Luncheon Keynote Address #1: An Engineer's Education and It's Use in Aerospace

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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

- **Gulfstream Aerospace Corporation** – Savannah, GA
  - Flight Test Engineer (2014 – Present)
Gulfstream Aerospace

- #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
    - $X = \text{Fuselage Station (FS)}$
    - $Y = \text{Buttock Line (BL)}$
    - $Z = \text{Water Line (WL)}$

- **Givens/Measurables**
  - Contact points
  - Forces at those points

FS297.4, BL-37.9, WL28.0
Jacktop Weighing

- Aircraft is jacked at three hard points
- Each hard point has known coordinates (X,Y,Z)
- Aircraft is leveled (0° pitch, 0° 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

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