)

# Gulfstream Aerospace

A Gulfstream G550 aircraft is shown in flight, viewed from a low angle, flying over a canyon with red rock formations and a river. The aircraft is white with blue accents and the number '5500' is visible on the tail. The background is a scenic landscape with a river and red rock cliffs under a blue sky.

- #1 Manufacturer of Purpose-Built Business Aircraft
- Fastest civilian aircraft in the world
- Quietest interior noise levels in the world
- Longest range of any purpose-built business aircraft
- Most advanced flight deck technology
- 2004 recipient of Collier Trophy for G550
- 2014 recipient of Collier Trophy for G650



# Engineering Airplanes

- Preliminary Design
- Initial Phase Engineering
- Final Phase Engineering
- Production Engineering
- Flight Test Engineering
- Service Engineering
- Sustaining Engineering
- Sales Engineering



# Initial Phase Engineering

- Flight Sciences
  - Applied Aero, Performance, Flight Dynamics
- Human Factors
- Structures/Powerplant (Acoustics/Vibration/Thermo) /ECS/Electrical/Mechanical Systems, Flight Controls
- Stress
  - Structural Analysis, Fatigue & Damage Tolerance, Methods
- Materials & Processes
  - Metallics, Composites, Coatings/Sealants
- Manufacturing
- Loads & Dynamics
- Mass Properties

# Mass Properties Engineering

- Aircraft weight & balance
  - Component/section weights & CGs
  - Moments/products of inertia
- Predict, track, and influence weight-efficient design
- Calculate aircraft buoyancy
- Aircraft tip-back protection
- Weighing aircraft

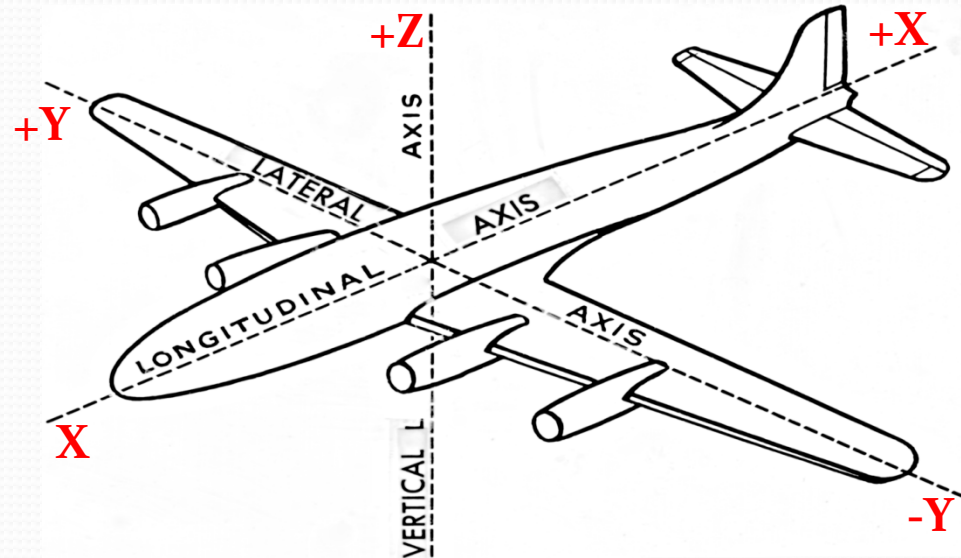


# Weighing Components



# Weighing An Airplane

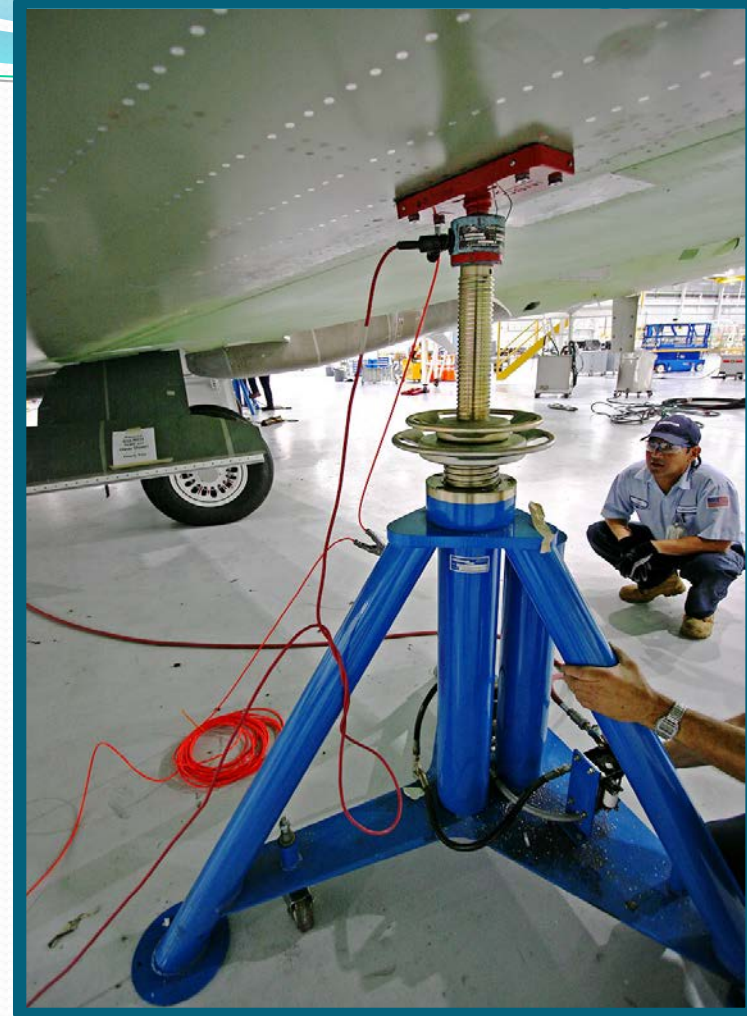
- Requirement
    - Measure weight of aircraft
    - Determine longitudinal (X-axis) center of gravity in relation to aircraft axes
- FS297.4, BL-37.9, WL28.0
- X = Fuselage Station (FS)
  - Y = Buttock Line (BL)
  - Z = Water Line (WL)
- Givens/Measurables
    - Contact points
    - Forces at those points



# Jacktop Weighing

- Aircraft is jacked at three hard points
- Each hard point has known coordinates (X,Y,Z)
- Aircraft is leveled ( $0^\circ$  pitch,  $0^\circ$  roll)

- $W = W_N + W_L + W_R$
- $CG = \frac{X_N W_N + X_L W_L + X_R W_R}{W_N + W_L + W_R}$



# Jacktop Weighing (cont'd)

- Pros

- Accurate
- Repeatable
- Ergonomically safe
- Lower initial investment

- Cons

- Takes time to level the aircraft
- Not recommended to jack the aircraft with tanks full of fuel
- Incorrect jacking technique can cause aircraft to fall off jacks



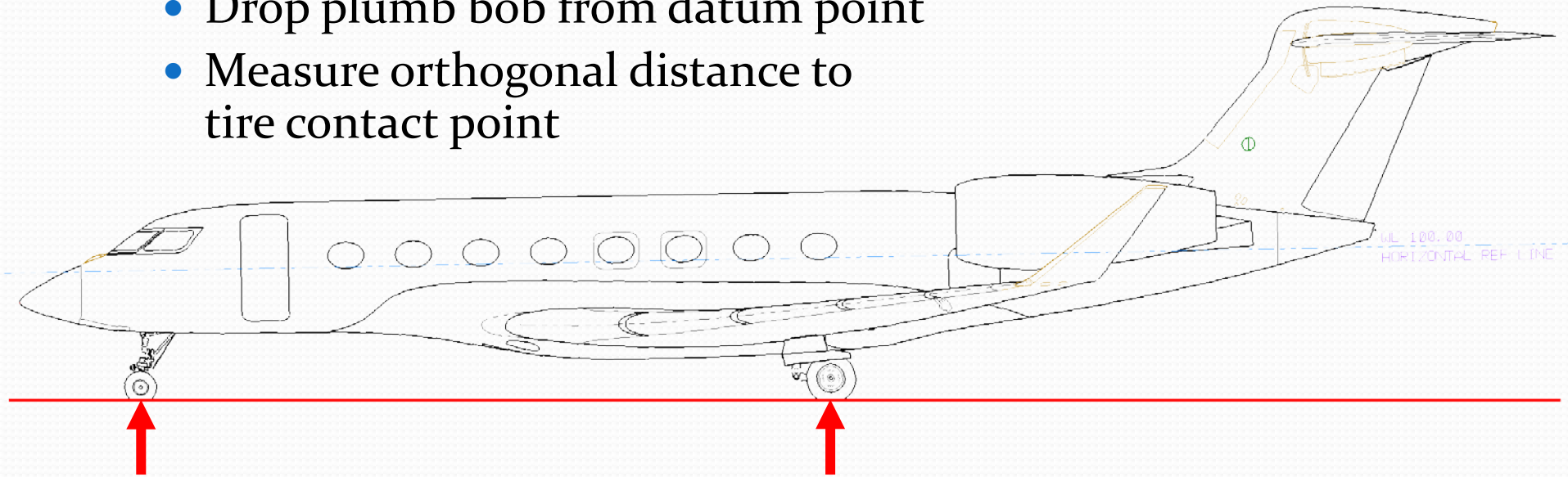
# Platform Weighing

- Measure
  - Contact points
  - Forces at those points
  - Aircraft pitch
- Contact Points
  - Measure directly using tape measure/measuring wheel
  - Derive from other (more convenient) measurements



# Determining Contact Point

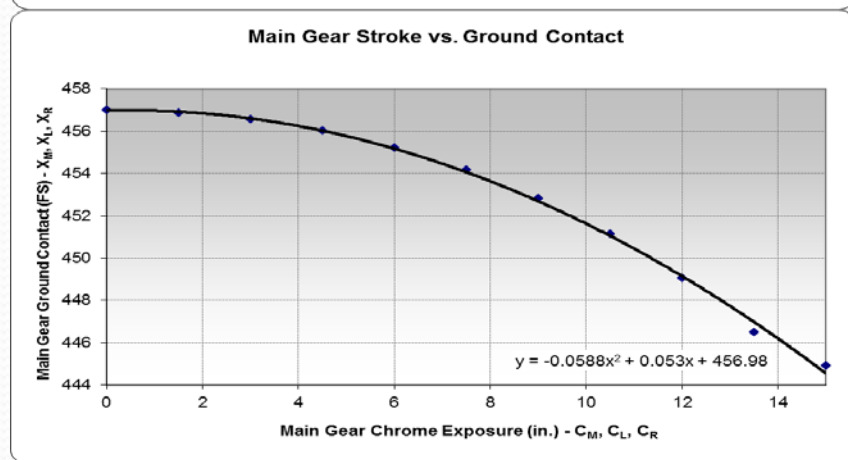
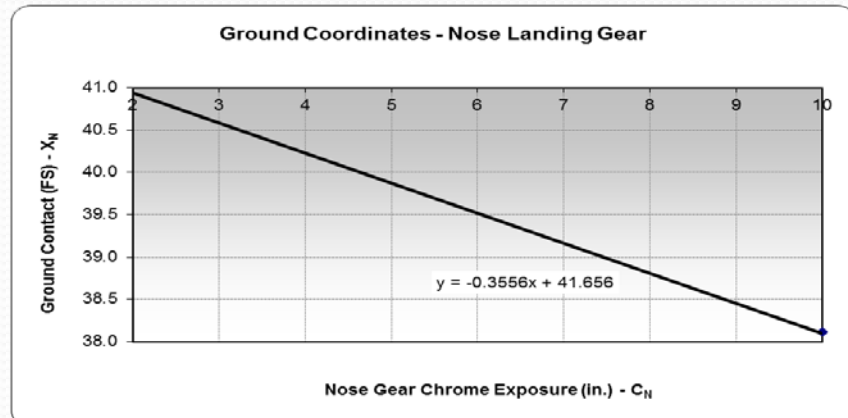
- Measure directly
  - Drop plumb bob from datum point
  - Measure orthogonal distance to tire contact point



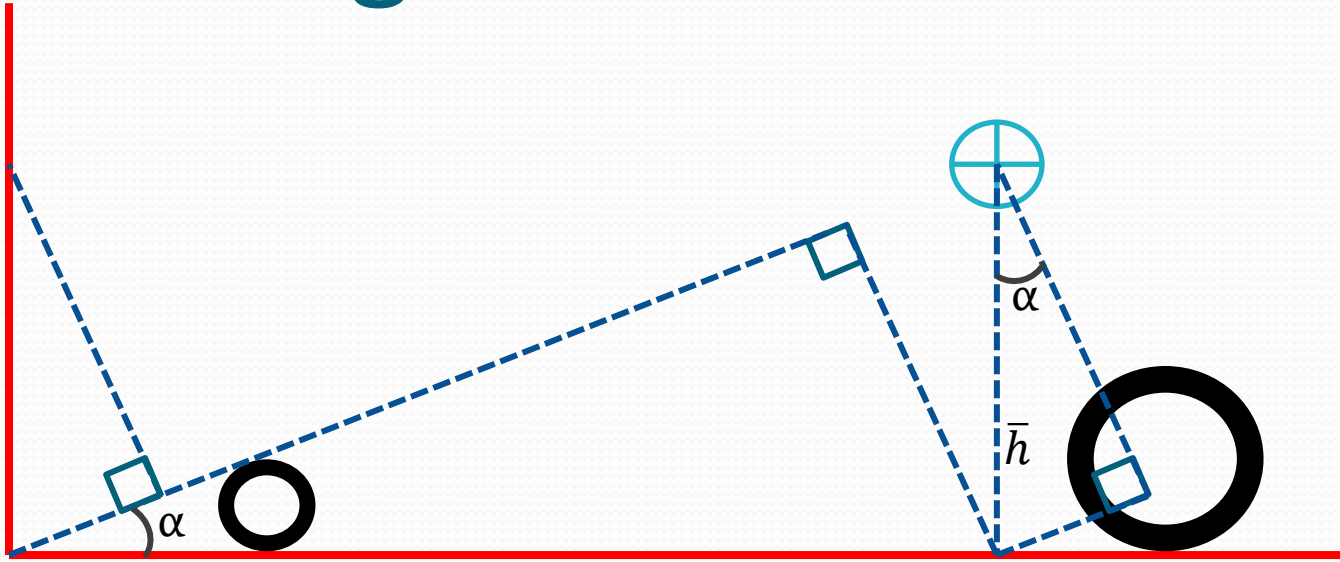
- Derive from secondary measurement

# Determining Contact Point (cont'd)

- Measure landing gear extension
- Landing gear kinematics described by polynomials
- Tire contact point can be calculated



# Calculating CG



- $Z_{LG} = (W_L + W_R) \times (4.2 \times 10^{-4}) - 14.287$
- $\bar{h} \cong (Z_{CG} - Z_{LG}) \cos \alpha$
- $x_{CG} = \frac{X_N W_N + X_L W_L + X_R W_R}{W_N + W_L + W_R} - \bar{h} \tan \alpha$

# What About Error?

- Compare:
- Jacktop Weighing
  - (3) Scales
  - 0.1% Accuracy
  - Level aircraft
- Platform Weighing
  - (5) Scales
  - 0.1% Accuracy
  - Aircraft in nominal attitude

# What Skills Do We Use

- Collaboration
- Mathematics
  - Algebra
  - Linear Algebra
  - Trigonometry
- Software (Excel, Matlab, CATIA V5, Word)
- Programming
- Basic physical sciences (Chemistry, Physics)
- Writing

**BASICS ARE ESSENTIAL**

# Realities of the Real World

- Training/Mentorship may not be good
  - Up to you to learn and teach yourself
- Being a “specialist” does not mean existing in a bubble
  - The best engineers make an effort to learn (and cooperate) across disciplines
  - Majoring in one field should not discount one from learning about other fields
- Many engineering firms require a bachelor’s degree in an engineering field

Questions?

